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Processing Compound Verbs in Persian

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List of Abbreviations

Acc = Accusative

Adj = Adjective

Adv = Adverb

ANOVA = Analysis of variance

APPLE = Automatic progressive parsing and lexical excitation

CL = Clitic

D = Determiner

DP = Determiner Phrase

DUR = Duration

EZ = Ezafe, which refers to the of-phrase in Persian. Ezafe is the short vowel /e/ that is added after the noun and before a possessive pronoun, a noun or an adjective.

IND= Indefinite

INF = Infinitive

M = Marker

MEG = Magnetoencephalography

NEG = Negative

NI = Noun Incorporation

NP = Noun Phrase

OM = Object Marker, which is a word, *ra*, that follows definite direct objects in Persian

PET = Positron Emission Tomography

PL = Plural

POSS = Possessive

PP = Past participle

SG = Singular

SOA = Simultaneous Onset Asynchrony

SUB = Subjunctive

VP = Verb Phrase

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Abstract

This study investigates how Persian compound verbs are processed in the mental lexicon, through which we can infer how they are stored, organized, and accessed. The study focuses on investigating Persian compound verbs in light of psycholinguistic theories on polymorphemic word processing as well as linguistic theories of complex predicates.

The psycholinguistic section details three experiments addressing the following three research questions: (1) whether compound verb constituents show significant priming in the masked-priming paradigm; (2) whether priming effects are constrained by semantic transparency; and (3) whether priming effects are due to morphological relatedness.

This study revealed several findings: (1) compound verbs in Persian are decomposed into their constituents at early stages of processing, (2) at early stages of processing, decomposition is based on purely orthographic similarity, (3) although both transparent and opaque compound constituents were facilitated while processing, transparency had an impact on processing in the early stages of processing.

Finally, the findings seem to support a parallel input effect or competing alternative effect for the verbal constituent of the transparent compound verb, as reflected in the slower facilitation for the verbal constituent compared to the nominal constituent.

In theoretical studies on Persian complex predicates, the compound verb formation can be either lexical or syntactic. The overall evidence reflected in the linguistic data for Persian complex predicates presented in this dissertation as well as the results of the experimental studies carried out in this research seem to point towards lexical compounding in Persian compound verb formation. The evidence comes from (1) the nominalization of the compound, i.e. the possibility of using the compound verb as a noun; (2) the atelicity

feature, i.e. the possibility of using the compound verb after the progressive expression *dar haale* ‘in the process of’, which indicates an incomplete action; and (3) the nonreferentiality of the nominal constituent in the compound verb, i.e. the nominal constituent cannot be followed by a pronoun that refers to it.

On the other hand, the results of the experimental studies reported in this dissertation seem to support a lexical approach to compound verbs in Persian. The technique used in these experimental studies was masked priming paradigm, which investigates the prelexical and lexical processing. The results, as discussed in Chapter 3, reveal constituent priming effects under masked priming technique. This indicates that Persian compound verb constituents are accessed at the prelexical stage of processing. Syntactic calculations are said to be done at later stages of processing. Therefore, the early processing of compound verb constituents leads us to the argument for the lexicality of Persian compound verbs.

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CHAPTER 1

INTRODUCTION

The issue of how words are stored and organized as well as how they are accessed and processed has been at the core of studies on the structure of the mental lexicon. Complex words have been the target of experimental research on word processing for the past 30-40 years. Studying polymorphemic words can contribute to a better understanding of the structure of the mental lexicon. There have been numerous studies on how morphologically complex and compound words are stored and accessed in different languages (Longtin et al., 2003 for French; Rastle et al., 2004 for English; Kazanina et al., 2008 for Russian, among others). However, very little has been done on less studied languages like Persian. The goal of the present study is to shed some light on the nature of the mental lexicon, and more specifically, on how compound verbs are represented and accessed. The study aims to assess the current theories of compound word processing in a less studied language (i.e., Persian) with a very productive compounding system.

This chapter is organized as follows. In the Section 1.1., the mental lexicon will be defined followed by a description of the models and theories on lexical processing. In Section 1.2., the goal of the study will be explained, followed by the thesis outline in Section 1.3..

1. 1. The Mental Lexicon

The mental lexicon encompasses ‘words,’ which are used by the speakers of a language to represent the mappings between phonological forms that are used to refer to objects in the world and their corresponding meanings. Research on the mental lexicon has mainly concentrated on lexical processing and lexical representation.

To this end, scholars who have tried to provide a definition of the mental lexicon have found it quite challenging, since the boundaries of the subject as well as its contents are rather vague. Jarema and Libben (2007:2) have defined the mental lexicon as, “the cognitive system that constitutes the capacity for conscious and unconscious lexical activity”.

The mental lexicon has been studied and explained through studies on the structure of the lexicon and on the lexical processing and representation for several decades. Studies on the structure of the lexicon have attracted theoretical linguists, while studies on lexical processing and representation have enticed psycholinguists.

Models of the lexicon in theoretical linguistics can be considered as being on a continuum. At one end are theories that consider the lexicon quite rich (Lexicalist Theories) and at the other end are theories that consider the lexicon quite poor (e.g., Distributed Morphology). Lexicalist Theories hold that the lexicon encompass words, roots, affixes and word formation rules, as well as more detailed information, such as information about the argument structures of various verbs. It has been argued that, in Lexicalist Theories, where the argument structures of verbs are linked via universal principles to particular syntactic positions, the argument structure alternations are

accomplished through a separate generative process that occurs within the lexicon and prior to projection (Levin and Rappaport, 1995). Distributed Morphology, on the other hand, holds that the mental lexicon only includes atomic roots, such as sound-meaning pairings (Marantz, 1997). Between these two ends and yet closer to the Lexicalist end are theories such as other Generative theories, which are not as radical as the strong lexicalist theories and which posit a robust computational model where both the new forms and new meanings are derived through computations using morphological rules.

It must be mentioned that there are two versions of lexicalist theories, mainly strong and weak. Strong lexicalist theories consider the lexicon quite rich and holds that syntactic transformations cannot be used in either derivational or inflectional morphology. In these theories, the mental lexicon is so rich as it includes words, roots, affixes, word-formation rules, and subcategorization frame (information about the verb arguments).

On the other hand, weak lexicalist theories (such as Distributed Morphology) consider the lexicon quite poor and hold that syntactic transformations cannot be used in derivational morphology. In these theories, the mental lexicon only includes atomic roots, such as sound-meaning pairings.

Psycholinguists have long been interested in the processing of complex words since through the study of polymorphemic words, they can understand the structure of the mental lexicon while at the same time discovering how words are stored and accessed from the mental lexicon. Models of the lexicon in psycholinguistics have yielded different theories of complex word processing, ranging from the decompositional to the non-decompositional theories.

Taft and Forster (1975) initially put forth the idea of the decompositionality of polymorphemic words when being processed. They proposed that morphologically complex words are accessed via their constituent morphemes, for example (teach – teach + er). This view was later challenged by Butterworth's (1983) non-decompositional full-listing approach to morphologically complex word processing, which held that polymorphemic words are stored and processed as whole words. Between the two extreme decompositional and non-decompositional approaches to morphologically complex word processing, we find mediating dual access theories that support morphological decomposition for some polymorphemic words, but non-decompositional status for others (Stanners et al., 1979; Baayen, 1992; Schreuder and Baayen, 1995; Baayen et al., 1997; among others). According to dual access theories, both decompositional and non-decompositional representations may exist simultaneously when processing complex words, while different factors, such as semantic transparency, cumulative frequency, productivity of the affix, and surface frequency would determine which lexical representation should be activated.

Experimental research has provided the field with valuable insights into how a word and its relevant information, such as its root, affixes and word formation rules, are stored in and accessed from the mind. These experiments have examined the effects of morphological relatedness (writer-write), semantic relatedness (doctor-nurse), syntactic relatedness (easily-surely), and orthographic or phonological relatedness (tape-ape) or a combination of these effects on the processing of polymorphemic words. Many studies have supported a decompositional approach to polymorphemic word processing (Longtin et al., 2003 for French; Rastle et al., 2004 for English; Fiorentino & Poeppel, 2007 for

English; Kazanina et al., 2008 for Russian; among others). On the other hand, the non-decompositional approach has been claimed for some kinds of polymorphemic words, including words that are formed by morphological processes such as regular past-tense formation (Baayen et al., 1997; Sereno & Jongman, 1997; among others.).

Most models of complex word processing consider abstract representations and algebraic rules to combine those representations for complex words, such as the models described above. However, there are some other models of lexical processing that challenge a computational theory of mind (e.g., Sidenberge and Gonnerman, 2000; Hay and Baayen, 2005; among others). For example, distributional-connectionist model of lexical processing considers morphology to be a graded, inter-level representation that reflects orthographic, phonological and semantic relationships. Another model that emphasizes on the orthographic, phonological or semantic representation is the Symbolic dual-route model (Coltheart et al., 1993; Coltheart et al., 2001).

The next section will discuss the goals of the present study, followed by the research questions, the results and the findings.

1. 2. Goals of the present study

The present study investigates the processing of polymorphemic words through examining compound verbs in Persian, which is a less studied language. It investigates the role of semantic transparency as well as morphological structure during lexical retrieval of noun-verb compound verbs. Semantic transparency refers to the compositionality of the compound, which differentiates between transparent (*qazaa-xordan* ‘food-to eat’ - *QAZAA* ‘food’ to eat), and opaque (e.g., *qasam-xordan* ‘oath-to eat’ - *QASAM* ‘oath’ to swear - oath)

compound. Morphological relatedness is broader and encompasses both semantically transparent and semantically opaque compounds. Morphological relatedness can differentiate between morphologically related prime-target pairs (*qazaa-xordan* ‘food-to eat’ - *QAZAA* ‘food’ to eat or *qasam-xordan* ‘oath-to eat’ - *QASAM* ‘oath’ to swear - oath) and orthographically related prime-target pairs (e.g., *shenaaxtan* ‘to recognize’ - *SHENAA* ‘swimming’).

Studies on morphologically complex, such as *teach-er* (Longtin et al., 2003; Kazanina et al, 2008; among others) and compound nouns, such as *quarter-back* (Fiorentino, 2006; among others) abound while studies on morphologically complex verbs are not as many (e.g., Smolka et al, 2009; Smolka et al., 2010 for German; Feldman et al., 2002 for Serbian; among others). In addition, there is a glaring lack of studies on processing compound verbs perhaps because such structures are not common in many languages. In Persian however, compounding is a common verb formation process, which is even applied to produce novel verbs with loan nonverbal elements and Persian base verbs.

Persian compound verbs are a combination of two constituents: the nonverbal and the verbal, respectively. The nonverbal part can be a noun (*gerye kardan* ‘tear-to do’ ‘noun-verb’ to cry), an adjective (*daagh kardan* ‘hot-to do’ ‘adjective-verb’ to get mad), a prepositional phrase (*az bar kardan* ‘of-on-to do’ ‘prep-prep-verb’ to memorize), an adverbial phrase (*pish bordan* ‘forward-to take’ ‘prep-verb’ to succeed), or a complex nominal phrase (*sar-be-sar-gozaashtan* ‘head-to-head-to put’ to tease). The specific compound verbs that are examined in the present study are noun-verb compound verbs.

There are two main approaches to compound verb formation in Persian, mainly the syntactic and the lexical approaches. The syntactic approach to Persian compound verb formation entails that the syntactic category of a lexical element is determined only by the syntactic context in which it appears.

On the other hand, the lexical approach to Persian compound verb formation entails that the syntactic category of a word is lexically specified. There are two versions to the lexical approach to Persian compound verb formation: strong version, which holds that mental lexicon encompasses words, roots, affixes, word-formation rules, and subcategorization frame (information about the arguments), and weak version, which holds that mental lexicon includes only atomic roots (such as sound-meaning pairings).

Persian compound verbs are said to be formed by combination and incorporation, the two lexical processes involved in compound verb formation in Persian (Dabir-Moghaddam, 1997). It must be mentioned that both combination and incorporation refer to the compound verb formation, which results in a non-compositional compound in the first one (i.e., combination, e.g., *qasam-xordan* ‘oath-to eat’ to swear), but a compositional compound in the latter (i.e., incorporation, e.g., *qazaa-xordan* ‘food-to eat’ to eat).

In fact, Persian is an interesting language for investigating lexical representations since it belongs to the same language family as English, French and German and thus possesses the concatenative morphology of Indo-European languages. Yet, it is different from many Indo-European languages in its morphological richness and productivity as demonstrated by the productivity of Persian compound verbs in this dissertation. The present study will enable us to compare data with experimental studies on the processing of complex and compound words in other concatenative languages. In fact, due to

morphologically richness of Persian, we anticipate that the results of the current study will be similar to the data derived from other priming experiments in morphologically rich languages like German (Smolka et al., 2010; among others) but less similar to those derived from priming experiments in morphologically less rich languages such as English or French (Longtin et al., 2003; Fiorentino, 2006; among others).

The research questions addressed in the present study is twofold: first, whether or not compound verb constituents show significant priming in the masked-priming paradigm; and second, whether or not priming effects are constrained by semantic transparency and morphological relatedness. To answer these questions, three masked-priming experiments were carried out to investigate the processing of compound verbs in Persian. Experiments 1, 2a and 2b all investigated the effect of semantic and morphological relatedness on priming. However, the conditions in each experiment were different. In Experiment 1, the priming effect of transparent and opaque compounds on their nominal and verbal constituents was investigated. In Experiment 2a, the priming effect of transparent and opaque compounds as well as pseudo-compounds on their nominal constituents or pseudo-constituents was examined. Finally, in Experiment 2b, the priming effect of transparent and opaque compounds as well as pseudo-compounds on their verbal constituents or pseudo-constituents was investigated.

The next section will describe the thesis outline.

1. 3. Thesis outline

Chapter 2 discusses previous experimental research on complex and compound word processing. It outlines theories of polymorphemic word processing and its repercussions on

the theories of word processing. This is followed by relevant studies on aphasic patients which have focused on the processing of complex words. The effects of different linguistic and nonlinguistic factors on the processing of polymorphemic words will be analyzed further. Some of these factors include prime duration and frequency effects.

Chapter 3 reports the findings of the three experiments, which examined how Persian compound verbs are represented and accessed while processing. The first study includes one masked-priming experiment, while the second encompasses two masked-priming experiments; one of which concentrated on the priming effect of the first constituent, the nominal constituent or the non-head, and the other concentrated on the priming effect of the second constituent, the verbal constituent or the head.

The first study did not separate the nominal and the verbal constituents into two experiments, but rather encompassed all the conditions in one single experiment. Although the transparent and the opaque conditions were analyzed separately, it was difficult to form a definitive conclusion since all conditions were included in one single experiment. Therefore, in our second study, we tried to organize the experiments in such a way that we can distinguish the priming effects in the verbal and the nominal constituents more clearly. The experiments investigated the role of semantic transparency as well as morphological structure in on-line visual recognition of Persian noun-verb compound verbs using a constituent priming paradigm in native speakers of Persian.

Chapter 4 discusses the theoretical background of compound verbs in Persian. This includes the syntactic and semantic accounts of noun-verb compound verbs and is followed by a discussion of noun incorporation. The results of the present study will help

to clarify the controversy existing in the field about whether the nominal element is incorporated into the verb or is simply an internal argument of the verb.

Chapter 5 discusses the results in light of the existing literature and presents the implications of the results for the psycholinguistic and linguistic fields.

Chapter 6 summarizes the findings of the thesis and concludes with suggestions for further research.

Finally, Appendix A includes a description of the lexical decision task as well as an overview of the masked priming paradigm. Appendix B lists the stimuli for Experiment 1, and Appendix C lists the stimuli used in Experiment 2.

CHAPTER 2

COMPLEX AND COMPOUND WORD PROCESSING

The issue of how words are stored and organized as well as how they are accessed and processed has been at the core of studies on the mental lexicon. Among different kinds of words, morphologically complex and compound words have attracted the attention of many scholars doing research on different languages (e.g., Longtin et al., 2003 for French; Rastle et al., 2004 for English; Kazanina et al., 2008 for Russian; among others). Through studying complex and compound words, we can learn about the structure of the mental lexicon in general and how such words are stored (whether as whole-words or their constituting elements or both). We learn also about how they are accessed and which route (whole-word or decompositional) has been taken to arrive at this. On the basis of these questions, different hypotheses have been formulated for complex and compound word processing, which will be discussed in the following section. Therefore, this chapter is organized as follows. In Section 2.1, there will be a discussion on the prevailing hypotheses of complex and compound word processing. Then the processing of morphologically complex nouns will be discussed in Section 2.2. Within this section, we will first discuss the effect of Stimulus Onset Asynchrony (SOA) on polymorphemic word processing. Then we will narrow down the discussion to compound noun processing. In

Section 2.3, the processing of morphologically complex verbs will be discussed. Then, in Section 2.4, we will review related studies on the processing of complex and compound words by patients with aphasia since investigating the studies on the morpheme retrieval in complex words by aphasic patients will provide further evidence as to how constituents in a morphologically complex word are retrieved. We will then compare noun and verb processing in aphasic patients, and discuss noun/verb prominence in aphasic patients. We will end this section by reviewing studies on aphasic patients in Persian. We will end this chapter by Section 2.5, where we will discuss the effect of linguistic factors, such as linearity, as well as nonlinguistic factors, such as priming technique and frequency on the processing of morphologically complex words.

2. 1. Hypotheses of complex and compound word processing

Studies on morphologically complex and compound word processing have mostly taken either a decompositional approach (where complex and compound words are broken down into their constituents while processing) or a non-decompositional approach (where complex and compound words are processed as a whole). Taft and Forster (1975) initiated the idea of decompositionality of complex and compound word processing. They proposed that polymorphemic words are accessed via their constituents (teacup → tea + cup). The decompositional hypothesis was later challenged by Butterworth's (1983) non-decompositional full-list hypothesis of polymorphemic word processing. In this approach, complex and compound words are believed to be stored and processed as whole-words. Between the two extreme decompositional and non-decompositional approaches to complex and compound word processing, there are mediating dual access theories that

support morphological decomposition for some complex and compound words. Words such as *teacup* and *government* are transparent, whereas other words such as *quarterback* and *department* are opaque (Stanners et al., 1979; Schreuder and Baayen, 1995; Baayen et al., 1997; Baayen, 1992; among others). According to dual access theories, both types of lexical representations (i.e., constituents and whole-words) may exist simultaneously when processing complex and compound words. At the same time, different factors, such as semantic transparency, cumulative frequency, productivity of the affix, and surface frequency would determine which lexical representation is activated.

Each of these theories for complex and compound word processing has its advantages and disadvantages when explaining the structure of the mental lexicon. Libben (2006) discusses the structure of the mental lexicon and the most efficient way to store complex and compound words through these theories. He adopts these three theories of multimorphemic word processing and proposes three models of polymorphemic word representation in the mental lexicon. In the first model, which Libben calls *Maximization of Computational Efficiency*, complex and compound words are represented as full forms and are independent of their constituents' representations. However, experimental studies on polymorphemic word processing provide evidence that the constituents of complex and compound words are activated while processing (Taft and Forster, 1975; Fiorentino, 2006; among others). Therefore, this model, according to Libben, overlooks the process of decomposition in processing polymorphemic words. In the second model, which Libben names *Maximization of Storage Efficiency*, only the constituents are stored in the lexicon. The idea behind such a model is to advocate the Principle of Economy; that is, the least possible storage cost for the memory. However, this model cannot account for the whole

word representation of complex and compound words, while there are experimental studies on multimorphemic word processing that report that the whole-word representation of complex and compound words is activated while processing (Butterworth, 1983; among others). Finally and somewhere between these two models, there is a mediating model called *Maximization of Computational and Storage Opportunity*, in which both polymorphemic words and their constituents are represented and linked. This model contradicts the common belief that the human mind computes or stores less in order to maximize efficiency. In fact, *Maximization of Computational and Storage Opportunity* entails that only when a multimorphemic word is heard so frequently as to be lexicalized, is it stored as a whole. Libben (2006) further proposes a new extension of the *Maximization of Computational and Storage Opportunity* model, suggesting that semantic opacity does not discourage constituent activation; instead, it “creates a mismatch of activation” (p. 14). In other words, when processing polymorphemic words, both the full form of the polymorphemic word (if lexicalized due to high frequency) and its constituents are activated. Yet, in case of semantically opaque complex and compound words, there would be a mismatch between the meaning of the constituents and the meaning of the full form. Such a mismatch will result in inappropriate semantic activation being inhibited, which leads to slower response times in priming experiments and in lexical decision tasks.¹ Below, we review the experimental findings on polymorphemic nouns where masked and other kinds of priming tasks were used in order to elucidate complex and compound word processing.

¹ In lexical decision tasks, participants have to decide as quickly and as accurately as possible whether a visually or auditorily presented string of letters is a word in their language or not by clicking on a YES or NO button. Once the priming effects are calculated by calculating the reaction times of the responses, they will be compared with the reaction times to unrelated prime-target pairs (For more information, refer to appendix A).

2. 2. Morphologically complex noun processing

Longtin et al. (2003) conducted a pioneering priming study on French morphologically complex nouns. They compared priming effects in four kinds of prime-target pairs. In three of the pairs, the prime was morphologically related to the target at the surface level; that is, the prime could be thought of as a combination of the target and another morpheme. In the remaining pair, the prime and the target were just orthographically related.

The four conditions of the morphologically complex nouns were: (1) transparent, where there is a morphologically related prime-target pair (*gaufrette* ‘little wafer’ – *GAUFRE* ‘waffle’); (2) opaque, where the prime and the target are historically but not synchronically related (*fauvette* ‘warbler’ – *FAUVE* ‘wildcat’); (3) pseudo-derived, where the prime and the target seem to be morphologically related, but actually are not (*baguette* ‘little stick’ – *BAGUE* ‘ring’); and (4) orthographic, where there is no morphological relation between the prime and the target, yet the prime contains the target orthographically (*abricot* ‘apricot’ – *ABRI* ‘shelter’).

Longtin et al. (2003) ran two experiments: a masked priming experiment (Experiment 1) and an unmasked auditory-visual cross-modal priming experiment (Experiment 2). Under masked priming conditions, the prime is displayed for a very short time so that the participants would not consciously notice it, yet the display time is enough for the word to be perceived subconsciously. In unmasked priming, the prime is displayed for a longer time interval so that it is noticeable to the participants, who are then required to decide whether the target, i.e., the second word, is a word in their language or not.

The pattern of results differed in Experiment 1 and 2. In Experiment 1, they found a significant facilitation for the morphologically related pairs (i.e., transparent: *gaufrette/GAUFRE* “wafer/waffle”; opaque: *fauvette/FAUVE* “warbler/wildcat”; and pseudo-derived: *baguette/BAGUE* “little stick/ring”; but not for the purely orthographic pair: *abricot/ABRI* “apricot/shelter”). However in Experiment 2, only in the semantically transparent condition was there a significant facilitation. Since the morphologically complex words were decomposed into their constituents regardless of their semantic transparency in the masked priming experiment, the researchers concluded that morphological decomposition applies automatically at an early stage of lexical access. However, the results of the auditory-visual cross-modal experiment (in which the participants had sufficient time to process the complex words consciously) showed that only semantically transparent words facilitated the recognition of their base. On the other hand, opaque and pseudo-derived pairs yielded similar results (i.e., not decomposing into their constituents) as expected due to their synchronically equivalent status and structure.

Longtin et al.’s (2003) results provided evidence for Taft and Forster’s (1975) theory of the prelexical affix-stripping process, where the affix of an affixed word is stripped off during lexical access at early stages of lexical processing. In addition, Longtin et al. (2003) assessed their results in the light of the connectionist approach to derivational morphology (Hay and Baayen, 2005; Gonnerman et al., 2007; among others). In this approach, morphemes are not represented directly but rather are considered to be the consequence of regular mapping between form and meaning. There is a direct connection between semantic overlap and formal overlap, in that, the more two words have formal overlap, the more priming will be observed between them provided that the semantic

overlap is held constant. Similarly, the more two words have semantic overlap, the more priming will be observed between them if the formal overlap is held constant. Under such an approach, there should be a significant difference between the transparent condition in which the prime-target pairs are semantically related and the opaque or pseudo-derived condition in which the prime-target pairs are not semantically related. However, the masked priming experiment in Longtin et al.'s (2003) study did not support this prediction as the size of the priming effect did not vary as a function of semantic proximity of the prime and target. The results of the present study, however, seem to support a connectionist or even a symbolic approach to derivational morphology. It appears that formal overlap led to the decompositionality in all the three conditions in the study (i.e., transparent, opaque and orthographic overlapping conditions). However, stronger priming effect was observed in the nominal constituent of semantically transparent compound verbs. The reason why stronger constituent priming effect was only observed in the nominal constituent but not in the verbal constituent of transparent compound verbs could be due to: (1) the semantic load of the compound being on the nominal constituent (compatible with nominal constituent retention and verbal constituent deletion observed in patients with aphasia); and (2) the simultaneous priming of related lexical items which have partial match with the verbal constituent (parallel input effect). These findings will be discussed in more detail in later chapters.

Longtin et al.'s (2003) results do not appear to be in line with the supra-lexical morphology model (Giraud and Grainger, 2001), which supports a dual activation of the whole-word and the decompositional forms. In this model, the decomposition occurs after the whole-word has been activated. In line with Longtin's results, Giraud and Grainger

(2001) reiterate Rey-Debove's (1984) idea that since seventy percent of French words are morphologically complex with a compositional meaning, it is strategically more efficient for the processing system to try out the decompositional route first and thus decompose any word that looks complex even if it leads to an incorrect analysis.

Different scholars have replicated Longtin et al.'s (2003) study and reached the same conclusion; that is, they observed an early decomposition of morphologically complex words into their constituents. Rastle et al. (2004) conducted a similar research to Longtin et al.'s study, but on English, and found evidence for morphological decomposition for English morphologically complex nouns by comparing compounds that were: (1) transparent (teacher – TEACH), (2) opaque (corner – CORN), and (3) related in form, which is similar to Longtin et al.'s orthographic condition (brothel – BROTH). They found facilitation in the first two conditions, but not in the form condition. Their results also supported an early morphological decomposition of compounds, which is independent of its semantic transparency.

Kazanina et al. (2008) investigated Russian morphologically complex nouns by comparing the following categories in multimorphemic nouns containing one stem and two affixes (unlike the previous studies that usually had one suffix): (1) transparent category, which represents a true morphological relation between the prime and the target (*gor-k-a* 'small mountain' – *GORA* 'mountain'); (2) pseudo-derived category, which represents a false morphological relation between the prime and the target (*lun-k-a* 'hole' – *LUNA* 'moon'); and (3) form category, which manifests an orthographical or phonological relation between the prime and the target (*par-t-a* 'noodles' – *PARA* 'pair').

Kazanina et al. (2008) obtained the same results that Longtin et al. (2003) had reached for French and Rastle et al. (2004) for English. They found a facilitatory priming effect for targets in the transparent and pseudo-derived pairs, but not in the form pairs. Their results, too, supported an early morphological decomposition for morphologically complex nouns independent of their semantic transparency. Furthermore, Kazanina et al. (2008) added a new finding on polymorphemic word processing and argued that decomposition continues until all morphemes and affixes are segregated. In other words, the polymorphemic words are stripped of all their morphemes until no other decomposition can be done. For example, the compound word *lunka* is decomposed to its smallest morphemes *lun-k-a*.

In the next section, the effect of Stimulus Onset Asynchrony (SOA) on the processing of morphologically complex words will be discussed.

2. 2. 1. The effect of SOA on polymorphemic word processing

Other than different priming techniques used in studies on polymorphemic word processing, the Stimulus Onset Asynchrony (SOA) (or the time that the prime is on display) has been investigated to see if it has any impact on the results of studies on polymorphemic word processing.

Stimulus Onset Asynchrony (SOA) is important in that it determines whether the participants see the stimuli consciously or not, which in turn affects lexical processing. Different studies have investigated the effect of different SOA's on the results of lexical processing. At different levels of consciousness, lie various stages of processing, which

encompass different information, such as orthographic, morphological, phonological, semantic and syntactic.

Marslen-Wilson, Bozic and Randall (2008) investigated the role of morphological, semantic and form relatedness in processing morphologically complex words using different SOA's of 36, 48, and 72 milliseconds in a masked priming paradigm. They ran two experiments. In the first one, they had six conditions in which the prime-target pairs were: (1) morphologically and semantically unrelated but orthographically related (*scandal-SCAN*); (2) morphologically and orthographically related but semantically unrelated (*archer-ARCH*); (3) morphologically and orthographically related but semantically moderately related (*barely-BARE*); (4) morphologically unrelated, semantically moderately related, and orthographically unrelated (*attach-GLUE*); (5) morphologically, semantically and orthographically related (*bravely-BRAVE*); (6) morphologically and orthographically unrelated but semantically related (*accuse-BLAME*). Their results showed that semantic relatedness did not affect morphological priming because they had observed significant priming between morphologically but not semantically related pairs. In addition, form overlap in their study did not lead to priming. In fact, their results indicate that at each SOA, it was the morphological relatedness that accounted for significant priming.

In their second experiment, Marslen-Wilson et al. (2008) reversed the order of prime-target pairs. While in their first experiment, they used derived-stem pairs (*bravely-BRAVE*), in their second experiment, they used stem-derived pairs (*brave-BRAVELY*). They obtained the same results. That is, they observed a significant priming effect for all the +M (morphologically) related pairs. In addition, they found that semantic transparency does

not modulate the amount of priming. Marslen-Wilson et al. (2008) also presented a broader implication of their study; that is, different techniques and tasks tap into different mechanisms (Marslen-Wilson et al., 1994; Marslen-Wilson & Zhou, 1999). For instance, the masked priming paradigm is capable of reflecting the overlap between prime-target pairs at an early stage of processing, hence taking into account only morphological relatedness. However, in overt priming tasks, such as auditory or visual cross-modal priming paradigm, semantic priming and morphological priming co-exist under certain conditions.

The impact of morphological, semantic, phonological and orthographic relations between the prime and the target on the priming of the target is a controversial and unresolved issue. For example, although in neither one of the studies discussed above, the orthographic overlap prime-target pairs resulted in the priming of the target, there are still other studies reported in the literature on polymorphemic word processing that state otherwise (Diependaele et al., 2005; Feldman, 2000; Giraud & Grainger, 2000; Rastle et al., 2000; among others). For example, primes like *tinsel* facilitate the recognition of the target *TIN* even though the remaining letters do not constitute an existing morpheme in English. This led to the interpretation that at early stages of complex and compound word processing, morphological segmentation operates on a purely orthographic basis regardless of semantic or morphological relatedness.

Similarly, Meunier and Longtin (2007) argued that at the prelexical stage of processing, morphological segmentation operates on an orthographic basis. This is followed by the lexical stage, where a reappraisal takes place on the decomposed constituents for the semantic and syntactic information. This reappraisal, which Libben

(2006) called the “mismatch of activation,” can account for the longer reaction times in opaque compounds compared to that in transparent compounds in the present study. The findings of the study will be discussed in Chapters 3 and 4 in more detail.

In the next section, we will discuss the processing of compound nouns.

2. 2. 2. Compound noun processing

It is interesting to see if the results obtained for affixed words can be extended to compound words whose constituents are selected from an open class of words. Shoolman & Andrews (2003) studied compound rather than affixed words to examine the processing of polymorphemic words. They chose compound words because compound constituents can be manipulated independently of the position of the constituents within the whole compound. They used the constituents of compounds as primes (e.g., *neck* or *lace*); while as targets, they used the compounds themselves (e.g., *NECKLACE*). The results revealed that, regardless of the semantic transparency of the constituents, there was a facilitation effect in the response latencies to the target (*NECKLACE*). Therefore, their results support the existence of localized representations of morphologically complex words activated by their constituent morphemes.

Unlike Shoolman & Andrews (2003), who used the compound as the target and the constituents as the prime, most studies on compound words used the compound as the prime and the constituents as the target. Zwitserlood (1994), for example, used a longer SOA (100 ms) to investigate the processing of three groups of prime-target pairs in Dutch for: semantically transparent (e.g., *kerkorgel* ‘church organ’ – *ORGEL* ‘organ’), semantically opaque (e.g., *klokhuis* ‘clockhouse’ – *HUIS* ‘house’ *core of apple/house*), and

orthographic overlap (e.g., *kerstfeest* ‘Christmas’ – *KERS* ‘cherry’) prime-target pairs. Significant priming was reported for both transparent and opaque prime-target pairs, but not for the orthographic overlap prime-target pair.

Later, Fiorentino & Poeppel (2007) investigated morphological decomposition in compound nouns using visual lexical decision with simultaneous magnetoencephalography (MEG). They compared compounds (e.g., *flagship*), single words (e.g., *crescent*), and pseudomorphemic foils (e.g., *crowskep*). They tested twelve native speakers of English on the recognition of 120 words (60 single words and 60 noun-noun compound words which were matched on frequency and word length) as well as 120 nonwords. They predicted that single words and compound words would result in different reaction times. This would confirm the decompositional account of compound word processing whereas if the reaction times were similar, then the results would be in line with the whole-word account of compound word processing. As for the magnetoencephalography, the decompositional account could predict an effect in the M350 component, in that, compounds should be faster than single words in M350 latency. Stimuli were presented in three blocks of 80 items. The results of the lexical decision task indicated that compounds were responded to faster than single words which were in turn responded to faster than the nonwords. The results of the magnetoencephalography task revealed a significantly earlier peak latency for the compound words (333 ms) than the single words (360 ms). Overall, the results of both lexical decision and MEG experiments indicate decomposition for compounds words, but not for single words and pseudomorphemic foils. Their results confirmed Longtin et al.’s (2003) and Rastle et al.’s (2004) results and appear to support an early decomposition of morphologically complex nouns into their constituents. Fiorentino & Poeppel (2007)

argue for a model in which morphological decomposition applies early, automatically and is semantically blind. The effects of semantic transparency that can be observed when a cross-modal priming technique is used (as in Experiment 2, Longtin et al., 2003) are considered to be late effects emerging at stages of processing that are subsequent to morphological decomposition.

Fiorentino & Poeppel's (2007) study also examined the effect of word length in compound word processing. The results showed morphological decomposition even for short compounds.² In addition, they investigated the effect of lexicalization on compound word processing and concluded that even lexicalized compounds (e.g., *rainbow*, *baseball*) are decomposed at early stages of processing. This contradicts Libben's (2006) *Maximization of Computational and Storage Opportunity*, which entails that when a complex or a compound word is heard so frequently as to be lexicalized, is it stored as a whole.

The present study focuses on processing compound verbs in Persian; therefore, in the next section, we will discuss studies on morphologically complex verbs.

2. 3. Processing Morphologically Complex Verbs

Despite the abundance of studies on morphologically complex and compound nouns, studies on morphologically complex and compound verbs are rare (e.g., Smolka et al, 2009; Smolka et al., 2010 for German; Feldman et al., 2002 for Serbian; among others). This is possibly because such structures are not found as commonly as morphologically

² This appears to contradict the previous studies on this topic (e. g. Bertram & Hyönä, 2003), which suggested that word length modulates decompositional versus whole-word processing of compound words. Bertram and Hyönä (2003) attributed the priming effects in the longer but not shorter compounds to non-structural effects; for instance, the possibility of needing two fixations rather than one.

complex nouns in many languages. Moreover, almost all of the experimental studies on the processing of morphologically complex verbs have studied either the inflectional affixes with verbs; for example, in regular and irregular past tenses of verbs (e.g., Baayen et al., 1997), or the derivational affixes with verbs, such as particles and prefixes with German verbs (e.g., Smolka et al., 2010). The non-decompositional approach has been claimed for verbs that are formed by morphological processes such as the process of regular past-tense formation (Baayen et al., 1997; Sereno & Jongman, 1997; among others). Some other studies, on the other hand, have claimed a decompositional approach for morphologically complex verbs. Below, two studies, which have claimed a decompositional approach, will be discussed. The first study was done on conjugated verbs in Hebrew, while the second study was done on German prefixed verbs.

Deutsch et al. (1998) investigated the role of root and verbal-pattern morphemes in lexical access to conjugated verbs in Hebrew, which is a Semitic language and thus nonconcatenative. In Hebrew, there are two, three, and four letter roots and all other words are composed from these roots. Like any other Semitic language, affixes are not added linearly, but rather they penetrate inside the root and change the word pattern. For example, the word *book* in Hebrew is ‘sefer’ and *writer* is ‘sofer’, while the root is ‘s-f-r’. Using the masked priming paradigm, Deutsch et al. (1998) found priming effects for both roots and word patterns in the verbal system, unlike in the nominal complex words, where there is priming for pairs that share the same root but not for those that share the same word pattern (Frost et al., 1997). In both the lexical-decision and naming tasks, Deutsch et

al. (1998) obtained facilitation effects when the prime-target pairs were conjugated with an identical pattern³ as well as when they shared the same root.

The authors justify this difference between verbal and nominal processing by arguing that, in real life, nouns and verbs are not treated in isolation but rather in sentences where the verb is the predicate and its specific pattern constrains the syntactic analysis of the sentence. In other words, different patterns of the verb require specific kinds of arguments. Thus, they will determine the syntactic analysis of the sentence. Therefore, the identification of the verbal pattern is crucial for the initial stages of syntactic analysis. Consequently, the identification of both the root and the verbal pattern is necessary because they serve different yet crucial roles in processing. For this reason, Deutsch et al. (1998) suggest that both the root and the verbal pattern are represented in the lexicon.

Smolka et al. (2008) investigated the processing of German prefixed verbs. They examined morphological, semantic and form relatedness in processing prefixed verbs in German. The study aimed at investigating whether morphological processing is modulated by semantic transparency. Smolka et al. (2008) conducted three experiments with different SOA's (two at 300 ms and one at 1000 ms). They found similar morphological priming effects for the base verbs, such as *kommen* ('come') in semantically transparent prefixed verbs such as *mitkommen* ('come along') and semantically opaque prefixed verbs such as *umkommen* ('perish'). Since both transparent and opaque complex verb constituents were primed, they concluded that morphological processing is not dependent on semantic transparency. Smolka et al.'s (2008) results were not compatible with those in the literature

³ In Semitic languages, there are specific morphological patterns that the speakers use to form nouns or verbs or adjectives or adverbs. For instance in Arabic, another Semitic language, one can make a verb in thirteen different patterns, such as the pattern *estefaal*, where the root is *f-a-l* (e.g. *esteshhaad* 'to give witness', where the root is *sh-h-d*); or the pattern *tafaal* (e.g. *tabaadol* 'to exchange', where the root is *b-d-l*).

for other Indo-European languages, where priming effect for semantically opaque complex words was reported only under masked priming at short SOA's (e.g., Rastle et al., 2000 in English; Longtin et al., 2003 in French; among others).

Smolka et al. (2008) attributed this discrepancy between their result and the results on other Indo-European languages like English and French to the rich morphology of German. In fact, their results indicated that morphological effects in German are so strong that even prime-target pairs with no meaning relatedness show priming effects.

Smolka et al. (2008) think of the morphological priming effects as a continuum, at one end of which are languages like Chinese with poor morphology and thus no morphological effects, and at the other end languages like Arabic with very rich morphology and strong morphological effects. Languages like English and French, which, in unmasked priming experiments, show morphological priming effects, only under semantically transparent conditions, fall towards the Chinese end. However, languages like German, which show morphological priming effects, independent of semantic transparency, fall closer to the Arabic end.

Smolka et al. (2009) continued their research on German prefixed verbs and argued that in German, unlike in English or French, both transparent and opaque complex and compound words are stored and accessed as their constituents. In other words, *depart* is not only decomposed to {de} and {part}, it is also represented as these constituents. In a later study, Smolka et al. (2010) replicated Smolka et al.'s (2009) study and examined verbs with either prefixes or particles in German. They conducted three experiments to discover the lexical representation of morphologically complex verbs in German. They investigated the impacts of morphological, semantic and orthographic relatedness of the

prime-target pairs on the priming of the target. The technique used was visual priming with: (a) simultaneous word exposure (at SOA 300 ms) in Experiment 1, (b) auditory primes with sequential word presentation in Experiment 2, and (c) visual primes with sequential word presentation in Experiment 3. Unlike masked priming, the techniques used in this study triggered the representation of lexical processes rather than processes of early visual word recognition. In all these prime presentation modes, morphological relatedness facilitated target recognition independent of semantic or form relatedness. Therefore, morphological structure seems to operate at the lexical representation of morphologically complex words. In other words, unlike English and French, which require semantic transparency for morphological decomposition in unmasked priming techniques and at long SOA's, German reveals morphological decomposition regardless of semantic transparency and regardless of the priming technique used and the prime presentation duration (SOA). For example, the German complex verb *entbinden* is not only decomposed to its constituents, i.e., *ent-*, *bind*, and *-en* at the prelexical level, but also it is lexically represented as its base {bind} and its constituents {ent} and {en}. The latter then activate their corresponding concepts at the conceptual level: *separate*, *bind* and *infinitive* (Smolka et al., 2010:41). They attribute this behaviour in German to its being morphologically rich. In fact, Smolka et al.'s (2010) results are compatible with connectionist accounts of lexical processing, where morphology is considered to be a mapping between the form and meaning. Of course, in morphologically rich systems, these mappings are straightforward and dominate the system. In this study, we investigated compound verb processing in Persian, another morphologically rich Indo-European language. Studies of Persian compound verbs divide them into two parts: the nonverbal

and the verbal, respectively. The nonverbal part can be a noun (*gerye kardan* ‘tear-to do’ ‘noun-verb’ *to cry*), an adjective (*daagh kardan* ‘hot-to do’ ‘adjective-verb’ *to get mad*), a prepositional phrase (*az bar kardan* ‘of-on-to do’ ‘prep-prep-verb’ *to memorize*), an adverbial phrase (*pish bordan* ‘forward-to take’ ‘prep-verb’ *to succeed*), or a complex nominal phrase (*sar-be-sar-gozaashtan* ‘head-to-head-to put’ *to tease*). The specific compound verbs that are examined in the present study are noun-verb compound verbs.

Language processing is defined as the way human brain processes speech or writing and understands it as language. Therefore, psycholinguists are interested in carrying out aphasia studies, which are done on patients who have lost a particular linguistic ability in their brain due to injury or disease. These studies are done in order to investigate where language processing happens and to provide further evidence for their studies on language processing. Below some aphasia studies on complex and compound words will be discussed since the aim of the present study is to shed light upon the structure and processing of compound verbs. Another way to do this is to look into the structure and processing of compounds, using aphasic patients.

2. 4. Processing of complex and compound words by aphasic patients

Investigating the studies on the morpheme retrieval in complex words by aphasic patients provides further evidence as to how constituents in a morphologically complex word are retrieved. Some of these studies have investigated the compound knowledge in the mental lexicon. For example, Semenza et al. (1992) investigated the knowledge of the compound by a naming task in German aphasic patients. The results revealed that the paraphasic (errors made by patients with aphasia) substitutions were simple word for simple word and

compound word for compound word. Therefore, they concluded that knowledge of the compound must be a part of the lexicon independent of the ability to identify or produce it. This result was further confirmed in a later study by Semenza et al. (1997) using a larger population of patients. In addition, they found out that not only knowledge of the compound, but also knowledge of the compound structure seems to be stored in the lexicon. Similarly, Hittmair-Delazer et al. (1994) and Semenza et al. (1997) discovered that aphasic patients tend to replace noun-noun compounds with well-formed noun-noun neologisms and verb-noun compounds with well-formed verb-noun neologisms. Therefore, they concluded that knowledge of the compound structure and knowledge of word building rules is part of the lexicon.

Later, Delazer and Semenza (1998) studied the processing of Italian compound words and different levels of processing through a study in aphasia. The aphasic patient they worked with had naming difficulties only in compound words. They related the patient's frequent errors in substituting semantically adequate constituents for the correct ones to the separate processing of constituents at the lemma level. The errors shared systematic characteristics, in that, they all possessed a compound structure and were semantically adequate substitutions of the target, and that they all respected Italian word building rules, for example:

tegicristallo	→	*raschiavetro
clean crystal		scrape glass
(windscreen wiper)		(neologism)

accendisigari	→	lanciafiamme
light cigar		throw flames
(lighter)		(flamethrower)

(Delazer and Semenza, 1998: 57)

The above examples indicate that the knowledge of the compound and its structure seem to be part of the lexicon.

In fact, Delazer and Semenza (1998) proposed that the compound structure as well as the position of each constituent is specified before lemmas are accessed. Since both first and second constituents are substituted by the patient, they concluded that both constituents are activated simultaneously and in parallel. They argued that unlike bound morphemes, such as inflections and derivations that belong to a closed class of morphemes, compounds belong to an open class of morphemes. These compounds denote contents that mono-morphemic words denote, while lacking the specific semantic or syntactic function that bound morphemes have. For this reason they declared that processing of compound words and single words should not be different. Delazer and Semenza (1998) also found that there was no frequency or headedness effect. They reported that in half of the cases, the paraphasias contained one part of the target while the first and second constituent was often equally retained (13 times for the first part and 14 times for the second part). The retained constituents often remained in their original position (25/27), for example:

portarifiuti	→	*spazzarifiuti
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carry rubbish		sweep rubbish
(dustbin)		(neologism)
fermacarte	→	*fermafogli
stop paper		stop sheets
(paperweight)		(neologism)

(Delazer and Semenza, 1998: 58)

The above examples indicate that frequency and headedness seem not to affect the retention of the compound constituents.

Nevertheless, the paraphasias were neologisms that followed the syntactic, semantic and phonological structure of the language. Judging from the types of errors the patient made, Delazer and Semenza (1998) located his disturbance with compounds at the retrieval stage.

Delazer and Semenza's (1998) results are compatible with models of word production that hold two lemmas, yet one lexeme for the constituents of compounds. There are two main steps in word production procedure. The first one starts with the lexical item, and it is called the lemma, where the semantic and syntactic information is stored. Lemmas are activated when their semantic conditions are met, which then activates their corresponding syntactic specifications (e.g., a verb activating its verb phrase). The second step is the retrieval of the phonological specification, and it is called the lexeme.

For compound word production, there are basically two theories. In the first one, constituents each might be linked to a lemma, yet they are represented as one single

lexeme. However, in the second theory, both constituents refer to one single lemma and one single lexeme. Delazer and Semenza (1998) support the first theory of compound word production because their study revealed that the paraphasias were produced by substituting either one of the constituents. Therefore, they must have different lemmas or lexical entries in the brain.

There is another interesting question related to this case, and that is: How do we know the paraphasias, the errors made by aphasic patients, did not occur at a later processing stage rather than at the lemma stage? Delazer and Semenza (1998) argue against this hypothesis based on the semantic properties of the paraphasias observed in their study. The neologisms observed in their study made sense semantically in the compound constituents per se and as a whole; furthermore, they were not semantically or phonologically related to the targets' constituents. In other words, the neologisms were similar in meaning to the whole compound rather than its constituents. For this reason, they conclude that the decomposition must be at the lemma level. This is compatible with Smolka et al.'s (2010) theory that when processing complex words, they are not only decomposed to their constituents prelexically, but they are also represented lexically as their constituents, which also activate their corresponding concepts at the conceptual level. For example, the German complex verb *entbinden* is not only decomposed to its constituents, i.e., *ent-*, *bind*, and *-en* at the prelexical level, but also it is lexically represented as its base {bind} and its constituents {ent} and {en}, which then activate their corresponding concepts at the conceptual level: *separate*, *bind* and *infinitive* (Smolka et al., 2010:41).

In the next section, we will discuss the studies on aphasic patients, which have focused on the distinction between noun and verb processing.

2. 4. 1. The distinction between noun and verb processing in aphasic patients

There are some studies on the noun and verb processing distinction in patients with aphasia. For example, Perani et al. (1999) investigated the neural correlates of noun and verb processing. They studied this subject in aphasic participants who were selectively impaired in the processing of nouns and verbs. The task they used was lexical decision making when reading concrete and abstract nouns and verbs. The technique they used was Positron Emission Tomography (PET) to measure regional cerebral activity during this task. The results revealed that the left temporal lobe plays a crucial role in processing nouns, whereas the right lobe is necessary for verbs. They attribute the difference between noun and verb processing to the syntactic richness of verbs.

Ahrens (1977) studied German aphasics through a naming task in noun-noun and verb-noun compounds. Although there were fewer errors in the high-frequency first constituent compounds, they found that, overall; the patients had a tendency to retrieve the first constituent, which is also the head in German. It must be noted that this first-constituent effect was not replicated in other aphasic studies in German (Hittmair-Delazer et al., 1994; Blanken, 2000). However, the results of the present study reveal some kind of first-constituent effect, which will be discussed, in later chapters. It must be mentioned that the first-constituent in Persian is not the head, but rather the non-head noun in noun-verb compound verbs.

2. 4. 2. Noun/verb prominence in aphasic patients

Several studies have found noun impairments to be more prominent (Miceli et al., 1984; Zingeser & Berndt, 1988, 1990; de Renzi & Di Pellegrino, 1995; Rapp & Caramazza, 1997; among others), whereas other studies have found verb impairments to be more significant (McCarthy & Warrington, 1985; Williams & Canter, 1987; Caramazza & Hillis, 1991; Hillis & Caramazza, 1995; Breedin et al., 1998; among others).

Most of these studies attribute the verbal or nominal impairments to semantic deficits for imaginable concrete actions or objects. Breedin et al. (1998) classify verbs as ‘heavy’ versus ‘light,’ and ‘specific’ versus ‘general.’ They describe ‘heavy’ verbs as those that are semantically complex (e.g., *run*) and ‘light’ verbs as those that are semantically simple (e.g., *go*). ‘Specific’ verbs are semantically specific (e.g., *wipe*), whereas ‘general’ verbs have a general meaning (e.g., *clean*). Their results revealed that aphasic patients were better at retrieving the more ‘heavy’ and ‘specific’ verbs than their less complex counterparts. They attributed this effect to “complexity effect,” which is the ease of access of semantically complex verbs.

However, there are other studies in the literature that have found different and even opposite results. For example, Breedin et al. (1994) reported an aphasic patient who did not perform well in identifying perceptual properties of objects. Nevertheless, this patient was better at verbs than at nouns. In fact, he performed better at verbs with fewer manner-related features (e.g., ‘speak’ as opposed to ‘whisper’). Marshall et al. (1996) propose that since verbs are associated with abstract words, while nouns are associated with concrete words, different aphasic patients have different kinds of impairments. However, this hypothesis cannot explain why some patients are better at retrieving the verbs or the nouns

depending on the task they are undertaking; for example, they might show impairment in writing or spelling, but not in speech (Caramazza & Hillis, 1991). Hillis & Caramazza (1995) reported a patient who had more noun impairments in speech, but more verb impairments in writing and lexical decision tasks. Many language production theories support the ‘syntactic mediation’ hypothesis, which holds that syntactic and semantic features of a word are decided at the lemma stage (Caramazza, 1997), whereas neurological and tip-of-the-tongue studies have rejected this hypothesis. Neurological studies have reported patients with semantic errors only in one output modality, and tip-of-the-tongue studies have revealed that availability of syntactic features is not a prerequisite for the retrieval of phonological information.

Caramazza (1997) proposed another model called ‘independent networks’ to account for this discrepancy. The ‘independent networks’ model holds that lexical knowledge is organized in sets of semantic, syntactic and form structure independent networks that are connected by a modality-specific lexeme. Therefore, it does not consider the lemma to be the single syntactic mediator between conceptual and modality-specific lexical representations. A study that supports Caramazza’s (1997) model is Shapiro et al.’s (2000) study, in which the authors state that their patient showed verb impairment in comprehension tasks, but noun impairment in production tasks. In addition, their patient showed exactly the same pattern of impairment with pseudowords, which have no conceptual representation, as he did with real words, which are said to have their conceptual representations at the lemma stage. Therefore, meaning or semantic information does not seem to be a prerequisite in decision-making about the grammatical class. These results are compatible with Caramazza’s (1997) ‘independent networks’ hypothesis, which

holds that lexical knowledge is organized in separate semantic, syntactic and form structure independent networks. Since Shapiro et al.'s (2000) patient had damage to the left frontotemporal regions and displayed a noun impairment that was selective; they suggest that noun and verb lexemes may have different physical organizations in the brain. This idea is compatible with neuropsychological and neuroanatomical studies that evaluate brain-damaged patients. These studies have revealed that noun naming is associated with the left anterior and middle temporal lobe, while verb naming is associated with the left prefrontal and premotor regions (Miceli et al., 1984; Damasio & Tranel, 1993).

Shapiro et al. (2000) account for the discrepancy observed in different tasks by assuming that there might be an impairment of the retrieval of the syntactic features of the noun in some tasks but not in others. For example, in naming tasks, the patient has to deal only with the semantic features of the noun ('noun feature'), whereas in propositional tasks such as sentence formulations, morphological and syntactic features of the noun should also be dealt with ('class feature'). Shapiro et al. (2000) propose the 'coordinated' or 'interactive' approach, which assigns an important role to grammatical class information in morphological production. According to this approach, the grammatical class is a property of stored lexical representations, in contrast to what is proposed in generative syntactic models (Halle, 1995).

Regarding the information contained within the mental lexicon, Libben (1998) investigated semantic transparency in compound nouns in an aphasic patient and observed that the patient interpreted an opaque compound with a combination of the meanings of its constituents and the whole compound (e.g., 'butterfly' was interpreted as 'it is a pretty fly, it's yellow'). Libben (1998) suggested that this is compatible with the Automatic

The results of the present study appear to support the APPLE model of compound processing (Figure 2.1.), which entails that compound constituents are processed through a left to right recursive parsing procedure. The only difference is that since Persian is read from right to left, this order is reversed. As the results seem to indicate, formal overlap led to the decompositionality in all the three conditions in the study, i.e., transparent, opaque and orthographic overlapping conditions. Stronger priming effect was observed in the nominal constituent of semantically transparent compound verbs but not in the verbal constituent. This can be explained through the APPLE model since the parser seems to process the compound verb in Persian from right to left starting with the nominal constituent in the initial position. This can account for the competing alternatives or parallel input for the verbal constituent in the transparent condition but not in the nominal constituent. The reason why this competing alternatives or parallel input effect is only observed in the transparent condition but not in the opaque or orthographic condition could be due to the fact that opaque compound verbs are frozen idiomatic expressions; hence not entailing competing parallel input for the verbal constituent. These results will be discussed in detail in later chapters.

In the next section, we will review the aphasic studies on Persian compound words.

2. 4. 3. Aphasic studies on Persian

As far as aphasic studies on Persian are concerned, Nilipour (2000) studied the grammar of two right-handed monolingual native speakers of Persian, who became aphasic due to left traumatic brain damage. The tasks tested both writing and speech modalities. Both patients used simple syntax with little variation. Most of the utterances lacked the lexical verb or

were erroneously replaced by the “filler” verb *ast* ‘is.’ The results revealed that one of the aphasic patients had impairments in handling verbs, and in cases where both patients used the verb, they used the verb *ast* ‘is’ as a general default verb. In addition, there was a tendency to use the present tense rather than the past, despite it being longer in form. Nilipour (1989) reported verb impairment, shorter phrases, slower speech rate, reduced syntax, omitted free grammatical morphemes, and omitted object marker *ra* (in two aphasic patients). This appears to contradict Breedin’s (1998) “complexity effect,” which supports the ease of access of semantically complex verbs or ‘heavy’ verbs compared to semantically simple verbs or ‘light’ verbs.

Later, Nilipour and Raghibdoust (2001) investigated linguistic deficits in seven aphasic native speakers of Persian. Their aim was to discover the general characteristics of agrammatic language in Persian as well as providing a general trend of aphasic deficits in different types of aphasia in Persian. They describe every one of the seven patients and give an account of their paraphasias. The first patient, TB, was diagnosed with transcortical motor aphasia, and his deficits included general disruption of the VP and lexical access restrictions. The second patient, PA, was diagnosed with conduction aphasia due to her impaired repetition as well as limited and slow oral production. The third patient, AS, suffered from transcortical sensory aphasia, and his deficits included paragrammatism and omission of obligatory morphemes. The fourth patient, MG, suffered from a left frontal lobe lesion specifically affecting Broca’s area. She was reported to use only nouns in the entire sample elicited from her speech. The fifth patient, RL, suffered from a cerebrovascular accident (CVA), and was characterized as a mild agrammatic aphasic with occasional word-finding problems in spontaneous speech as well as slight

impairment in his comprehension. The sixth patient, HB, became aphasic as the result of a trauma. His comprehension and production were both impaired. All his utterances were single clauses with the lexical verbs being the most salient disrupted major lexical category, which was either deleted or substituted. The seventh patient, MN, also became aphasic as the result of a trauma. His comprehension was better preserved than his expression. He was reported to use the infinitive form of the verbs rather than the conjugated form. Overall, the results observed in these seven patients revealed interruption in the verb, deletion of free grammatical morphemes, substitution of bound grammatical morphemes, and reliance on nouns rather than verbs, for example:

a. deletion of bound morpheme (the noun is prominent)

/mardom	do	nafar	[ra]	bord-and/
People	two	persons	[OM]	took-3PL

People took two persons.

b. substitution of the verb (the noun is prominent)

/yedafe	pare	-od (shod)/
suddenly	tore	was-3SG

It suddenly tore off.

(Nilipour and Raghibdoust, 2001: 215-217)

The above examples indicate that the omission of the verbal constituent is much more prevailing than the omission of the nonverbal constituent.

These results replicated the results obtained in other studies on other languages like Italian (Semenza et al., 1997; Mondini et al., 2004; among others), where the omission of verbal constituents was much higher than the omission of nominal constituents in verb-noun compounds in aphasic patients.

The results of masked-priming experiments reported in this dissertation are compatible with Nilipour and Raghibdoust's findings (2001), in that, the nominal constituents of the noun-verb compound verbs are primed more significantly than the verbal constituents.

Findings like those reported above in Section (2.4.) led some scholars, such as Badecker (2001), to suggest that in aphasic patients, compound words seem to be decomposed into their constituents regardless of their semantic transparency. Badecker (2001) provides evidence from an aphasic patient who showed decomposition not only for transparent compounds, but also for opaque ones. On the other hand, there is paraphasic evidence, such as that offered in Delazer and Semenza (1998), suggesting the whole compound is substituted. This is observed in meaning substitutions for the whole compound rather than for its constituents. Therefore, it can be concluded that both the whole compound and its constituents are activated simultaneously. Nevertheless, if this is true, at what stage are the constituents combined? Other than suggesting that there must be "an intermediate form between the conceptual semantic representation and the phonological form" (Semenza and Mondini, 2006:85), aphasic studies have not answered this question explicitly. The experimental studies on complex and compound word processing as well as studies on patients with aphasia, described above, will be used to

answer this question and to discuss the results obtained in the current study in the chapters ahead.

Below, we will review the linguistic and nonlinguistic factors that affect complex and compound word processing.

2. 5. Linguistic and nonlinguistic effects on the processing of morphologically complex words

In this section, the effect of linguistic factors, such as linearity, as well as nonlinguistic factors, such as priming technique and frequency on the processing of morphologically complex words will be discussed.

2. 5. 1. Influence of linearity on priming effect

The idiosyncratic linguistic characteristics of the language under investigation play a crucial role in studies on processing polymorphemic words (e.g., Smolka et al., 2008; among others). One such characteristic is said to be concatenativeness, that is, the linear order of morphemes in a morphologically complex word. According to experimental research on complex and compound word processing, in concatenative languages, like English, semantic transparency does have an impact on processing. The evidence comes from the study by Marslen-Wilson et al. (1994) on morphologically complex English words using a series of auditory-visual cross-modal priming. As discussed earlier, they observed that semantically transparent complex words (*government*) prime their root (*GOVERN*), whereas semantically opaque complex words (*apartment*) do not prime their root (*APART*). Accordingly, they proposed that opaque polymorphemic words are stored as

a whole, while transparent polymorphemic words are stored as separate morphemic constituents. Longtin et al. (2003) found similar results under the same priming paradigm for French, another concatenative language.

However, in nonconcatenative languages, like Hebrew, semantic transparency does not affect processing even under the unmasked priming paradigm (Frost et al., 1997; among others). Boudelaa and Marslen-Wilson (2000) reported similar observations for another nonconcatenative language of the Semitic family, Arabic. In fact, in both studies, a significant priming effect was found for morphologically related prime-target pairs in both transparent and opaque complex words. The reason they gave was that languages with such a rich morphology have a high number of morphologically complex words, which will eventually be more frequent and less marked and thus more likely to be parsed even when they are semantically opaque.

Smolka et al. (2008) reject the direct relationship between concatenativeness and semantic transparency effects in complex and compound words since Hebrew, a language with a nonconcatenative system, shows weak priming effects for semantically opaque prime-target pairs, whereas German, a concatenative language, reveals strong priming effects for semantically opaque prime-target pairs in two overt visual priming experiments. They compared the priming effects of three kinds of primes on the verb targets (*kommen*, come). The three primes were: purely semantically related verb (*nahen*, approach), morphologically and semantically related verb (*mitkommen*, come along), purely morphologically related verb (*umkommen*, perish), versus an unrelated verb (*schaden*, harm).

Their results revealed that morphological relatedness produced strong facilitation, which was not influenced by semantic relatedness. Moreover, orthographically similar primes (*kāmmen*, *comb*) were reported to produce interference effects; indicating that the morphological facilitation effects were not the result of sheer form overlap between primes and targets. Their findings reveal that morphological relations are processed independently of form and meaning relatedness (Smolka et al., 2008).

Nonconcatenative or nonlinear languages, like Arabic or Hebrew, are also said to have a richer morphology than concatenative or linear languages, such as English or French. Likewise, morphological richness of a language is another factor identified in the experimental studies on complex and compound word processing as possibly affecting morphological priming. Smolka et al. (2008), however, challenge this idea by questioning what makes a language rich. They also inquire as to what linguistic characteristics of a language determine the strength of morphological priming in that language. The factors they mention that might play a role are: (1) the structure of the inflectional and derivational systems; (2) the productivity of the compounding system; and (3) the proportion of semantically transparent versus semantically opaque compounds. For example, since both Persian and English are Indo-European languages, affixes follow or precede the stem in a linear format (*book*, *book-s*; *ketaab*, *ketaab-ha*), whereas Semitic languages such as Arabic and Hebrew have their affixes intertwined in their three-letter stems (*k-t-b*, *ketaab*, *kotob*). The productivity of the compounding system refers to the ability of the language users to easily coin a novel word and equally easily be understood by other native speakers of the language. For example, in Persian; in the media, in the Persian Academy and on the street, new words are coined, used and understood easily. This phenomenon is seen more vividly

in the novel compound verbs that include a Persian verbal constituent and a foreign nominal constituent (e.g., *click-kardan*, ‘click-to do’ *to click*). The third factor; that is, the proportion of semantically transparent compared to semantically opaque compounds, refers to the frequency of idiomatic expressions as compounds. Persian contains numerous idiomatic or opaque compounds (e.g., *del-daadan*, ‘heart-to give’ *to fall in love*).

Based on Smolka et al.’s (2008) factors that determine the morphological richness of the language, Persian is quite rich as revealed by its very productive system of morphology, which will be discussed later in this dissertation.

2. 5. 2. Influence of Simultaneous Onset Asynchrony (SOA) on priming effects

Differences in prime duration can also lead to differences in lexical decision times at the target in priming tasks. The main aim of priming tasks is to discover the relatedness between the prime and the target. This relatedness can be morphological, orthographic, semantic, and phonological. As soon as the prime is perceived, all related lexical items are activated, which will help with the recognition of the target as a word or nonword. For example, under masked priming conditions, the prime is only presented for a short period and is not consciously perceived by the participant, whereas under unmasked priming technique, the prime is presented for a longer period and is consciously perceived by the participant. Therefore, unlike unmasked priming, masked priming is reported to be blind to semantic transparency (Frost, Forster, and Deutsch, 1997; Feldman and Soltano, 1999; and Rastle et al., 2000 among others). In a study on English complex nouns, Marslen-Wilson et al. (1994) found out that semantic transparency is a determining factor in the organization of the lexicon. Using a series of auditory-visual cross-modal priming, they observed that

semantically opaque complex words such as *apartment* do not prime their root, i.e., *apart*, whereas semantically transparent complex words such as *government* do prime their root, i.e., *govern*. However, in their study, the participants had enough time to process the morphologically complex words consciously. Later, Feldman and Soltano (1999) as well as Rastle et al. (2000) replicated Marslen-Wilson et al.'s (1994) study, but used the masked priming technique, where they observed significant priming for both transparent and opaque complex words. Similarly, the masked priming technique that Frost, Forster, and Deutsch (1997) used for Hebrew resulted in significant priming for both transparent and opaque compounds. Then, Frost et al. (2000) replicated this study on Hebrew using a cross-modal priming technique and observed significant priming for both transparent and opaque complex words, yet with a stronger priming effect for the transparent complex words. Boudelaa and Marslen-Wilson (2000, 2001) obtained similar results for Arabic, which has a nonconcatenative structure, as does Hebrew. Therefore, the kind of the priming technique seems to have a direct impact on the results when one is comparing the processing of semantically transparent and semantically opaque complex and compound words (e.g., Lontin et al., 2003; among others).

In visual masked priming, Longtin et al. (2003) obtained facilitation for transparent, opaque and pseudo-derived morphologically related prime-target pairs, but inhibition for the orthographic prime-target pairs, whereas in auditory-visual cross-modal priming, facilitation was observed only for the transparent prime-target pairs. In addition, in both experiments, similar results were obtained for both the opaque and the pseudo-derived prime-target pairs, which were expected due to their synchronical status and structure.

Masked priming, which tests the processes that the prime undergoes in its first 50 ms of processing, taps into very early processes in word recognition. This was revealed by comparing priming the same pairs in unmasked and masked priming experiments. For example, primes that orthographically overlapped with the target (e.g., *flower-PLOWER*) did not prime the target in unmasked visual priming experiments (Colombo, 1993; among others), whereas under masked priming conditions, they yielded significant priming effects in some studies (Forster et al, 1987; among others). In addition, under unmasked priming conditions, participants seem to integrate or fuse the prime with the target (e.g., *fish-SWIMS*) (Forster, 1987). However, under masked priming conditions, semantic and syntactic integration seems to occur only if both the prime and the target reach consciousness (Forster, 2003).

Below, the frequency effect, another nonlinguistic factor, which affects complex and compound word processing, will be discussed.

2. 5. 3. Influence of frequency on priming effect

Another non-linguistic property of the word, frequency effect, is reported in studies on the processing of polymorphemic words as affecting lexical decision processes.

Some models of compound and complex word processing, such as the dual-route models (Baayen, Dijkstra and Schreuder, 1997; Kuperman, Bertram and Baayen, 2008 among others) postulate that low-frequency words involve decomposition, resulting in their decompositional access route whereas high-frequency words involve lexical lookup, resulting in their whole-word access route. Some proponents of the dual-route theory, like Hay (2001), consider the frequency-decompositionality to be relative, suggesting that

decomposition occurs if the compound constituents are more frequent than the compound itself.

Balota and Chumbly (1984) investigated the word frequency effect in the three different tasks of lexical decision-making, pronunciation, and category verification. The results showed the highest frequency effect in lexical decision-making tasks and the lowest in category verification tasks. As for complex words, the frequencies of both the whole word (surface frequency) and the constituents (base frequency) play a role based on the theoretical model on which complex word processing is based. In whole-word or full-list theories of complex and compound word processing, the surface frequency is more important, whereas in decompositional theories of polymorphemic word processing, the frequency of the constituents plays an important role. In dual-access theories, both surface and base frequencies affect processing.

In contrast, McCormick, Brysbaert and Rastle (2009) investigated the impact of frequency effect on decompositionality/nondecompositionality of morphologically complex words in: (1) high-frequency prime condition (e.g., government – GOVERN); (2) low-frequency prime condition (e.g., concretely – CONCRETE); and (3) pseudoword prime condition (e.g., monkage – MONK). They obtained similar priming effects for all the conditions (24ms – 27ms – 22ms, respectively) and concluded that morpho-orthographic segmentation process is not limited to low-frequency words or nonwords.

Frequency effects were also studied in aphasic patients. Rochford and Williams (1965) investigated the relative frequency of complex word constituents using a naming task with English-speaking aphasic patients. Stimuli were classified as high-high, high-low, low-low, and low-high frequency combinations. The results revealed that the

frequency of the first constituent determines the success in retrieving the complex word. This reiterates the importance of the first constituent effect, which was discussed earlier and will be discussed further in the next chapter through the current study.

The present study investigates the processing of compound verbs in Persian under the masked priming paradigm in native speakers of Persian. As illustrated by the review of the experimental research on complex word processing in this chapter, there are quite a number of experimental research on affixed words word processing especially on morphologically complex noun (e.g., Longtin et al., 2003; among others). However, studies on compounds are quite rare (e.g., Fiorentino, 2006; among others). Similarly, there are far fewer studies on morphologically complex verb processing (e.g., Smolka, 2010; among others) compared to morphologically complex noun processing, and hardly any studies on compound verb processing probably because they do not exist in many languages. However, in Persian, compound verbs outnumber simple verbs, and compounding is a highly productive verb making process, which is constantly used to make novel compound verbs. In fact, Persian is an interesting language to investigate lexical representations, since it belongs to the same language family as English, French and German do and thus possesses concatenative morphology of Indo-European languages, yet it is different from many Indo-European languages in its morphological richness and productivity, as is demonstrated by the productivity of Persian compound verbs in this study. Persian compound verbs are said to be formed by combination and incorporation, the two lexical processes involved in compound verb formation in Persian (Dabir-Moghaddam, 1997). It must be mentioned that both combination and incorporation refer to the compound verb formation, which results in a non-compositional compound in the first

one (combination), but a compositional compound in the latter (incorporation). These two lexical processes in the formation of Persian compound verbs as well as the structure of compound verbs in Persian will be discussed in detail in Chapter 4.

In the next chapter, two separate studies, each of which contains one or two experiments on compound verb processing in Persian will be discussed.

CHAPTER 3

EXPERIMENTAL STUDIES

Other than a few exceptions like Fiorentino and Fund-Reznicek's (2009) study on the morphological priming of compound constituents, most of the priming studies on multimorphemic words have been on affixed words. In addition, there is hardly any study on compound verb processing reported in the literature of experimental research on complex and compound word processing. Therefore, the present study will permit direct comparison with studies on polymorphemic words as well as with studies on compound nouns in order to investigate the possibility of generalizing the finding of masked morphological priming in affixed words and/or compound nouns to masked morphological priming in compound verbs. The special kind of compound under investigation in this study is the noun-verb compound verb in Persian.

It should be mentioned that the nonverbal constituents of compound verbs in Persian are of different types and could be a noun (*gerye-kardan* 'tear-to do' to cry), an adjective (*daagh-kardan* 'hot-to do' to get mad), a prepositional phrase (*az-bar-kardan* 'from-on-to do' to memorize), an adverbial (*pish-bordan* 'further-to take' to succeed), or a complex nominal (*sar-be-sar-gozaashtan* 'head-to-head-to put' to tease). In the compound verb that is used in this study and that has a noun-verb structure, both constituents of the compound are drawn from the open-class vocabulary of the language rather than the

closed-class set of affixes, which has been investigated in many studies as reviewed in the previous chapter. In addition, in the compound verbs used in this study, the second constituent is the head, unlike in English compound nouns where the first constituent is the head as reported by Fiorentino (2006) in his study on compound noun processing in English. Furthermore, since we are dealing with compound verbs, the prelexical decomposition of compound words will be more complex than decomposition of affixed words (de Almeida and Libben, 2002).

In order to investigate whether the experimental studies on affixed nouns and verbs (Longtin et al., 2003; Deutsch et al., 1998; among others) as well as those on compound nouns (Fiorentino, 2006; among others) hold for Persian compound verbs, we ran three experiments. In Experiment 1, we examined constituent and semantic transparency effects as well as transparency similarity⁴ effect in transparent and opaque compound verbs. In order to test the validity of the results, we ran two additional experiments (Experiments 2a and 2b) on transparent and opaque compound verbs, concentrating on constituent and semantic transparency effects. However, this time, we added a third condition; that is, orthographic overlap condition, which included simple verbs that contained a pseudo-constituent and a non-morpheme in Persian to see if the priming effects for the constituents were merely morphological or not.

The first experiment investigated three research questions: (1) whether constituents of Persian compound verbs show significant priming in masked-priming paradigm (e.g., *kaado-daadan* ‘gift-to give’ - *KAADO* ‘gift’ - *DAADAN* ‘to give’), (2) whether priming effects

⁴ Transparently similar prime-target pairs, in our study, refer to prime-target pairs of compound verbs that are both semantically transparent (e.g., *kaado-daadan* ‘gift-to give’ – *QAZAA-XORDAN* ‘food-to eat’ *to give gifts/to eat food*) or both semantically opaque (e.g., *rox-daadan* ‘face-to give’ - *KAMAR-BASTAN* ‘belt-to tie’ *to happen/to decide*).

are constrained by semantic transparency (e.g., *kaado-daadan* ‘gift-to give’ *to give a gift* versus *rox-daadan* ‘face-to give’ *to happen*), and (3) whether priming effects are constrained by the degree of transparency of the prime and target; in other words, whether transparent compounds prime transparent compounds more, and opaque compounds prime opaque compounds more (e.g., *rox-daadan* ‘face-to give’ – *KAADO-DAADAN* ‘gift-to give’ *to happen/ to give a gift*).

The second and third experiments, on the other hand, aimed at answering three questions: (1) whether compound verb constituents show significant priming in the masked-priming paradigm; (2) whether priming effects are constrained by semantic transparency; and (3) whether priming effects are due to morphological relatedness. In these experiments, the target and the prime were matched on three kinds of relatedness: (1) relatively transparent (e.g., *qazaa-xordan* ‘food-to eat’ - *QAZAA* ‘food’ *to eat*), (2) relatively opaque (e.g., *qasam-xordan* ‘oath-to eat’ - *QASAM* ‘oath’ *to swear - oath*), and (3) orthographically overlapping (e.g., *shenaaxtan* ‘to recognize’ - *SHENAA* ‘swimming’). While Experiment 2a investigated the priming effect of these compounds and pseudo-compounds (in the orthographic overlapping prime-target pairs) on their nominal constituent or pseudo-constituent, Experiment 2b examined the priming effect of these compounds and pseudo-compounds (in the orthographic overlapping prime-target pairs) on their verbal constituent or pseudo-constituent.

This chapter is organized as follows. We will report Experiment 1 in Section 3.1. We will begin the section by reporting the results of relatedness rating and frequency studies. Then we will discuss the method and the results of Experiment 1 in opaque and transparent compound verbs. We will then discuss the constraints and shortcomings of

Experiment 1, which led us to carry out Experiment 2. In Section 3.2, we will discuss Experiment 2. We will begin by reporting the results of the relatedness rating study as well as the frequency rating study in this experiment. Experiment 2 is divided into two subsections of Experiment 2a, which focuses on the Priming of non-head/word-initial position, and Experiment 2b, which concentrates on the Priming of head/word-final position. In each of these subsections, we will discuss the method, results and conclusion. The chapter ends with a general conclusion of the results of the two experiments presented in this chapter.

3. 1. Experiment 1

In this section, the masked priming experiment which was carried out on Persian opaque and transparent noun-verb compound verbs will be discussed. The stimuli include relatively transparent (e.g., *kaado-daadan* ‘gift-to give’ - *KAADO* ‘gift’), relatively opaque (e.g. *rox-daadan* ‘face-to give’ - *ROX* ‘face’ to *happen/face*), transparently similar (e.g., *rox-daadan* ‘face-to give’ - *KAMAR-BASTAN* ‘belt-to tie’ to *happen/to decide*), and transparently different (e.g., *rox-daadan* ‘face-to give’ – *KAADO-DAADAN* ‘gift-to give’ to *happen/ to give a gift*) prime-target pairs. The aim of Experiment 1 was to investigate constituent and semantic transparency effects as well as transparency similarity effect in transparent and opaque compound verbs in Persian. The questions we ask are: (1) whether constituents of Persian compound verbs show significant priming in masked-priming paradigm, (2) whether priming effects are constrained by semantic transparency, and (3) whether transparent compound primes facilitate the recognition of transparent compound targets or opaque compound targets.

Based on the results of similar studies on other languages, we can make several predictions to address the above research questions. If Persian is like other concatenative Indo-European languages, we would expect to have a positive answer to question 1, but not question 2. In other words, under masked priming paradigm, compound verbs should be decomposed to their constituents disregarding semantic transparency. This has been the mainstream results reported in the literature for French, English, German, etc.

As for the third question, we know that in Semitic languages, like Hebrew and Arabic, not only the verb root but also the verb pattern is said to be a part of the mental lexicon (Deutsch et al., 1998). Therefore, we would expect to have stronger facilitation in transparent-transparent pairs, in comparison to transparent-opaque pairs. In addition, in paraphasic neologisms, the form of the compound seems to be retained (Delazer and Semenza, 1998); therefore, we would expect to have a positive answer to the third question too.

Before the priming experiment, a relatedness rating study was carried out to select the stimuli for the priming experiment.

3. 1. 1. Relatedness rating and frequency studies

As mentioned earlier in this chapter, the compound verbs that were used in this study had a noun-verb structure. Both constituents are lexical items rather than affixes; that is, both constituents are selected from among an open-class of words.

In order to examine the relatedness between the prime and the target in each prime-target pair, forty undergraduate students from Azad University, Karaj branch, judged the degree of similarity of meaning (and not phonological or structural similarity) between the

two words of each pair by assigning a number to each pair. The task was to rate, on a 5-point scale – where 1 represented the least related and 5 represented the most related – the relatedness between the primes that were the noun-verb compound verbs and the targets that were the nominal or the verbal constituents of those noun-verb compound verbs. The participants were instructed to rate the semantic (and not phonological or orthographical) relatedness of the two words in each pair by assigning them a number between 1 and 5 (1 representing the least related and 5 representing the most related). As expected, the participants found the pairs with transparent compound primes and their verbal (average rating of 4.91, standard error 0.04) and nominal (average rating of 4.85, standard error 0.09) constituent targets as closest in meaning. The pairs with opaque compound primes and their verbal (average rating of 1.04, standard error 0.02) and nominal (average rating of 1.15, standard error 0.06) constituent were rated low.

To test for the surface frequency of compound verbs and the base frequency of their constituents, since no Persian corpus was available to the researcher, she relied on her own judgment as a native speaker of Persian. In fact, compound verbs in Persian are quite common and even more common than their mono-morphemic words with the same meaning, which are often archaic. The fact that the lexical frequency of prime-target pairs was not controlled might have affected the results of the priming experiment in the first study; therefore, in the second study, twenty native speakers of Persian rated the commonality of compound verbs and their constituents on a 7-point scale.

3. 1. 2. Method

Participants. Initially, forty-eight native speakers of Persian (aged 20-40), all university students in Iran, participated in this study. They all had normal or corrected-to-normal vision. Prior to the experiment, they provided their written informed consent to participate in the study, and they all filled out a language background questionnaire in which they all confirmed that Persian was their first language. Later in the study, two participants were removed from the analysis due to their high number of errors (96.7%), resulting in a final total of forty-six participants. The reason for the high number of errors on the part of these two participants was not known; possibly they were unable to follow the instruction.

Stimuli. Stimuli were organized into sets of seven conditions. The first four conditions included a compound verb as the prime and either its nominal or its verbal constituent as the target. Each critical noun and verb target (e.g., *DAADAN* ‘to give’, *ROX* ‘face’, *KAADO* ‘gift’) was combined with three types of prime: (a) a morphologically but not semantically related prime (+ M – S, *rox-daadan* ‘face-to give’ *to take place*), (b) a morphologically and semantically related prime (+ M + S, *kaado-daadan* ‘gift-to give’ *to give a gift*), and (c) a semantically, morphologically and orthographically unrelated prime (U, *raftan* ‘to go’).

The transparency similarity effect was further evaluated by adding prime-target pairs, in which each critical compound verb target (*KAMAR-BASTAN* ‘belt-to tie’ *to decide*) was combined with three types of prime: (a) a transparently similar prime (*rox-daadan* ‘face-to give’ *to happen*), (b) a transparently dissimilar prime (*kaado-daadan* ‘gift-to give’ *to give a gift*), and (c) an unrelated prime (U, *raftan* ‘to go’). These conditions were added to the experiment in order to investigate whether transparent compound verb primes

facilitate the recognition of transparent compound verb targets faster than they do with the opaque compound verb targets. The results will help us to discover whether transparency similarity is calculated while processing compound verbs.

Then sixty more prime-target pairs were added to the experimental pairs to hide the purpose of the study. These latter sixty pairs were divided into three sets of three types of prime-target pairs. The first set of twenty pairs had verb primes and noun targets to balance the number of noun targets, since there were fewer nouns than verbs in the target stimuli. The second set of twenty pairs was composed of semantically related prime-target pairs with nouns as both the prime and the target (*doctor* ‘doctor’ - *PARASTAR* ‘nurse’). Lastly, the third set of twenty pairs was semantically unrelated prime-target pairs with nouns in the prime and in the target (*sharaab* ‘wine’ - *PARASTAAR* ‘nurse’). These semantically related/unrelated pairs were then used in the analyses to further evaluate the reliability of the results. In addition to the experimental pairs and sixty word fillers, one hundred and fifty additional filler pairs were constructed. These fillers with non-word targets were constructed by changing two phonemes of existing words in Persian such that the transformed version is not an existing word in Persian, yet it does not violate phonological or structural rules of the language.

Some control pairs were repeated in the opaque and transparent conditions, and that is why there are fewer control prime-target pairs than the experimental ones. The repeated control pairs are written in *italics* in the table above. The reaction times were compared in the experimental pairs and control pairs. The results are reported below in the *Results* section.

As for the numbers of the stimuli, there were 40 transparent compounds and 40 opaque compounds, which comprised the primes, and which were paired with the targets

comprising of 40 nominal constituents of the transparent compounds, 40 nominal constituents of the opaque compounds, and 40 verbal constituents the compounds. The number of the semantically related and semantically unrelated pairs was 20 each. Each experimental pair was then matched with a control pair comprising of a simple verb as the prime and the same target as in the experimental pair. This great number of stimuli were divided into 4 sets of 10 stimuli per each stimuli type. Each participant took one of these sets. In the end, all the data were analyzed in two parts of transparent condition and opaque condition, which included 40 items in each prime-target type.

Table 3.1 below represents examples of stimuli for each condition. For each condition (1-9) below, there is an opening line, which indicates which priming effects were compared. As illustrated in the following table, this study was too complicated as it contained too many conditions. In the revised study, which will be discussed later in this chapter, the study is divided into two experiments of nonhead or initial position constituent and head or final position constituent.

Table 3.1

Examples of stimuli for the transparent conditions

Condition	Test Prime	Simple Control Prime	Target
1. Transparent- noun1 <i>versus</i> control simple verb- noun1			
Transparent Compound-NOUN	<i>kaado-daadan</i>	<i>raftan</i>	<i>KAADO</i>
	gift-to give	to go	gift
	‘to give a gift’	‘to go’	‘gift’

2. Transparent-**verb** *versus* control simple verb-**verb**

Transparent Compound-VERB	<i>kaado-daadan</i>	<i>raftan</i>	<i>DAADAN</i>
	gift-to give	to go	to give
	‘to give a gift’	‘to go’	‘to give’

3. Transparent-**transparent** *versus* control simple verb-**transparent**

Transparency similarity	<i>rox-daadan</i>	<i>raftan</i>	<i>KAMAR-BASTAN</i>
	face-to give	to go	belt-to tie
	‘to recognize’	‘to go’	‘to decide’

4. Transparent-**opaque** *versus* control simple verb-**opaque**

Transparency dissimilarity	<i>rox-daadan</i>	<i>raftan</i>	<i>KAADO-DAADAN</i>
	face-to give	to go	gift-to give
	‘to recognize’	‘to go’	‘to give a gift’

Examples of stimuli for the opaque conditions

Condition	Test Prime	Simple Control Prime	Target
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1. Opaque-**noun2** *versus* control simple verb-**noun2**

Opaque Compound-NOUN	<i>rox-daadan</i>	<i>raftan</i>	<i>ROX</i>
	face-to give	to go	face
	‘to happen’	‘to go’	‘face’

2. Opaque-**verb** *versus* control simple verb-**verb**

Opaque Compound-VERB	<i>rox-daadan</i>	<i>raftan</i>	<i>daadan</i>
	face-to give	to go	to give
	‘to happen’	‘to go’	‘to give’

3. Opaque-transparent *versus* control simple verb-transparent

Transparency similarity	<i>rox-daadan</i>	<i>raftan</i>	<i>KAMAR-BASTAN</i>
	face-to give	to go	belt-to tie
	‘to recognize’	‘to go’	‘to decide’

4. Opaque-opaque *versus* control simple verb-opaque

Transparency dissimilarity	<i>rox-daadan</i>	<i>raftan</i>	<i>KAADO-DAADAN</i>
	face-to give	to go	gift-to give
	‘to recognize’	‘to go’	‘to give a gift’

Examples of stimuli for the semantic relatedness condition

Condition	Related Prime	Unrelated Control Prime	Target
Semantically related pairs (doctor-nurse) <i>versus</i> Semantically unrelated pairs (wine-nurse)			
Semantic relatedness	<i>doktor</i>	<i>sharab</i>	<i>PARASTAR</i>
	doctor	wine	nurse
	‘doctor’	‘wine’	‘nurse’

Once the critical stimuli were constructed, they were divided into four lists. In each of these lists, there were one hundred and thirty experimental prime-target pairs, ninety of

which had a verb as target (*rox-daadan* ‘face-to give’ – *DAADAN* ‘to give’ to *happen/to give*) and forty of which had a noun as target (*rox-daadan* ‘face-to give’ – *ROX* ‘face’ to *happen/face*).

Procedure. Forster and Davis’ (1984) masked priming paradigm was employed in this study. The advantage of this paradigm over the competing ones is that constituent priming (i.e., one of the constituents of the prime being in the target or vice versa) had been found robust under masked conditions as reported in the experimental studies on the processing of polymorphemic words (Forster & Davis, 1984; Forster et al., 2003; Evette & Humphreys, 1981; among others). A premask of hashmarks in black appeared on a white screen for 500 ms, followed by the prime, which was displayed for 50 ms, and then followed immediately by the target. The target remained on the screen for 527 ms.. The prime was displayed for the duration of three 16.64 ms long refresh intervals. Using the DMDX software, the reaction times were measured from the onset of the target display on the screen.

Prior to the experiment, the participants filled out two forms: a consent form to indicate their willingness to participate in the study, and a language background questionnaire form in Persian to ensure that their first language was Persian. The experiment was done using a Toshiba laptop. Before the experiment began, the participants received oral instruction as to how to perform the task. In order to hide the purpose of the study and to give meaning to the experiment for the participants, they were told that they were taking a Reaction Time test. There was no mention of the presence of the visual prime. The participants were instructed that they would see a string of letters on the screen

in each trial, and they would have to decide as quickly and as accurately as possible if each of these strings of letters is a word in Persian or not by pressing the WORD (the F button) or the NONWORD (the J button) on the keyboard. All participants had a practice trial for 5 minutes before they were left alone in a quiet room to do the experiment. The whole experiment took approximately 20-25 minutes.

3. 1. 3. Results

One of the problems of the first study was its complexity due to the large number of conditions in one single experiment. However, when analyzing the data, we divided them into two sections: transparent compounds and opaque compounds.

3. 1. 3. 1. Transparent Compounds

Response time and accuracy. As stated earlier, two participants were removed from the analysis due to their high number of errors (96.7%), resulting in a total of forty-six participants. The reason for the high number of errors on the part of these two participants was not known; possibly they were unable to follow the instruction.

For all the remaining forty-six participants, mean reaction times and error rates for each stimulus were calculated using the data obtained by the DMDX software. Then trials with incorrect responses were excluded (approximately 5.5% of the data). Moreover, only the response times which were within 2.5 SD of the mean were retained for analysis (excluding approximately 3.5% of the data).

Response times. A two-way repeated measures Analysis of Variance (ANOVA) was performed to investigate the difference between the priming effects of simple verbs in comparison to transparent compound verbs on: (1) the nominal constituent of the compound verb, (2) the verbal constituent of the compound verb, (3) another transparent compound verb, (4) and an opaque compound verb. Thus the independent variables are the prime type with two levels (simple verb – transparent compound verb) and the target type with four levels (noun – verb – transparent compound verb₂ – opaque compound verb). The dependent variable is the reaction time to the recognition of targets as being existing words in Persian or not through a lexical decision task.

There was a significant effect of prime type $F_1(1, 44) = 141.301, p = .000$; $F_2(1, 38) = 54.494, p = .000$.⁵ As expected, there was a significant effect of target type in participant analysis $F_1(3, 132) = 6.144, p = .001$; but not in item analysis $F_2(3, 114) = 1.611, p = .191$.

⁵ It must be noted that in recent research on word processing, another statistical value called minF' is also calculated rather than two separate analyses of F for items and participants. However, different psycholinguists have used different methods to analyze their data. The mainstream method has been to calculate a separate F1 and F2, i.e. for participant and item analyses.

Yet, a few scholars (Clark, 1973) have used a third value called minF' to generalize at the same time across participants and items. Some have been against minF' (Baayen, 2006-7), who preferred a mixed effect or multi-level modeling; others (Raaijmaker, 1999) noted that F2 analysis is not always required, and in some cases, it leads to a needless loss of power.

In the current study, however, since the goal of the study is to compare the results observed for constituent priming in compound verbs with the results of other studies in the literature, such as Longtin et al. (2003) for French, Rastle et al. (2004) for English, Fiorentino (2006) for English compounds, and Kazanina et al. (2008) for Russian, and since in all these studies, the analysis used has been the F1-F2 mainstream analysis, in order to investigate the generalizability of the results and to compare them to the previous results, the F1-F2 analysis was chosen. In addition, the fact that the data points, which were 2.5 SD above and below the mean were excluded in each analysis, lowers the chance of extreme values, hence the need for calculating minF'. Having said that, I calculated the minF' for several F1 and F2 values reported in this study, and in all of them the same significant results as in F1-F2 were reached. See Appendix D for the calculations.

In addition, there was a significant interaction effect of prime type by target type in participant analysis $F_1(3, 132) = 3.840, p = .011$; but not in item analysis $F_2(3, 114) = 2.098, p = .104$. Further, planned comparisons did not reveal any significant priming effect. Planned comparisons were carried out between the related and unrelated prime-target pairs to see if the observed effect sizes were statistically significant.

Error rates. There was a significant effect of prime type $F_1(1, 44) = 73.599, p = .000$; $F_2(1, 38) = 8.241, p = .007$. There was a significant effect of target type in the participant analysis $F_1(3, 132) = 5.080, p = .002$; but not in the item analysis $F_2(3, 114) = .881, p = .453$. In addition, there was a significant interaction effect of prime type by target type $F_1(3, 132) = 16.038, p = .000$; $F_2(3, 114) = 6.156, p = .001$. However, planned comparisons did not reveal any significant difference between the error rates of related and unrelated prime-target pairs.

Table 3.2 summarizes RT's and % errors for the transparent conditions in this experiment.

Table 3.2

RT and % errors for the transparent condition in the first study

	<i>transparent conditions</i>				
	<i>prime type</i>				
	<u>test prime</u>		<u>simple control</u>		<u>difference</u>
<i>TARGET type</i>	RT	% errors	RT	% errors	RT

Noun	573	4.3	580	4.3	-7 ⁶
Verb	584	1.5	566	2.2	18
Transparent comp	691	5.6	695	6.9	-4
Opaque comp	745	13.7	709	14	36

There is no significant RT difference in the transparent condition in the masked priming experiment. In other words, there is no significant constituent priming effect observed for the constituents of the transparent compound verbs. However, constituent priming for the nominal constituent is numerically greater than the verbal constituent. This trend, i.e., the greater nominal constituency effect, is later observed in the opaque condition in Experiment 1 as well as in Experiments 2a and 2b.

Neither is there a transparency similarity effect as transparently similar and transparently dissimilar pairs did not show significantly different results. However, the transparent-transparent condition resulted in a numerically greater priming effect for the target than did the transparent-opaque. In fact, a very strong priming effect in the transparent-opaque prime-target pair could be an indication of a strong inhibition when a transparent compound prime is followed by an opaque compound target. At first, this inhibitory effect could be taken as supporting evidence for the claim that the compound being a part of the lexicon, in that, transparent-transparent prime-target pairs show greater priming effect than transparent-opaque prime-target pairs. In other words, when the prime and the target are both transparent compounds, there is a stronger priming effect than when the prime is a transparent compound, but the target is an opaque compound.

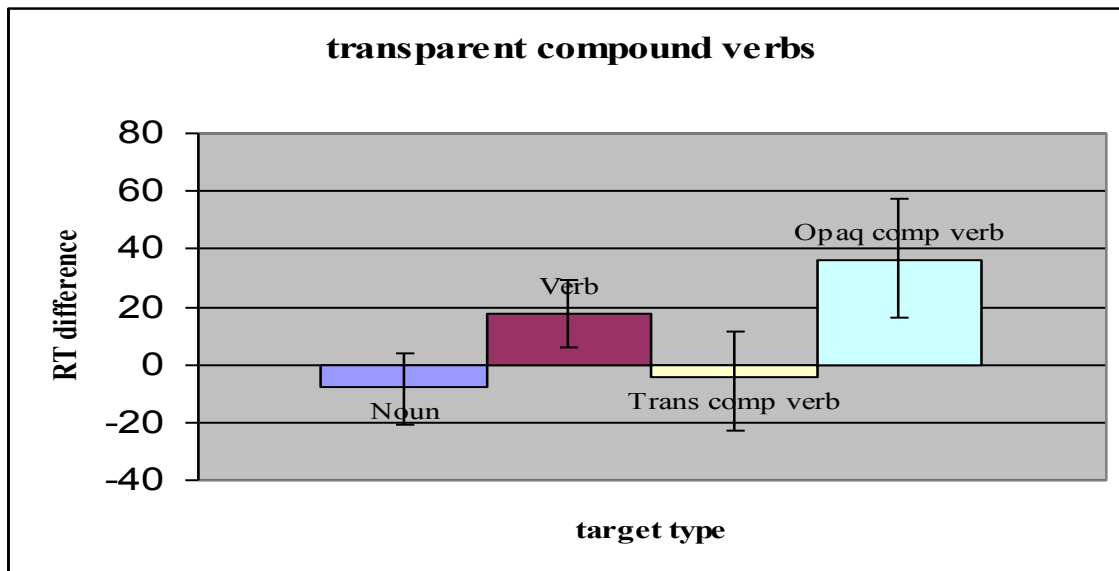
⁶ It should be noted that throughout this study, a negative priming effect is a facilitatory effect, whereas a positive priming effect is an inhibitory effect. The reason is that the priming effect was calculated by subtracting the response time in the control pair from the response in the experimental pair.

However, this finding cannot be generalized because in the opaque conditions the opaque-transparent condition also resulted in a numerically higher priming effect for the target than did the opaque-opaque. These results can imply that, in general, participants find it easier to recognize transparent compound verbs as existing words in Persian than they do with opaque compound verbs.

Figure 3.1 below illustrates RT differences for each target type for the transparent prime.

Figure 3.1

RT difference for target types in the transparent condition



As the error bars show, there is no significant RT difference in different target types. However, the nominal constituent shows a relatively stronger priming effect than the verbal constituent in the transparent condition. This finding, though not significant, is seen as a trend in the opaque condition in the first study as well as the transparent condition of the second study.

In the next section, the results of the opaque condition will be reported.

3. 1. 3. 2. Opaque Compounds

Response time and accuracy. For the forty-six participants, mean reaction times and error rates for each stimulus were calculated using the data obtained by the DMDX software. Then trials with incorrect responses were excluded (approximately 5.5% of the data). Moreover, only the response times which were within 2.5 SD of the mean were retained for analysis (excluding approximately 3.5% of the data).

Response times. A two-way repeated measures ANOVA was performed to investigate the difference between the priming effects of simple verbs in comparison to opaque compound verbs on: (1) the nominal constituent of the compound verb, (2) the verbal constituent of the compound verb, (3) a transparent compound verb, (4) and another opaque compound verb. Thus the independent variables are the prime type with two levels (simple verb – opaque compound verb) and the target type with four levels (noun – verb – transparent compound verb – opaque compound verb₂). The dependent variable is the reaction time to the recognition of targets as being existing words in Persian or not through a lexical decision task.

There was a significant effect of prime type $F_1(1, 44) = 150.852, p = .000$; $F_2(1, 38) = 89.543, p = .000$. As expected, there was a significant effect of target type in participant analysis $F_1(3, 132) = 3.807, p = .012$; but not in item analysis $F_2(3, 114) = 2.012, p = .116$.

In addition, there was a significant interaction effect of prime type by target type $F_1(3, 132) = 4.839, p = .003$; $F_2(3, 114) = 2.929, p = .037$. Further, planned comparisons revealed a significant facilitatory nominal priming effect $t_1=3.324, p = .001$; $t_2=2.051, p = .047$. In other words, “Yes” responses to noun targets were faster when the noun targets were preceded by a compound verb that contained them than when they were preceded by an unrelated simple verb.

Error rates. There was a significant effect of prime type $F_1(1, 44) = 81.903, p = .000$; $F_2(1, 38) = 7.152, p = .011$. There was no significant effect of target type $F_1(3, 132) = 2.361, p = .074$; $F_2(3, 114) = .708, p = .549$. In addition, there was a significant interaction effect of prime type by target type $F_1(3, 132) = 19.283, p = .000$; $F_2(3, 114) = 6.391, p = .000$. However, planned comparisons did not reveal any significant difference between the error rates of related and unrelated prime-target pairs. Table 3.3 summarizes RT’s and % errors for the opaque conditions in this experiment.

Table 3.3

RT and % errors for the opaque condition in the first study

	<i>opaque conditions</i>				
	<i>prime type</i>				
	<u>test prime</u>		<u>simple control</u>		<u>difference</u>
<i>TARGET type</i>	RT	% error	RT	% errors	RT
Noun	573	4.3	606	7.4	-33**
Verb	579	2.4	566	2.2	13

Transparent comp	685	8.0	695	6.9	-10
Opaque comp	739	14.6	709	14	30

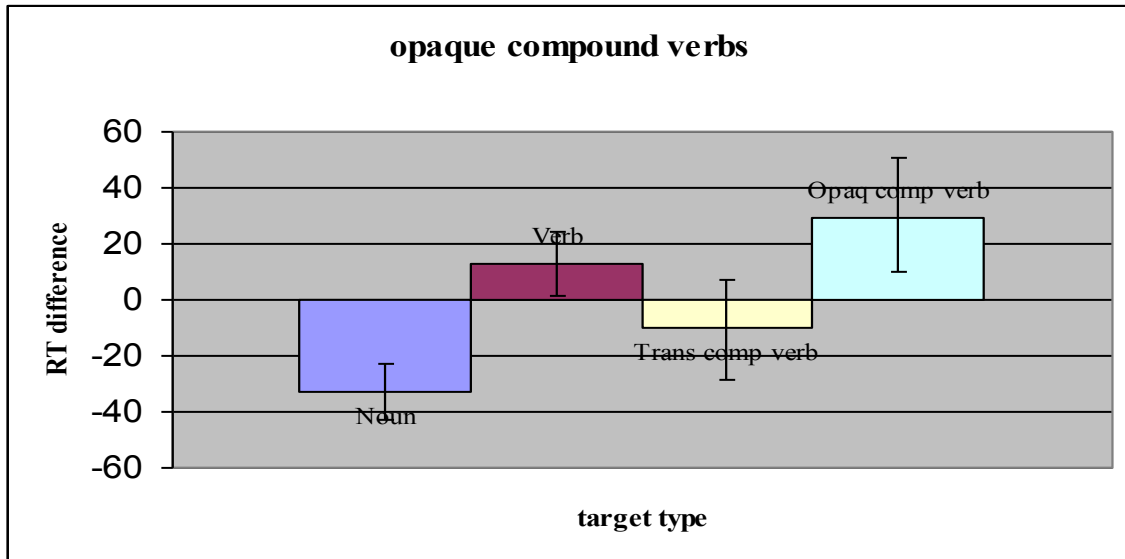
* $p < .005$ ** $p < .001$

There is a significant RT difference when the opaque prime is followed by its nominal constituent. The negative sign indicates that there was a facilitatory effect when the opaque prime was followed by its nominal constituent as the target. This finding, however, must be taken with caution as it is not compatible with other masked priming studies on complex and compound word processing (e.g., Longtin et al., 2003; Fiorentino, 2006; among others). In these studies, the constituents of the transparent polymorphemic word show either a similar or a numerically greater constituent priming effect compared to the constituents of the opaque polymorphemic words. Another observation in this table is a solid inhibitory effect of 30 ms for the opaque-opaque prime-target pair in comparison to the opaque-transparent prime-target pair. This finding, however, is contrary to the findings of the transparent condition, where transparent-transparent prime-target pairs showed greater priming effect than transparent-opaque prime-target pairs. Therefore, we cannot generalize on the basis of these contradictory results.

Figure 3.2 below illustrates RT differences for each target type for the opaque prime.

Figure 3.2

RT difference for target types in the opaque condition



As the error bars indicate, the only significant RT difference occurs when the opaque prime is followed by its nominal constituent. As in the transparent condition, here, too, we observe a stronger priming effect for the nominal constituent than the verbal constituent.

The Related-Unrelated filler pairs (*doctor-NURSE*, *wine-NURSE*) were analyzed separately as follows.

3. 1. 3. 3. Related-Unrelated filler pairs (*doctor-NURSE*, *wine-NURSE*) comparison

Planned comparisons did not reveal a significant facilitatory priming effect $t = 1.112$, $p = .272$ for the related-unrelated filler pairs (*doctor-NURSE*, *wine-NURSE*) in the masked priming experiment.

semantic relatedness condition

<i>prime type</i>				
<u>related prime</u>		<u>unrelated control</u>		<u>difference</u>
RT	% errors	RT	% errors	RT
579	6.4	580	9.4	1

In addition, the Wilcoxon Signed Ranks Test confirmed this result $Z_1 = -.73, p > .05$; $Z_2 = -1.43, p > .05$. Wilcoxon Signed Ranks Test is a non-parametric test, and it was done to verify the robustness of the results of the semantically related versus semantically unrelated pairs. This finding is compatible with the results of other studies on semantic relatedness (e.g., Marslen-Wilson et al., 2008; among others), which argue that semantic information is calculated lexically at longer SOA's, for example, under unmasked conditions.

In conclusion, the results of Experiment 1 indicate a constituency effect for the nominal constituent, which is significant in the opaque conditions but did not reach significance in the transparent condition. As mentioned earlier, this is not compatible with the results of other studies on complex and compound word processing, where constituency effect has been reported to be equal or greater in the transparent condition compared to the opaque condition. These unexpected and incoherent results might be due to some methodological shortcomings of Experiment 1. For example, in this experiment, the relatedness and the frequency ratings of the primes and targets were not controlled systematically; in addition, some participants might have needed a longer trial test. These extraneous factors might have affected the results. Therefore, a second experiment was

carried out, where there was more control over these extraneous factors that were likely to affect the results.

Nevertheless, in this experiment, there is a trend for the nominal constituent to have a stronger facilitation than the verbal constituent in both transparent (non-significant) and opaque (significant) compound verbs. This finding will also be observed in the second study (only in the transparent condition) which is compatible with other experimental studies on polymorphemic word processing (e.g., Longtin et al., 2003; Fiorentino, 2006; among others), where constituent priming is stronger in transparent complex and compound words than in opaque complex and compound words. In other words, the nominal constituent shows a stronger facilitation compared to the verbal constituent when preceded by the transparent compound. We will argue later in this chapter that, in transparent compounds, the parallel input or competing alternatives for the verbal constituent can account for the increase in the processing load, which results in less significant priming for the verbal constituent of the transparent compound verbs compared to the nominal constituent of these verbs.

The first study was replicated in a second study with an additional condition of orthographic relatedness so that we would be able to investigate whether the observed constituent effects are morphological or whether they are due to other relations between the prime and the target, such as orthographic relation.

3. 2. Experiment 2

The current study included two masked priming experiments: Experiment 2a priming of the non-head constituent, which is in the word-initial position; and Experiment 2b priming of the head constituent, which is in the word-final position.

In this section, these two masked priming experiments, which were carried out on Persian opaque and transparent noun-verb compound verbs will be discussed. The stimuli include relatively transparent (e.g., *qazaa-xordan* ‘food-to eat’ - *QAZAA* ‘food’ *to eat*), relatively opaque (e.g., *qasam-xordan* ‘oath-to eat’ - *QASAM* ‘oath’ *to swear* - *oath*) and orthographically overlapping (e.g., *shenaaxtan* ‘to recognize’ - *SHENAA* ‘swimming’) prime-target pairs.

In Experiment 2a, the priming for the non-head, i.e., word-initial constituent will be investigated. In Experiment 2b, the priming for the head, i.e., word-final constituent will be examined. As mentioned at the beginning of this chapter, the non-head of Persian compound verbs can vary from a noun, to an adjective, or a prepositional phrase or an adverb; however, the type of compound verb that has been focused on throughout the present study is the noun-verb compound verb.

The aim of the two experiments was to investigate the role of semantic transparency as well as morphological structure on the processing of compound verbs in Persian. Therefore the research questions were: (1) Do compound verb constituents show significant priming in the masked-priming paradigm? (2) Are priming effects constrained by semantic transparency? (3) Are priming effects due to morphological relatedness? The results were then compared with the results observed in other experimental studies on the

processing of compound words (Fiorentino, 2006; among others) and on affixed words (Longtin et al, 2003; among others).

One of the goals of the present study was to compare its results with similar studies on complex and compound word processing in other languages. Therefore, based on the results reported for these studies, we can make several predictions in addressing the above research questions.

In other experimental studies on the processing of compound words (Fiorentino, 2006; among others) and on affixed words (Longtin et al, 2003; among others), it is claimed that at early stages of processing, morphological relatedness modulates the decomposition of a complex/compound word. Therefore, we would expect to have a positive answer to questions 1 and 3. However to answer question 2, if Persian is like other Indo-European languages we would expect not to observe semantic transparency effect under masked conditions, so the answer would be negative.

The next section reports and discusses the subsections of the current study.

3. 2. 1. Relatedness rating study

In order to choose a set of prime-target pairs for the priming experiment, first, a rating study on an initial set of 180 candidate compound words was conducted. This study was done in Iran with twenty native speakers of Persian, who had to complete a rating questionnaire. The task was to rate, on a 7-point scale – where 1 represented the least related and 7 represented the most related – the semantic relatedness between the primes that were the noun-verb compound verbs and the targets that were either the nominal or the verbal constituents of those noun-verb compound verbs (e.g., *qasam-xordan* ‘oath-to eat’ -

QASAM ‘oath’ to swear/oath or *qasam-xordan* ‘oath-to eat’ - *XORDAN* ‘to eat’ to swear/to eat). From among the initial highest-and-lowest rated pairs, 160 pairs were selected, i.e., 40 transparent and 40 opaque for each experiment: Experiment 2a (non-head) and Experiment 2b (head). In each list of pairs, the prime was a compound verb and the target was the nominal constituent of this compound verb in Experiment 2a (non-head, i.e., word-initial constituent) and the verbal constituent of this compound verb in Experiment 2b (head/word-final). The results of the relatedness ratings will be reported in each experiment.

3. 2. 2. Frequency rating study

A frequency corpus that would include Persian compound verbs was unavailable to the researcher. Therefore, the frequencies of the experimental and control prime-target pairs were compared by conducting a frequency rating experiment (for a study on problems in corpus building in Persian, read Ghayoomi et al., 2010). This was another screening measure that was taken when choosing the stimuli. In this phase of the study, twenty native speakers of Persian rated the commonality of compound verbs and their constituents on a 7-point scale, where 1 represented the lowest frequency and 7 represented the highest frequency. Participants were instructed as follows, “Assign a number from 1-7 to indicate the frequency of the following words: 1 for the lowest frequency and 7 for the highest frequency.” Later, the frequencies of the experimental and control prime-target pairs were compared using a one-way Analysis of Variance (ANOVA). The results of the frequency ratings will be reported in each experiment.

3. 2. 3. Experiment 2a. Priming of non-head/word-initial position

In Experiment 2a, the priming of the nominal constituent of a compound verb, which is also the word-initial non-head constituent, is tested, while the compound verb is used as the prime (e.g., *zabaan-rixtan* ‘tongue-to pour’ – *ZABAAN* ‘tongue’ to *flatter-tongue*).

3. 2. 3. 1. Method

Participants. Forty native speakers of Persian, all university students in Iran between the ages 20-35 with normal or corrected-to-normal vision, gave their written informed consent to participate in the study.

Stimuli. The experimental prime-target pairs included 120 primes which were paired with monomorphemic targets. The pairs consisted of: 40 relatively semantically transparent Persian compound verbs as the prime (e.g., *chaai-rixtan* ‘tea-to pour’ to *pour tea*) and their nonhead (i.e., initial) constituent as the target (*CHAAI* ‘tea’); 40 relatively semantically opaque Persian compound verbs as the prime (e.g., *zabaan-rixtan* ‘tongue-to pour’ to *flatter*) and their nonhead (i.e., initial) constituent as the target (*ZABAAN* ‘tongue’); and 40 primes containing an embedded pseudo-morpheme in the word-initial position and a non-morphological ending (e.g., *shenaaxtan* ‘to recognize’) with the embedded pseudo-morpheme as the target (e.g., *SHENAA* ‘swimming’).

These experimental primes were paired with 120 unrelated control primes. The experimental primes and the control primes were identical in length and proportion of prime-target overlap and matched on frequency (all $F < 1$, $p > .56$, one-way ANOVA). The

orthographic-overlap primes and their corresponding control primes were also matched in length and frequency.

Table 3.4 below represents examples of stimuli for each condition.

Table 3.4

Examples of stimuli: Experiment 2a

Condition	Test Prime	Control Prime	Target
Transparent Compound Prime	<i>chaai-rixtan</i>	<i>davaa-xordan</i>	<i>CHAAI</i>
	tea-to pour	medicine-to eat	tea
	‘to pour tea’	‘to take medicine’	‘tea’
Opaque Compound Prime	<i>zabaan-rixtan</i>	<i>zur-zadan</i>	<i>ZABAAN</i>
	tongue-to pour	strength-to hit	tongue
	‘to flatter’	‘to try very hard’	‘tongue’
Orthographic Form Overlap	<i>shenaaxtan</i>	<i>resaandan</i>	<i>SHENAA</i>
	‘to recognize’	‘to give sb a ride’ ‘swimming’	

The transparent, opaque and orthographically overlapping conditions were matched with one another on prime-target length ratio, i.e., the average length of the primes over the average length of the target, as well as prime-target frequency ratio, i.e., the average frequency rate of the prime over the average frequency rate of the target. The reason why

prime-target length ratio was considered rather than the prime length and the target length separately is due to the writing system in the Persian language, where short vowels are almost never written, yet long vowels are usually written. Therefore, the length of the word cannot be on the basis of counting the letters or on the basis of counting the phonemes as there could be vowels that are written but not read or vowels that are not written but read. Therefore, this technique was used to give a more homogeneous way of comparing prime-target pair length. To establish uniformity, the same technique was used to report the frequency as well. The results are summarized below in Table 3.5.

Table 3.5

Stimulus Properties: Experiment 2a

	Condition			ANOVA
	Transparent	Opaque	Form	
Prime/Target Length Ratio	2.4	2.6	2.25	F(2,117) = 2.37 <i>p</i> > .05, n.s.
Prime/Target Frequency Ratio	.99	1	1	F(2,117) = .23 <i>p</i> > .05, n.s.
Prime/Target Relatedness Ratio	7	1.02	1	F(2,117) = 3.07 <i>p</i> < .001, s.

The statistical tests reported here are one-way ANOVA.

The relatively semantically opaque and relatively semantically transparent compounds were rated significantly different in the relatedness rating experiment, which was conducted before the main experiments (refer to Section 3.2.1.). Out of the 7-point scale, transparent pairs received an average rating of 7 (standard error 0.0), opaque pairs were rated 1.02 (standard error 0.02). The difference was significant on a two-tailed paired t-test ($t(39) = 239, p < .001$). Relatedness ratings for the form overlap condition had an average rating of 1 (standard error 0.0). The difference in the relatedness ratings of the prime-target pairs among the three conditions of opaque, transparent and form overlap was significant ($F(2, 117) = 3.07, P < .001$) as reported in table 3.5.

In order to make the word to nonword ratio 1:1, an additional 120 words were added that included 80 compound verbs and 40 words with an embedded pseudo-morpheme. These 120 words served as primes for 120 nonword targets. These nonword targets were pronounceable since in Persian, short vowels are almost never written, so you can pronounce any order of consonants considering that you can add any of the three short vowels (i.e., /a/, /e/, and /o/) in between (e.g., *sar* ‘head’, *ser* ‘secret’, and *sor* ‘slippery’).

The targets were divided into two counterbalanced lists: one list including half of the experimental targets and preceded by related primes; the other list including the second half of the experimental targets and preceded by unrelated control primes. The total number of trials each participant had to respond to was 240.

Procedure. DMDX software (Forster & Forster, 2003) was used to present the stimuli in the centre of the screen in B Zar black font on a white background. As there is no difference between upper or lower case in the Persian writing system, the primes were

differentiated from targets by writing the targets in bold and with bigger fonts. Before the outset of the experiment, participants were instructed that they would see strings of letters on the screen and they had to decide as quickly and as accurately as possible whether each string of letters was a word or a nonword in Persian. Each trial began with a 500 ms presentation of hash marks (#####) in the centre of the screen as the forward mask, which was roughly equal to the length of the prime that was going to follow. The mask was followed by a 50 ms presentation of the prime in the centre of the screen followed by the target stimulus which remained on the screen until the participant's response or a 2500 ms timeout. A given trial looked like (##### / *qasam-xordan* - QASAM)⁷.

WORD and NONWORD responses were recorded upon pressing two buttons on the keyboard. The key on the left (i.e., “F”) was for the WORD and the key on the right (i.e., “J”) was for the NONWORD. In order to make it more visible for the participants, WORD and NONWORD stickers were posted on the upper-left and upper-right corners of the keyboard, below the screen in addition to the ones attached on the “F” and “J” keys. Each participant completed a practice experiment that was different from the list he was going to respond to, and he took this trial test until he was comfortable with doing the task. This was done because it took different participants different time lengths to understand how to do the task.

3. 2. 3. 2. Results

The DMDX software recorded the response times from the onset of the target display. Incorrect responses (5%) and response times that were over 1500 (0.5%) were removed

⁷ (##### / *qasam-xordan* ‘oath-to eat’ - QASAM ‘oath’ to swear / oath)

from the data. Response times and accuracy rates were analyzed statistically using both participant mean and item mean data using a 3x2 Repeated-Measure ANOVA, with *Condition* (Transparent / Opaque / Orthographic-Overlap) and *Relatedness* (Related / Unrelated) as factors.

Table 3.6 summarizes the results of priming of non-head or word-initial position by participants. It represents the response time and the accuracy rates of each prime type; it also indicates the mean difference between the experimental and the control prime-target pairs.

Table 3.6

Priming of Nominal Constituent in Non-head/Word-initial Position (by Participants)

Condition	Response Time in ms.		Mean Difference
	<i>Target</i>	<i>Control</i>	<i>(Priming)</i>
	Mean (SE)-Accuracy	Mean (SE)-Accuracy	
<i>Transparent Compound Primes</i>	519 (5.04)-98%	559-5.41-96%	-40**
<i>Opaque Compound Primes</i>	513 (5.3)-98%	538-5.59-96%	-25*
<i>Orthographically Overlapping Primes</i>	542 (6.43)-97%	568-5.61-95%	-26*

* p < .005 ** p < .001

As illustrated by Table 3.6, there is significant constituent priming for the nominal constituents of both transparent and opaque compound verbs as well as for the initial pseudo-morpheme of the orthographic overlap condition. Yet, the constituent priming for the nominal constituent of the transparent compound verbs is numerically greater compared to the constituent priming for the nominal constituent of the opaque compound verbs as well as for the initial pseudo-morpheme of the orthographic overlap condition.

Response Time. The response time results indicated a significant effect of *Condition* both by participants and items ($F_1(2, 78) = 62.083$, $MSE = 286.501$, $p < .001$; $F_2(2, 78) = 6.469$, $MSE = 2845.116$, $p < .005$). There was also a significant effect of *Relatedness* both by participants and items ($F_1(1, 39) = 199.643$, $MSE = 277.121$, $p < .001$; $F_2(1, 39) = 70.635$, $MSE = 840.792$, $p < .001$). The *Condition* \times *Relatedness* interaction was significant by participants ($F_1(2, 78) = 6.188$, $MSE = 164.225$, $p < .005$), but did not reach significance by items ($F_2(2, 78) = 1.572$, $MSE = 990.591$, $p = .214$).

The transparent condition yielded the most robust facilitation for the related vs. the unrelated control prime type (40 ms), whereas opaque and orthographically overlapping conditions each showed significant facilitation (25 and 26 ms facilitation respectively). This is shown in the following set of planned comparisons regarding the effect of relatedness on each condition.

Planned comparisons, using the Bonferroni test, showed a highly significant facilitation for the related versus unrelated prime types within transparent condition by participants and items ($F_1(1, 78) = 29.533$, $MSE = 467.3509$, $p < .001$; $F_2(1, 78) = 26.732$, $MSE = 1320.909$, $p < .001$). Planned comparisons also showed a significant response time

facilitation for the opaque condition by participants and items ($F_1(1, 78) = 10.563$, $MSE = 473.5986$, $p < .005$; $F_2(1, 78) = 26.732$, $MSE = 1992.809$, $p < .005$) as well as for the orthographically overlapping condition by both participants and items ($F_1(1, 78) = 29.533$, $MSE = 408.9688$, $p < .005$; $F_2(1, 78) = 26.732$, $MSE = 1747.206$, $p < .005$). This significant difference was observed in a planned direct comparison of the magnitude of the priming effect (prime-control response time) across transparent and opaque conditions, which yielded a significant result in a two-tailed t-test by participants ($t(39)=3.255$, $p<.05$), although not by items ($t(39)=1.629$, $p>.05$). Planned comparisons were carried out between the related and unrelated prime-target pairs to see if the observed effect sizes were statistically significant.

Accuracy. The accuracy results also yielded a significant effect of *Condition* by participants ($F_1(2, 78) = 4.850$, $MSE = 6.723$, $p = .01$, although it did not reach significance by items $F_2(2, 78) = 1.160$, $MSE = 28.117$, $p > .05$). There was also a significant effect of *Relatedness* both by participants and items ($F_1(1, 39) = 32.117$, $MSE = 4.321$, $p < .001$; $F_2(1, 39) = 16.454$, $MSE = 8.434$, $p < .001$). The *Condition* x *Relatedness* interaction was not significant by participants or by items ($F_1(2, 78) = .615$, $MSE = 7.284$, $p > .05$; $F_2(2, 78) = .370$, $MSE = 12.118$, $p > .05$).

Planned comparisons showed significant effects of accuracy, revealing an increase in accuracy for the related vs. unrelated prime type for transparent condition both by participants and items ($F_1(1, 78) = 17.586$, $MSE = 6.838$, $p < .001$; $F_2(1, 78) = 5.886$, $MSE = 19.920$, $p < .05$). A significant effect of accuracy revealing an increase in accuracy was observed for the related vs. unrelated prime type for opaque condition by participants

($F_1(1, 78) = 5.465$, $MSE = 7.411$, $p < .05$, but not by items $F_2(1, 78) = 2.021$, $MSE = 17.319$, $p > .05$). There was no significant effect for the orthographically overlapping condition by participants or items ($F_1(1, 78) = 3.232$, $MSE = 9.501$, $p > .05$; $F_2(1, 78) = 1.076$, $MSE = 25.668$, $p > .05$). A planned comparison of the magnitude of the priming effect with respect to accuracy (prime-control accuracy) across transparent and opaque conditions was not significant in a two-tailed t-test by participants ($t(39)=-1.08$, $p>.05$), or by items ($t(39)=-0.854$, $p>.05$).

3. 2. 3. 3. Discussion

The research questions addressed in the present study were: (1) Do compound verb constituents show significant priming in the masked-priming paradigm? (2) Are priming effects constrained by semantic transparency? (3) Are priming effects due to morphological relatedness?

The results of Experiment 2a revealed highly significant priming for the nominal constituents of transparent noun-verb compound verbs (40 ms facilitation). Opaque and orthographically overlapping conditions yielded a significant priming effect (25 and 26 ms facilitation respectively). This gives positive responses to the first two research questions; that is, the constituents of compound verbs in Persian are primed, and semantic transparency has an effect on priming. However, the third research question did not yield a positive answer as the priming effect of the pseudo-morpheme of the orthographically overlapping condition indicated. In other words, the results of Experiment 2a reveal a priming effect for the target when it is orthographically contained within the prime regardless of morphological relationship between the prime and the target. This seems

compatible with the distributed connectionist model of lexical processing (Hay and Baayen, 2005; Gonnerman et al., 2007; among others), where morphemes are not represented directly but rather considered to be the consequence of regular mapping between form and meaning. In addition, as Smolka (2010) puts it, in morphologically rich systems, these mappings are straightforward and dominate the system. In fact, in this model, there is a direct connection between semantic overlap and formal overlap, in that, the more two words have formal overlap, the more priming will be observed between them provided that the semantic overlap is held constant. Under such an approach, there should be a significant difference between the priming effect in the transparent condition in which the prime-target pairs are semantically related and the opaque condition in which the prime-target pairs are not semantically related. In Experiment 2a, the masked priming experiment supported this prediction as the size of the constituent priming effect in transparent pairs was greater than the size of the constituent priming effect in opaque and orthographic pairs. It must be noted that in our study, we investigated the priming of compound verbs, where the prime duration was only 50 ms, which would only represent prelexical activity. Therefore, we argue that at very early stages of processing, the parser only has enough time for orthographical processing in compound verbs in Persian. In fact, constituent priming effects observed in semantically transparent, semantically opaque and orthographically overlapping prime-target pairs indicate that noun-verb compound verbs in Persian are processed orthographically, which is in turn affected by semantic transparency and parallel input effect. This finding is compatible with the findings of similar studies on morphologically rich languages like German (e.g., Smolka et al., 2010; among others), but

incompatible with the findings of similar studies on morphologically less rich languages like English (e.g., Fiorentino et al., 2009; among others).

Similar to our study, other studies using comparable primes and masked-priming conditions, with priming durations between 32-66 ms, have observed facilitation due to pure orthographic similarity without morpheme-like endings; for example, primes like *tinsel* facilitated the recognition of a target like *TIN* (Diependaele et al., 2005; Feldman, 2000; Giraudo & Grainger, 2000; Rastle et al., 2000; Segui & Grainger, 1990; among others). In other words, at very early stages of processing, orthographic priming occurs without semantic or morphological relationship. Likewise, Meunier and Longtin (2007) argue that complex words are processed in two stages: (1) the prelexical stage, in which complex words are decomposed on an orthographic basis; (2) the lexical stage, where the decomposed constituents are reappraised for semantic and syntactic information. At this stage, if the words are decomposed in an incorrect way, as in semantically opaque words, they will be corrected through the reappraisal process. This is supported by the results of Experiment 2, where the compound verbs are decomposed on an orthographic basis as illustrated by the significant priming effects of the targets in transparent, opaque and orthographic overlap conditions, as well as by the most robust priming effect for the transparent prime-target pairs where a reappraisal does not seem to be needed.

Experiment 2a investigated the priming of the first constituent that is the non-head in noun-verb compound verbs in Persian. Significant priming effects were observed for the target in transparent, opaque and orthographic overlap conditions, while the priming effect was the most robust in the transparent condition.

In Experiment 2b, the priming of the head morpheme, which is in the word-final position, will be investigated.

3. 2. 4. Experiment 2b. Priming of head/word-final position

In Experiment 2b, the priming of the verbal constituent of a compound verb, which is also the word-final or the head constituent, is tested, while the compound verb is used as the prime (e.g., *del-daadan* ‘heart-to give’ – *DAADAN* ‘to give’ *to fall in love / to give*).

3. 2. 4. 1. Method

Participants. Forty additional Persian speakers of Persian, all university students in Iran between the ages 20-35 with normal or corrected-to-normal vision, gave their written informed consent to participate in the study.

Stimuli. The experimental prime-target pairs included 120 primes which were paired with monomorphemic targets. The pairs consisted of: 40 relatively semantically transparent Persian compound verbs as the prime (e.g., *kaado-daadan* ‘gift-to give’ *to give a gift*) and their head (i.e., final) constituent as the target (*DAADAN* ‘to give’); 40 relatively semantically opaque Persian compound verbs as the prime (e.g., *del-daadan* ‘heart-to give’ *to fall in love*) and their head (i.e., final) constituent as the target (*DAADAN* ‘to give’); and 40 primes containing an embedded pseudo-morpheme in the word-final position and a non-morphological onset (e.g., *xandidan* ‘to laugh’) with the embedded pseudo-morpheme as the target (e.g., *DIDAN* ‘to see’).

These experimental primes were paired with 120 unrelated control primes. The experimental primes and the control primes were identical in length and proportion of prime-target overlap and matched on frequency (all $F < 1$, $p > .56$, one-way ANOVA). The orthographic-overlap primes and their corresponding control primes were also matched in length and frequency.

Table 3.7 below represents examples of stimuli for each condition.

Table 3.7

Examples of stimuli: Experiment 2b

Condition	Test Prime	Control Prime	Target
Transparent Compound Prime	<i>kaado-daadan</i>	<i>baalaa-raftan</i>	<i>DAADAN</i>
	gift-to give	up-to go	to give
	‘to give gifts’	‘to go up’	‘to give’
Opaque Compound Prime	<i>del-daadan</i>	<i>lab-duxtan</i>	<i>DAADAN</i>
	heart-to give	lip-to sew	to give
	‘to fall in love’	‘to be silent’	‘to give’
Orthographic Form Overlap	<i>xandidan</i>	<i>xaabaandan</i>	<i>DIDAN</i>
	‘to laugh’	‘to make sb sleep’	‘to see’

The transparent, opaque and orthographically overlapping conditions were matched with one another on prime-target length ratio, i.e., the average length of the primes over the average length of the target as well as prime-target frequency ratio, i.e., the average frequency rate of the prime over the average frequency rate of the target. The reason why the prime-target length ratio was considered rather than the prime length and the target length separately is described in experiment 2a. The results are summarized below in Table 3.8.

Table 3.8

Stimulus Properties: Experiment 2b

	Condition			ANOVA
	Transparent	Opaque	Form	
Prime/Target Length Ratio	1.55	1.4	1.3	F(2,117) = 2.47 <i>p</i> > .05, n.s.
Prime/Target Frequency Ratio	.99	1	1	F(2,117) = .64 <i>p</i> > .05, n.s.
Prime/Target Relatedness Ratio	7	1.02	1	F(2,117) = 3.07 <i>p</i> < .01, s.

The statistical tests reported here are one-way ANOVA.

The relatively semantically opaque and relatively semantically transparent compounds were rated significantly different in the relatedness rating experiment, which was initially

conducted before the main experiments (refer to section 3.2.1.). Out of the 7-point scale, transparent pairs received an average rating of 6.975 (standard error 0.025), opaque pairs were rated 1 (standard error 0.0). The difference was significant on a two-tailed paired t-test ($t(39) = 239, p < .001$). Relatedness ratings for the form overlap condition had an average rating of 1 (standard error 0.0). The difference in the relatedness ratings of the prime-target pairs among the three conditions of opaque, transparent and form overlap was significant ($F(2, 117) = 3.07, P < .01$) as reported in table 3.8.

In order to make the word to nonword ratio 1:1, an additional 120 words were added that included 80 compound verbs and 40 words with an embedded pseudo-morpheme. These 120 words served as primes for 120 pronounceable nonword targets.

The targets were divided into two counterbalanced lists: one list including half of the experimental targets and preceded by related primes; the other list including the second half of the experimental targets and preceded by unrelated control primes. The total number of trials each participant had to respond to was 240.

Procedure. The procedure in Experiment 2b was identical to that in Experiment 2a. A given trial looked like (##### / *qasam-xordan* - *XORDAN*)⁸.

Below the results of Experiment 2b will be reported and described.

3. 2. 4. 2. Results

The DMDX software recorded the response times from the onset of target display. Incorrect responses (5%) and response times that were over 1500 (0.5%) were removed

⁸ (##### / *qasam-xordan* ‘oath-to eat’ – *XORDAN* ‘to eat’ to swear / to eat)

from the data. Response times and accuracy rates were analyzed statistically using both participant mean and item mean data using a 3x2 Repeated-Measure ANOVA, with *Condition* (Transparent / Opaque / Orthographic-Overlap) and *Relatedness* (Related / Unrelated) as factors.

Table 3.9 summarizes the results of priming of head/word-final position by participants. It represents the response time and the accuracy rates of each prime type; it also indicates the mean difference between the experimental and the control prime-target pairs.

Table 3.9

Priming of Head/Word-final Position (by Participants)

Condition	Response Time in ms.		Mean Difference (Priming)
	Target	Control	
	Mean (SE)-Accuracy	Mean (SE)-Accuracy	
<i>Transparent Compound Primes</i>	515 (6.10)-98%	532 (6.14)-97%	-17*
<i>Opaque Compound Primes</i>	507 (5.59)-98%	532 (6.15)-97%	-25*
<i>Orthographically Overlapping Primes</i>	526 (6.40)-96%	551 (6.64)-93%	-25*

* p < .005 ** p < .001

As illustrated by Table 3.9, there is significant constituent priming for the verbal constituents of both transparent and opaque compound verbs as well as for the final pseudo-morpheme of the orthographic overlap condition. Yet, the constituent priming for the verbal constituent of the transparent compound verbs is numerically smaller compared to the nominal constituent priming of the transparent compound verbs, whereas the constituent priming for the verbal constituent of the opaque compound verbs is numerically similar to the nominal constituent priming of the opaque compound verbs.

Response Time. The response time results indicated a significant effect of *Condition* both by participants and items ($F_1(2, 78) = 40.425$, $MSE = 205.637$, $p < .001$; $F_2(2, 78) = 5.020$, $MSE = 2374.235$, $p = .01$). There was also a significant effect of *Relatedness* both by participants and items ($F_1(1, 39) = 72.066$, $MSE = 420.775$, $p < .001$; $F_2(1, 39) = 33.486$, $MSE = 1106.902$, $p < .001$). The *Condition* x *Relatedness* interaction did not reach significance by participants or by items ($F_1(2, 78) = 2.995$, $MSE = 164.225$, $p > .05$; $F_2(2, 78) = .937$, $MSE = 985.750$, $p > .05$).

Transparent, opaque and orthographically overlapping conditions all yielded facilitation for the related vs. the unrelated control prime type (17 ms, 25 ms and 25 ms respectively). This is shown in the following set of planned comparisons regarding the effect of relatedness on each condition.

Planned comparisons showed a significant facilitation for the related versus unrelated prime types within the transparent condition by participants and items ($F_1(1, 78) = 3.888$, $MSE = 398.8579$, $p = .05$; $F_2(1, 78) = 4.585$, $MSE = 1178.345$, $p < .05$). Planned comparison also showed a significant response time facilitation for the opaque condition

by participants and items ($F_1(1, 78) = 9.850, \text{MSE} = 396.3002, p < .005; F_2(1, 78) = 10.519, \text{MSE} = 1255.498, p < .005$) as well as for the orthographically overlapping condition by both participants and items ($F_1(1, 78) = 7.696, \text{MSE} = 643.414, p < .01; F_2(1, 78) = 6.159, \text{MSE} = 3388.822, p < .05$). A planned direct comparison of the magnitude of the priming effect (prime-control response time) across the transparent and opaque conditions yielded a significant result (two-tailed paired t-test) by participants ($t(39) = -3.164, p < 0.005$), but not by items ($t(39) = -1.420, p > 0.05$).

Accuracy. The accuracy results also yielded a significant effect of *Condition* by participants and by items ($F_1(2, 78) = 42.889, \text{MSE} = 5.839, p < .001; F_2(2, 78) = 5.452, \text{MSE} = 45.929, p < .01$). There was also a significant effect of *Relatedness* both by participants and items ($F_1(1, 39) = 19.063, \text{MSE} = 9.185, p < .001; F_2(1, 39) = 7.350, \text{MSE} = 23.822, p = .01$). The *Condition* x *Relatedness* interaction was significant by participants ($F_1(2, 78) = 4.749, \text{MSE} = 6.405, p < .05$), but did not reach significance by items ($F_2(2, 78) = 1.713, \text{MSE} = 17.756, p > .05$).

Planned comparisons did not reveal an increase in accuracy for the related vs. unrelated prime type for transparent condition either by participants or by items ($F_1(1, 78) = 3.064, \text{MSE} = 6.044, p > .05; F_2(1, 78) = 1.071, \text{MSE} = 16.739, p > .05$). In the opaque condition, a significant effect of accuracy revealing an increase in accuracy was observed for the related vs. unrelated prime type by participants ($F_1(1, 78) = 5.966, \text{MSE} = 5.957, p < .05$), but not by items ($F_2(1, 78) = 1.708, \text{MSE} = 17.877, p > .05$). There was a significant effect for the orthographically overlapping condition by participants ($F_1(1, 78) = 15.550, \text{MSE} = 18.240, p < .001$), but not by items ($F_2(1, 78) = 2.755, \text{MSE} = 18.240, p > .05$). A

planned direct comparison of the magnitude of the priming effect with respect to accuracy (prime-control accuracy) across the transparent and opaque conditions was not significant (two-tailed paired t-test) by participants ($t(39)=0.627$, $p>0.05$) or by items ($t(39)=0.598$, $p>0.05$).

3. 2. 4. 3. Discussion

The research questions addressed in the present study were: (1) whether compound verb constituents show significant priming in the masked-priming paradigm; (2) whether priming effects are constrained by semantic transparency; and (3) whether priming effects are due to morphological relatedness.

The results of Experiment 2b revealed significant priming for the head or verbal constituents of transparent (17 ms), opaque (25 ms) and orthographically overlapping (25 ms) conditions. Therefore, the results of Experiment 2a are supported in Experiment 2b as the answer to the first two research questions is positive, whereas the third research question did not yield a positive answer.

Constituent priming effects observed in semantically transparent, semantically opaque and orthographically overlapping prime-target pairs indicate that noun-verb compound verbs in Persian are processed orthographically, which is in turn affected by semantic transparency and parallel input effect, which refers to the simultaneous priming of related lexical items which have partial match with the input that exists for the verbal constituent of Persian transparent compound verbs.

There is a semantic transparency effect for the nominal constituent as the nominal constituent in the transparent condition is primed faster than the nominal constituent in the

opaque and the orthographic conditions. Studies on aphasic patients indicate that the nominal constituent is retained while the verbal constituent is deleted in compound verbs (Refer to Section 2.4). This could be due to the fact that the semantic load of the Persian transparent compound verbs is primarily on the nominal constituent. Thus, the semantic transparency effect in the nominal constituent can be accounted for by the semantic load being on the nominal constituent.

Semantic load was discussed for verbs by Breedin et al. (1998), when they classified verbs as ‘heavy’ versus ‘light,’ and ‘specific’ versus ‘general.’ They describe ‘heavy’ verbs as those that are semantically complex (e.g., *run*) and ‘light’ verbs as those that are semantically simple (e.g., *go*). ‘Specific’ verbs are semantically specific (e.g., *wipe*), whereas ‘general’ verbs have a general meaning (e.g., *clean*). Breedin et al.’s (1998) results revealed that aphasic patients were better at retrieving the more ‘heavy’ and ‘specific’ verbs than their less complex counterparts. They attributed this effect to “complexity effect,” which is the ease of access of semantically complex verbs. In our study, the “complexity effect” in the nominal constituent of the semantically opaque compound verbs leads to an increase in processing load for these constituents in comparison to the nominal constituents of the semantically transparent compound verbs. This is reflected by the longer reaction times for the nominal constituent of the semantically opaque compound verbs in comparison to the nominal constituents of the semantically transparent compound verbs.

On the other hand, Ahrens (1977), who studied German aphasics through a naming task in noun-noun and verb-noun compounds, found that, overall; the patients had a tendency to retrieve the first constituent, which is also the head in German. The results of

the present study supports this finding as indicated by the semantic transparency effects observed in the nominal constituent, which is the first constituent, but not in the verbal constituent, which is the second constituent in Persian noun-verb compound verbs.

The semantic transparency effect is not observed for the verbal constituent as the verbal constituent is primed at the same rate in all opaque, transparent and orthographic conditions. This could be due to the simultaneous priming of related lexical items which have partial match with the input that exist for the verbal constituent but not for the nominal constituent.

In fact, the increase in the processing load, which results in slower facilitation for the verbal constituent compared to the nominal constituent in the transparent condition has also been claimed in several studies on complex and compound word processing (Kuperman et al., 2010; and Newman et al., 2010; among others). Kuperman et al. (2010) argue that the processing costs of constituents with smaller families or competing alternatives -- such as the constituents of the verbal constituent in the opaque compound verbs in Persian -- is smaller than the processing costs of constituents with larger families - - such as the verbal constituent in the transparent compound verbs in Persian. The reason why verbal constituents in the transparent condition have larger families compared to verbal constituents in the opaque condition is that opaque noun-verb compound verbs in Persian are idiomatic hence, fixed or frozen expressions. In other words, opaque compound verb constituents cannot be replaced by any other word.

It must be noted that, in Persian noun-verb compound verbs, the verbal constituent is in the final position and the nominal constituent is in the initial position. The position of the constituents is important in the retrieval of the constituents as observed by Ahrens

(1977), who studied German aphasics through a naming task in noun-noun and verb-noun compounds; he discovered that the patients had a tendency to retrieve the first constituent, which is also the head in German. In the present study, the first constituent in Persian noun-verb compound verbs is not the head, but yet it is reported in studies on patients with aphasia to be retrieved more than the second constituent, which is the head (Nilipour, 1989, 2000; Nilipour and Raghibdoust, 2001).

Furthermore, there is a discrepancy in the results of Experiment 2b compared to the results of Experiment 2a, in that, the size of the priming effect in the transparent condition is smaller than the size of the priming effects in the opaque and orthographic conditions, while this effect was greater in Experiment 2a. This finding is interesting and can be interpreted as follows.

The discrepancy in the transparent condition can be accounted for by the possibility of competing verbs that can be matched with the noun. In opaque compounds, we do not have this competition since they are fixed expressions. In other words, in order to form a transparent compound verb, *kaado* ‘gift’ can select from among different verbs, such as - *gereftan* ‘to get a gift’, - *kardan* ‘to wrap a gift’, - *daadan* ‘to give a gift’, - *xaridan* ‘to buy a gift’, - *bordan* ‘to take a gift’. Therefore, it takes the parser longer to select from among these competing alternatives. This results in an increase in the processing load, which is reflected in the smaller priming effect of the verbal constituent of transparent compound verbs. However, in order to form the opaque compound verb *qasam xordan* ‘to swear’, *qasam* ‘oath’ has only one option; that is, *xordan* ‘to eat’ since opaque compounds are idiomatic and fixed expressions.

The increase of the processing load due to the need to compute competing alternatives has been discussed in a number of studies on polymorphemic processing (see Manouilidou, 2006; Kuperman et al., 2010; and Newman et al., 2010; among others). Kuperman et al. (2010) identify two subprocesses in complex word processing: (1) recognition of the constituents, and (2) inhibition of competing members. They argue that the processing costs of constituents with smaller families or competing alternatives is smaller than the processing costs of constituents with larger families.

The results of Experiments 2a and 2b are compatible with Kuperman et al.'s (2010) two subprocesses in processing complex words, in that, the constituents of compound verbs were primed in both opaque and transparent conditions. Yet, the constituent priming effect was stronger in the nominal constituent compared to the verbal constituent which is affected by the competing alternatives or related lexical items which have partial match with the input.

3. 3. General conclusion

In the current study, since significant constituent priming effect is observed in all three conditions of transparent compound, opaque compound and orthographically overlapping, we can conclude that there is a systematic relation between the prime and the target in all conditions. This relation does not seem to be morphological because even the orthographically overlapping targets were facilitated by their primes. The results seem to be in line with the convergence theory, which considers morphological relations to reflect correlations among orthography, phonology and semantics. In Experiment 2a (priming of the non-head, i.e., word-initial position), the priming effects were higher for the

semantically and orthographically related prime-target pairs such as *bedroom-bed* (40 ms) than the semantically unrelated but orthographically related prime-target pairs such as *quarterback-quarter* (25 ms) and *spinach-spin* (26 ms). In Experiment 2b (priming of the head, i.e., word-final position), priming effects were lower for the semantically and orthographically related prime-target pairs such as *bedroom-room* (17 ms) than the semantically unrelated but orthographically related prime-target pairs such as *quarterback-back* (25 ms) and *snow-now* (25 ms).

The results of this study indicate that the opaque and the orthographically overlapping conditions show a similar pattern of prime-target facilitation for both the nominal and the verbal constituents or pseudo-morphemes; while the transparent condition reveals a numerically stronger facilitation for the nominal constituent and a numerically weaker facilitation for the verbal constituent.

As discussed in the previous section, this discrepancy in the transparent condition can be accounted for by the possibility of competing verbs that can match with the noun, resulting in the increase of processing load due to computing competing alternatives (Kuperman et al., 2010; and Newman et al., 2010; among others). In opaque compounds, the competition between verbs does not exist or is weak since they are fixed expressions. This discrepancy is also observed in the results of the semantic relatedness study reported in this study. Although not significantly higher, the nominal constituent in the transparent condition were rated as having a higher level of relationship to the compound compared to the verbal constituent.

In the theoretical linguistic studies on Persian compound verbs, the compound verb formation can be accounted for by incorporation or combination (Dabir-Moghaddam,

1997; among others). As mentioned earlier, both combination and incorporation are compound verb formation processes. However, combination refers to the noncompositional compound, whereas incorporation refers to the compositional compound. In the light of the results of the current study, we argue that semantically transparent and opaque compound verbs are different while being processed as it was observed in the numerically greater priming effect for the nominal constituent than the verbal constituent in transparent compound verbs, but equal priming effects for the nominal and verbal constituents in opaque compound verbs in Persian. Since the nominal and verbal constituents in the opaque compound verb are recognized at the same time (25 ms), and so do the pseudo-constituents in the orthographic overlap condition yet the nominal and verbal constituents in the transparent compound verb are recognized at different times (40 ms for the noun and 17 ms for the verb), it can be argued that both semantically transparent compound verbs in Persian (formed by incorporation) and semantically opaque (formed by combination) are produced prelexically. However, it seems that incorporation involves computations like selection of competing alternatives for the verbal constituent in transparent compound verbs in Persian. This is reflected by an inhibitory effect of competing alternatives or parallel input for the verbal constituent and the increase in the processing load.

In the next chapter, the syntactic and semantic accounts of Persian compound verbs will be discussed to shed more light on the distinction between transparent and opaque compound verbs in Persian.

CHAPTER 4

COMPOUND VERBS IN PERSIAN

The present study investigated processing compound verbs in Persian. The aim of the study was to examine whether Persian compound verbs are processed as a whole or as their constituents, and whether semantic transparency and orthographic relationship has an impact on processing compound verbs in Persian. As discussed in the previous chapter, constituent priming effects observed in semantically transparent, semantically opaque and orthographically overlapping prime-target pairs reveal that N-V compound verbs in Persian are processed orthographically, which is in turn affected by semantic transparency and parallel input effect.

In this chapter, we will review relevant studies on semantic and syntactic aspects of Persian compound verbs. We will introduce different prevailing theories, followed by a critique on each, and then relating it to the findings of the present study. We will continue by a discussion on the existing theories on the constituents of Persian compound verbs, such as noun incorporation. Therefore, this chapter is organized as follows. First, the two compound verb formation processes in Persian; that is, incorporation and combination will be discussed and compared. Then in Section 4.1., the syntactic /semantic account of Persian compound verbs will be discussed. Some scholars have identified Persian

compound verbs as syntactic phrases (e.g., Folli et al., 2005, among others), while other scholars have declared Persian compound verbs to be lexical and represented in the lexicon as compound verbs (e.g., Goldberg, 2007, among others).

The syntactic approach to Persian compound verb formation (e.g. Folli et al., 2005, among others) entails that the syntactic category of a lexical element is determined only by the syntactic context in which it appears. In other words, the syntactic properties of the verb determine the position and interpretation of each argument in the verb phrase.

The lexical approach to Persian compound verb formation (e.g. Goldberg, 2007, among others), on the other hand, entails that the syntactic category of a word is lexically specified. There are two versions to the lexical approach to Persian compound verb formation: strong version, which holds that mental lexicon encompasses words, roots, affixes, word-formation rules, and subcategorization frame (information about the arguments), and weak version, which holds that mental lexicon includes only atomic roots (such as sound-meaning pairings).

In Section 4.2., we will discuss the constituents of Persian compound verbs as well as how these constituents are combined in order to form a compound verb. We will continue discussing noun incorporation and combination, which seem to be the two processes involved in compound verb formation. Finally, we will examine the criteria for distinguishing between compound verbs and syntactic phrases. We will end the chapter by discussing the productivity of Persian compound verbs, which causes novel compound verbs to be made in Persian, and which is said to be a sign of morphological richness of a language.

The results of the present study reveal a semantic transparency effect for the nominal constituent. This is observed by the most robust priming effect in the nominal constituent of the transparent condition in comparison to the nominal constituent in the opaque and the orthographic conditions. On the other hand, studies on the aphasic patients indicate that the nominal constituent is retained while the verbal constituent is deleted in compound verbs (Mondini et al., 2004, among others). This could be due to the fact that the semantic load of the transparent compound verb is primarily on the nominal constituent. In other words, the semantic transparency effect in the nominal constituent can be accounted for by the semantic load being on the nominal constituent.

Nevertheless, the semantic transparency effect is not observed for the verbal constituent. The latter is primed at the same rate in all opaque, transparent and orthographic conditions. This could be due to the simultaneous priming of related lexical items which have partial match with the input that exist for the verbal constituent but not for the nominal constituent.

The reason why the simultaneous priming of related lexical items occurs only for the verbal constituent but not for the nominal constituent can be due to the fact that participants read the compound verbs linearly from right to left, encountering the nominal constituent first. In other words, following Kuperman et al.'s (2010) classification of the subprocesses in complex word processing, as soon as the participants recognize the nominal constituent, they start comparing competing verbal constituent candidates to incorporate in or combine with the initial nominal constituent. These calculations result in the processing costs of verbal constituent selection as the competing alternatives will slow down the processing of these compound verbs.

In the theoretical linguistic studies on Persian compound verbs, the compound verb formation can be accounted for by incorporation or combination (Dabir-Moghaddam, 1997; among others). Although both combination and incorporation refer to the compound verb formation process, in compounds resulted by the incorporation process, a nominal that functions as the direct object of a transitive verb loses its grammatical endings to incorporate with the verb to form a compound verb (e.g., *qazaa-xordan* ‘food-to eat’ *to eat*). Compounds that are formed by incorporation are usually transparent and mostly intransitive. However, in compounds that are resulted by combination, a noun, a prepositional phrase, an adverb, an adjective or a noun phrase combines with the verb to form a compound verb (e.g., *qasam-xordan* ‘oath-to eat’ *to swear*). Compounds that are formed by combination are usually opaque. Dabir-Moghaddam (1997) calls the incorporation process an intransitivization process and the meaning of the compound, compositional, unlike the combination process which involves metaphoric extension (i.e., idiomatic expression). These two compound verb formation processes will be tested in the light of the results of the current study in this chapter. As suggested by the results of the present study, semantically transparent and semantically opaque compound verbs are processed in different ways. We will argue in this chapter that while semantically transparent compound verbs in Persian appear to be formed by incorporation, semantically opaque compound verbs in Persian seem to be formed by combination. However, incorporation involves computations, such as the selection of competing alternatives for the verbal constituent in transparent compound verbs in Persian. This is reflected by an inhibitory effect of competing alternatives or parallel input for the verbal constituent and the increase in the processing load.

As mentioned in the previous chapter, there have been very few experimental studies on compound verb processing, although there have been several studies on compound noun processing (Fiorentino, 2006; among others). This is likely due to the fact that most experimental studies on morphologically complex words have been on languages that do not contain compound verbs (e.g., Longtin et al., 2003 for French; Rastle et al., 2004 for English, among others). Yet, in Persian, compounding is a very highly productive verb formation process which is applied to produce novel verbs even with loan nonverbal elements and Persian base verbs.

Therefore, an overview of the structure of compound verbs in Persian will enable us to understand the results of the study better. In this chapter, we will discuss the semantic and syntactic structure of Persian compound verbs as well as competing theories for these complex predicates as the issue is a controversial one in the Persian linguistics domain.

The morphological richness of a language is said to be determined by: (1) the structure of the inflectional and derivational systems; (2) the productivity of the compounding system; and (3) the proportion of semantically transparent versus semantically opaque compounds (Smolka et al., 2008). Compound verbs are very productive and very commonly used in Persian, even more than their corresponding simple verbs. The frequency of use and productivity of compound verbs in Persian are demonstrated in the following examples in order to investigate its morphological richness.

(1) Frequency

- | | | |
|----|---------|--------|
| a. | Kushesh | kardan |
| | attempt | to do |

'to try'

b. kushidan

'to try'

In the above examples: (1a) is a compound verb and is more common than (1b), which is its corresponding simple verb. Often, the corresponding simple verb sounds poetic or even archaic to native speakers of Persian.

(2) Productivity

a. email zadan

email to hit

'to email'

b. telefon kardan

telephone to do

'to telephone'

In the above examples, the English loan words *email* and *telephone* have combined or incorporated into the Persian verbal base in order to form a compound verb.

Combination and incorporation are the two compound word formation processes involved in making Persian compound verbs (Dabir-Moghaddam, 1997). Combination entails that a noun (*qasam-xordan* 'oath-to eat' *to swear*), an adjective (*daagh kardan* 'hot-to do' *to get mad*), an adverbial phrase (*pish bordan* 'forward-to take' *to succeed*), a prepositional phrase (*az bar kardan* 'of-on-to do' *to memorize*), or a complex nominal

phrase (*sar-be-sar-gozaashtan* ‘head-to-head-to put’ to *tease*) be combined with a verb to form a compound verb in Persian. Incorporation, on the other hand, entails that a nominal element that functions as the direct object loses its grammatical endings (the postposition *ra*, the indefinite marker *-i*, the plural suffix *-ha*, the possessive pronominal suffix *-am*) and some prepositional phrases that function as adverbs lose their prepositions and incorporate into the verb, as demonstrated in the examples below.

(3)

- a. kushesh-am-ra kard-am
 attempt-POSS-OM did-1SG
 ‘I did my best.’
- b. kushesh kard-am
 attempt did-1SG
 ‘I tried.’
- c. kushid-am
 attempted-1SG
 ‘I tried.’
- d. *aan-raa kushesh kard-am
 that-OM attempt did-1SG
 ‘I attempted that.’

The above examples illustrate noun incorporation with the verb to form compound verbs in Persian. Although (3a) contains a direct object identified by the possessive pronoun and

the object marker *ra* followed by a simplex transitive verb, (3b) contains a compound verb that is intransitive, and (3c) is its corresponding simple verb that is also intransitive. However, (3d), which contains both a noun-verb compound verb and an object is ungrammatical as the internal argument position is already saturated by the nominal constituent of the noun-verb compound verb.

There are some distinctions between compound verbs formed by incorporation and compound verbs formed by combination (Dabir-Moghaddam, 1997). The first distinction is that in incorporation, there is always a corresponding construction, where the object or internal argument has not been incorporated (Example (3a-3b)). The second difference is that incorporation almost always results in an intransitive compound verb, while combination might lead to a transitive or an intransitive compound verb (Example (3b) and Example 4(b) below).

(4)

a. kushesh kard-am

attemptdid-1SG

‘I tried.’

b. u-ra shekastdaad-am

he-OM defeat gave-1SG

‘I defeated him.’

In the above example, (4a) is an example of incorporation, which results in an intransitive compound verb. Example (4b) is an instance of combination, which is transitive and requires an object.

The third distinction between compound verbs produced by combination and incorporation is that, incorporation almost always results in transparent compound verbs, while combination may result in opaque compound verbs.

(5)

a. kushesh kard-am

attemptdid-1SG

‘I tried.’

b. agar pa-be-dah-ad mi-rav-am

if foot-SUB-give-3SG DUR-go-1SG

‘If the opportunity knocks, I will go.’

In the above example, (5a) is an example of incorporation, where the constituents are compositional and the compound is semantically transparent, whereas (5b) is an example of combination whose constituents are noncompositional resulting in an opaque compound verb.

The fourth distinction is that combination is less productive than incorporation since most compound verbs produced by combination are idiomatic and thus considered fixed or frozen expressions (as in (5b)).

Having described the distinction between compound verbs as a result of combination or incorporation, we must bear in mind that both processes produce morphologically compound verbs in Persian. In addition, there is no prosodic distinction between compound verbs formed by combination and those formed by incorporation. As a general rule, if the compound verb is used in its infinitive form, the primary stress will fall on the final syllable of the verb. If the compound verb is used in the affirmative finite form, the primary stress will fall on the final syllable of the non-verbal element. Therefore, we do not distinguish between the compound verbs formed by either incorporation or combination in the present study. We refer to them as compound verbs in Persian.⁹ These two compound verb formation processes, i.e., incorporation and combination, can be viewed under either a syntactic or a lexical approach.

In the following section, we will discuss the prevailing theories, which have tackled Persian compound verbs either lexically or syntactically. We will begin by a short description of these theories followed by a few relevant examples. Then we will test each of these theories through various additional examples.

4. 1. Syntactic/semantic account of compound verbs in Persian

Studies of Persian compound verbs divide them into two parts: the nonverbal and the verbal, respectively. The verbal part has been called the light verb. Although the definition of a light verb is a verb, which is semantically bleached, some verbal constituents in compound verbs have meanings of their own and contribute to the meaning of the compound. The nonverbal part, however, can be a noun (*gerye kardan* ‘tear-to do’ ‘noun-

⁹ For more information and different examples of combination/incorporation in Persian, see Dabir-Moghaddam (1997:37-49).

verb' *to cry*), an adjective (*daagh kardan* 'hot-to do' 'adjective-verb' *to get mad*), a prepositional phrase (*az bar kardan* 'of-on-to do' 'prep-prep-verb' *to memorize*), an adverbial phrase (*pish bordan* 'forward-to take' 'prep-verb' *to succeed*), or a complex nominal phrase (*sar-be-sar-gozaashtan* 'head-to-head-to put' *to tease*). In Persian compound verbs, this so-called light verb seems to show some lexical properties of lexical verbs and some functional properties of syntactic verbs. Therefore, the verbal part of Persian compound verbs is more compatible with the semi-functional verbs in the Algonquian literature, which behave like functional predicates regarding their syntactic properties, yet like lexical predicates regarding their thematic properties. Following Johns's (2007) work on Inuktitut, Mathieu hypothesized that Ojibwe verbal suffixes are light verbs, i.e., elements with both lexical and functional properties. This is compatible with semi-functionality of such light verbs. Similarly, Wurmbrand (2003) categorized some verbs in German, such as motion verbs (e.g., *go*, *come*), causatives (e.g., *let*), perception verbs (e.g., *see*, *hear*), and modal verbs (e.g., *must*, *can*, *want*) as semi-functional.

The specific compound verbs that are examined in the present study are noun-verb compound verbs. There have been a number of studies on the nature and characteristics of Persian compound verbs. Some have identified them as syntactic phrases, while others have declared them to be compound words. Still others have attributed them to noun incorporation or to lexicalization. Several of the studies that have adopted these approaches are described below and the problems with each are discussed.

4. 1. 1. Folli, Harley and Karimi: Determinants of Event Types (2005)

Taking the syntactic approach, Folli et al. (2005) studied compound verbs in Persian and discovered that both the nonverbal and the verbal constituents are responsible for determining the syntactic properties of the whole compound. They argue against a lexicalist approach or a projectionist approach where the argument assignments, alternations and interpretations, all happen in the lexicon. Folli et al. (2005) assign an independent syntactic nature to the light verb and nonverbal element. They discuss different properties of compound verbs. They support their constructionalist view by stating that, in Persian, compound verbs are not lexical units since the two constituents comprising the compound can be interrupted when an adjective is inserted after the nominal part to modify it.

(6)

a. harf zadan
words to hit
‘to speak’

b. harf-e moft zadan
words-EZ¹⁰ free to hit

¹⁰ EZ refers to the of-phrase in Persian. Ezafe is the short vowel /e/ that is added after the noun and before a possessive pronoun, a noun or an adjective, e.g.:

daftar-e	man
notebook-EZ	I
notebook-of	mine
‘my notebook’	
doxtar-e	zibaa

‘to speak nonsense’

(7)

a. kotak xordan

beating to eat

‘to be beaten’

b. kotak-e hesaabi xordan

beating-EZ much to eat

‘to be beaten hard’

This interruption of the nominal and verbal constituents discussed by Folli et al. (2005) can be explained in light of the results of the present study. As mentioned earlier, the results of the present study seem to support the idea that there are two processes involved in Persian compound verb formation: incorporation and combination. Incorporation seems to apply for non-idiomatic or transparent compound verbs, whereas combination appears to work for idiomatic or opaque compound verbs. The distinctions between these two processes were discussed earlier in this chapter. One distinction was that transitive compound verbs, which are formed by incorporation, have a corresponding simple verb plus direct object counterpart as illustrated by Example (3a) above. Example (3b) is an instance of incorporation. It contains a transitive compound verb, whose nominal constituent is not followed by any grammatical marker. However, in Example (3a), the direct object is

girl-EZ pretty
‘pretty girl’

followed by both a possessive and an object marker. Therefore, the verb in this sentence is a simple verb plus its direct object rather than a noun-verb compound verb. Similarly, Examples (6b) and (7b) are no longer compound verbs, but rather converted to their corresponding simplex transitive verb plus direct object. The possibility of the intervening modifier between the two constituents has been used as an argument in favour of the syntactic account of compound verb formation in Persian (Folli et al., 2005). However, the major argument for the syntactic analysis of noun incorporation (Mathieu et al., 2009) that in many languages that allow noun incorporation, it is possible to refer to a nominal that was incorporated into a verb (e.g., Inuktitut, Sadock, 1980; Mohawk, Baker, 1988, 1996), cannot be supported using the Persian data. In other words, the nominal constituent in Persian compound verbs cannot be coreferent with the pronoun that follows the compound, as illustrated in Example (8).

(8)

a. *un	qazaa	xord.	Xeili	xub	bud
	He	food	ate-3SG.	Very good	was-3SG

*He ate. It was very delicious.

b. un	qazaa-raa	xord.	Xeili	xub	bud
	He	food-OM	ate-3SG.	Very good	was-3SG

He ate the food. It was very delicious.

In above examples, (8a) is not acceptable as the pronoun “it” cannot be coreferent with the nominal constituent “qazaa” in the compound verb “qazaa-xordan”, whereas (8b) is acceptable as the pronoun “it” can be coreferent with the direct object “qazaa”.

Therefore, it seems that there is a tension in the Persian data. In other words, while the possibility of the intervening element between the nominal and verbal constituents of the Persian compound verbs has been taken as evidence to support a syntactic approach to noun incorporation (e.g., Folli et al., 2005, among others), the anaphoric status of the nominal constituent in Persian compound verbs tends to support a lexical approach to noun incorporation. The distinction between the compound verbs and the intervened verb phrase in Persian will be illustrated and explained through Example (23-29) in this chapter.

The second property of compound verbs introduced by Folli et al. (2005) is the inability of compound verbs to be scrambled out of *v'* unless carrying heavy stress due to having a quantificational element (Karimi, 2003). They illustrate this property in the following example, where the *i* has moved out of *v'* only when it is modified by an Adjective.

(9)

a. Kimea [che zamin-e saxti]_i diruz [CV t_i xord]
 Kimea what ground-EZ hard yesterday collided
 ‘What a hard fall Kimea had yesterday.’

b. *Kimea zamin diruz xord
 Kimea ground yesterday collide

‘Kimia had a fall yesterday.’

(Folli et al., 2005)

Folli et al. (2005) assign different and separate roles to each of the components of the compound. They hold that agentivity or causativity, eventiveness and duration are assigned by the verbal part, whereas telicity is determined by the nominal part. The compound verb in (10a) assigns a causative role. The compound verb in (10b) assigns an inchoative role¹¹ to its external arguments, i.e., the subject.

(10)

a. Amir	man-o	farib	daad
Amir	I-OM	deception	gave-3SG

‘Amir deceived me.’

b. man	az	Amir	farib	xord-am
I	of	Amir	deception	ate-1SG

‘I was deceived by Amir.’

Therefore, it is the semantics of *daadan* and *xordan* that determines whether the subject is agentive or inchoative. Likewise, the verbal part can determine eventiveness, as represented in the following example.

¹¹ Referring to Hale and Keyser’s (1993) causative/inchoative alternation: He opened the door/The door opened.

(11)

a. Armin tu in kaar dast dar-e

Armin in this job hand have-3SG

‘Armin is involved in this job.’

b. *Armin tu in kaar daar-e dast dar-e

Armin in this job have-3SG hand have-3SG

‘Armin is being involved in this job.’

(12)

a. Armin tu in parvande dast mi-bar-e

Armin in this file hand DUR-take-3SG

‘Armin alters this file.’

b. Armin tu in parvande daar-e dast mi-bar-e

Armin in this file have-3SG hand DUR-take-3SG

‘Armin is altering this file.’

Examples (11) and (12) both contain a compound verb whose nonverbal part is ‘hand’ *dast*. They are represented once as stative and once as eventive respectively, resulting in the ungrammaticality of (11b) but not (12b).

The final property that is assigned by the verb is the duration of the compound phrase (Folli et al., 2005; Megerdooian, 2002; among others). This property is illustrated in the following example. In (13a) and (13b), the nonverbal element is the same and it is

the verbal constituent that changes and by this change, it is determined whether the compound verb is durational or non-durational.

(13)

a. dast zadan (nondurational)

hand to hit

‘to touch’

b. dast keshidan (durational)

hand to draw

‘to keep touching’

However, Folli et al.’s (2005) categories do not seem to hold for all compound verbs. Take the following, for example, where the verbal element is the same, but it is the nominal constituent that determines whether the compound verb is durational or not. Durationality is tested by adding the adverb ‘suddenly’ to both sentences, the result of which shows that the change in the nominal element determines durationality in these two sentences.

(14)

a. xune yeho aatish gereft

house suddenly fire caught-3SG

‘Suddenly the house caught fire.’

- b. *unaa yeho koshti gereft-an
 they suddenly wrestling caught-3PL
 ‘Suddenly they wrestled.’

The above example shows that when there is an adverb like *yeho* ‘suddenly,’ in a sentence containing a compound predicate, then it will be the nominal part that determines the duration aspect.

This is counter-evidence for the last two features of compound verbs that were introduced by Folli et al. (2005). It contradicts the duration property since (14b) has the duration aspect, whereas (14a) does not, although their verbal part is the same. Therefore, it seems that the nominal part can also determine the duration aspect.

In addition, this very example contradicts the second property of compound verbs mentioned by Folli et al. (2005), which is eventiveness. The example they offer contains the verb *daare* — ‘is in the process of’ — which can never be used as a stative verb. Therefore, adding *daare*, which is the equivalent of ‘ing’ in English, does not allow the verb to be stative. There are only two verbs in Persian that have this property of not having a stative form: one is *daashtan* ‘to have,’ which is discussed here, and the other one is *budan* ‘to be.’ All other verbs can have both eventive and stative aspects based on their meaning in conjunction with the nominal part of the compound. In (14a), for example, the combination of *aatish* ‘fire’ and *gereftan* ‘to catch’ forms the compound *aatish gereftan* ‘to catch fire,’ and the end result is a stative verb. In (14b), however, the combination of *koshti* ‘wrestling’ and *gereftan* ‘to catch’ gives us the compound *koshti geretan* ‘to wrestle’ and the resulting compound is an eventive verb. Therefore, adding *daare*, which is the

equivalent of ‘ing’ in English, will result in the ungrammaticality of (15a) which contains a stative compound verb and the grammaticality of (15b) which contains an eventive compound verb.

(15)

*a. xune daar-e aatish mi-gir-e
house have-3SG fire DUR-catch-3SG
‘The house is catching fire.’

b. unaa daar-an koshti mi-gir-an
they have-3PL wrestling DUR-catch-3PL
‘They are wrestling.’

Let us return to the first property introduced by Folli et al. (2005), i.e., agentivity. In their examples, they show that it is the verbal part that determines agentivity. However, the following example contradicts this idea and suggests that it is not the verbal part, but the whole compound, which is responsible.

(16)

a. Majid shekast xord
Majid defeat ate-3SG
‘Majid was defeated.’

b. Majid qazaa xord
 Majid food ate-3SG

‘Majid ate food.’

In (16a) and (16b), the verbal part is the same, but (16a) is inchoative, while (16b) is agentive. Similarly, they assume telicity to be determined by the nonverbal part, whereas it has been shown that it is the combination of the two constituents of the compound that assigns this aspect. Let us take the following examples into consideration.

(17)

a. xune aatish gereft (telic)
 house fire caught-3SG

‘The house caught fire.’

b. *xune baraaye yek saa’at aatish gereft
 house for one hour fire caught-3SG

*‘The house caught fire for one hour.’

(18)

a. unaa koshti gereftan (atelic)
 they wrestling caught-3SG

‘They wrestled.’

b. unaa	baraaye	yek	saa'at	koshti	gereft-an
they	for	one	hour	wrestling	caught-3PL

‘They wrestled for an hour.’

Although (17) and (18) are similar in their verbal part, their nonverbal constituent is a different noun in each case. Now, according to Folli et al.’s (2005) classification, all noun-verb compound verbs are atelic (p. 17). Why then is it that the compound verb in (17b) cannot be atelic, while the compound verb in (18b) can?

Folli et al.’s (2005) analysis also predicts that atelic noun-verb compounds do not have a passive form (p. 22). However, there are some noun-verb compound verbs that allow passivization, as illustrated in (19) and (21) below, while examples (20) and (22) represent passivization in simple verb.

(19)

a. man	divaar-o	rang	zad-am
I	wall-OM	colour	hit-1SG

‘I painted the wall.’

b. daasht-am	divaar-o	rang	mi-zad-am
had-1SG	wall-OM	colour	DUR-hit-1SG

‘I was painting the wall.’

c. ba'd	az	in	ke	divaar	rang	zade
---------	----	----	----	--------	------	------

after of this that wall colour hit-PP
 shod baayad bargh-esh b-endaaz-im
 was-3SG must shine-3SG.CL SUB-throw-2PL

‘After the wall has been painted, we must polish it.’

(20)

a. man divaar-o shekast-am
 I wall-OM broke-1SG

‘I broke the wall.’

b. daasht-am divaar-o mi-shkast-am
 had-1SG wall-OM DUR-broke-1SG

‘I was breaking the wall.’

c. ba’d az in ke divaar shekaste shod
 after of this that wall broke-PP was-3SG
 aalmaan yeki shod

Germany one was-3SG

‘After the wall was broken, Germany was united.’

(21)

a. man paarcha-ro andaaze gereft-am
 I cloth-OM measure caught-1SG

‘I measured the cloth.’

b. daasht-am paarcha-ro andaaze mi-gereft-am
had-1SG cloth-OM measure DUR-caught-1SG

‘I was measuring the cloth.’

c. ba’d az in ke paarche andaaze gerefte
after of this that cloth measure catch-PP
shod baayad be-bor-im-esh
was-3SG must SUB-cut-2PL-3SG.CL

‘After the cloth has been measured, we have to cut it.’

(22)

a. man paarcha-ro borid-am
I cloth-OM cut-1SG

‘I cut the cloth.’

b. daasht-am paarcha-ro mi-borid-am
had-1SG cloth-OM DUR-cut-1SG

‘I was cutting the cloth.’

c. ba’d az in ke paarche boride shod
after of this that cloth cut-PP was-3SG

baayd be-duz-im-esh
must SUB-sew-2PL-3SG.CL

‘After the cloth has been cut, we should sew it.’

Therefore, we suggest that Folli et al.’s (2005) proposal that the two elements of the compound verb are separately generated and combined in syntax requires more extensive research in order to determine where compound verbs are generated and how they are represented. Folli et al. (2005) argue against a lexicalist approach to compound verbs, where the argument assignments, alternations and interpretations all happen in the lexicon. However the results of the present study seem to illustrate that compound verb constituents are represented and accessed prelexically. This could potentially support a lexicalist approach to compound verbs. In fact, the counter-examples given in this section to Folli et al.’s (2005) theory seem to support a lexicalist approach to compound verb processing as they indicate that semantic choices, such as telicity, agentivity or causativity, eventiveness and duration are made by the combination of the compound verb constituents as a single lexical unit rather than by one of the constituents. For example, when the compound verb constituents were separated by the insertion of a syntactic element, such as the object marker, in Examples (3a), or modifiers in (6b) and (7b), the compound verb lost its lexicality and transformed into two separate lexical items, i.e., a verb and a noun.

Below we will discuss three pieces of evidence to illustrate that the structure of compound verbs, and the structure of a compound verb that has been intervened by an intervening element, such as a modifier or an indefinite marker, are different. The evidence comes from (1) the nominalization of the compound verb (Examples (23-24)); (2) the

usage of the compound verb after the progressive expression ‘dar haale’ *in the process of* (Examples 25-26); and (3) the nonreferentiality of the nominal constituent in the compound verb (Examples 27-28).

The difference between the two cases of compound verbs and separated compound verbs by means of an intervening element is demonstrated in the deverbal nouns below in Examples (23-24).

(23)

a. man sarmaa xord-am

I cold ate-1SG

‘I have the flu.’

b. sarmaa-xord-an-e man zaif-am kard

cold-ate-INF-EZ I weak-1SG.CL did-3SG

‘My having the flu weakened me.’

(24)

a. man sarmaa-ye shadid-i xord-am

I cold-EZ severe-IND ate-1SG

‘I have a severe flu.’

b. *sarmaa-ye shadid xord-an-e man zaif-am kard

cold-EZ severe-EZ ate-INF-EZ I weak-1SG.CL did-3SG

‘My having a severe flu weakened me.’

Example (23) illustrates a compound verb, whose constituents have not been separated, and Example (24) depicts a compound verb whose constituents have been separated by an intervener. The deverbal noun in (23b) makes an acceptable sentence, whereas the deverbal noun in (24b) makes an unacceptable sentence in Persian. Therefore, it seems that in Persian, compound verbs can be transformed to deverbal nouns (as in 23a), whereas syntactic phrases cannot (as in 24b).

Another test, which is also mentioned by Dabir-Moghaddam (1997) is that we can use the progressive expression ‘dar haale’ *in the process of* with the compound verb but not with the intervening element. This is illustrated in Examples (25-26) below.

(25)

- | | | | | | |
|----------------------------------|-------|------------|-------|---------|---------|
| a. man | qazaa | xord-am | | | |
| I | food | ate-1SG | | | |
| ‘I ate.’ | | | | | |
| b. man | dar | haal-e | qazaa | xord-an | hast-am |
| I | in | process-EZ | food | ate-INF | is-1SG |
| ‘I am in the process of eating.’ | | | | | |

(26)

- | | | | | | |
|-------------------|----------|---------|----------|---------|---------|
| a. man | qazaa-ro | xord-am | | | |
| I | food-OM | ate-1SG | | | |
| ‘I ate the food.’ | | | | | |
| b. *man | dar | haal-e | qazaa-ro | xord-an | hast-am |

I in process-EZ food-OM ate-INF is-1SG
 ‘I am in the process of eating the food.’

Example (25) contains a compound verb, whereas Example (26) contains an intervening element; that is, the object marker, hence making the verb, a transitive verb and the noun, its direct object. As illustrated in Examples (25b-26b), the compound has the ability of being in progressive form after adding the progressive expression, but the construction containing the intervening element cannot be in the progressive form. This results in the grammaticality of (25b), but ungrammaticality of (26b).

Another test of noun-verb compoundness is the anaphoric status of the nominal constituent. In Persian compound verbs, the nominal constituent cannot be followed by a pronoun that refers to it. Therefore, if a pronoun finds its reference in the noun-verb phrase, the noun is most likely the object of the verb rather than a nominal constituent of a compound verb. This anaphoric status is illustrated in Examples (27-28) below.

*(27)

man sarmaa_i xord-am ke_i zaif-am kard-e
 I cold_i ate-1SG that_i weak-1SG.CL did-PP
 ‘I have the flu_i that_i has weakened me.’

(28)

a. man sarmaa_i-ye shadid-i xord-am ke_i zaif-am
 I cold_i-EZ severe-IND ate-1SG that_i weak-1SG.CL

kard-e

did-PP

‘I have a severe flu_i that_i has weakened me.’

b. man sarmaa_i-i xord-am ke_i zaif-am

I cold_i-IND ate-1SG that_i weak-1SG.CL

kard-e

did-PP

‘I have the flu_i that_i has weakened me.’

In Example (27), the verb is a noun-verb compound verb; therefore, the relative pronoun that is used after this verb cannot refer back to the nominal constituent. The verb phrase in Example (28), on the other hand, contains an intervening element, which is an adjective in (28a) and an indefinite marker in (28b). In both of these sentences, the relative pronoun refers back to the nominal inside the verb phrase.

To sum, we argue that compound verbs and intervened verb phrases are different structures for the reasons mentioned above; that is: (1) the possibility of making a nominal with the compound verb, but not with the intervened verb phrase; (2) the possibility of using the compound progressive expression ‘dar haale’ *in the process of* with the compound verb but not with the intervened verb phrase; and (3) the possibility of a pronoun referring to the noun in the preceding verb phrase but not the nominal in the preceding compound verb.

It must be mentioned that although we have considered compound verb constituents as independent once there is an intervening element, such as the object marker

or a modifier in our argument for a lexical approach to Persian compound verbs, Folli et al. (2005) have used these intruders as an evidence for the noun incorporation being a syntactic operation. Similar to our argument, Barjesteh (1983) divides Persian compound verbs into separable and non-separable compound verbs, yet when an object marker or a modifier intervenes the compound constituents, he argues that the nominal constituent functions syntactically as the direct object. Dabir- Moghaddam (1997) calls this separation process, an operation which is the inverse of noun incorporation. This inverse operation will be considered syntactic by the proponents of a syntactic approach to noun incorporation, whereas the supporters of a lexical approach to noun incorporation will consider it lexical. This debate between the syntactic and lexical approaches to noun incorporation is ongoing and requires further theoretical and experimental research to be resolved.

However, we are supporting a lexical approach to compound verb processing in Persian, and further evidence for the processing of Persian compound verbs being lexical comes from the results of the present study, where there is a competition between the verbal constituent candidates to be incorporated into or combined with the nominal constituent. Since the technique used in the present study was masked priming, and masked priming reveals the mental processes at the prelexical stage, before the syntactic and semantic information is calculated, the constituent effect and the competing alternative effects seem to support a lexicalist approach to compound verb processing in Persian.

Therefore, the overall evidence reflected in the counter-examples above as well as the results of the experimental studies carried out in this dissertation seem to point towards lexical compounding. The fact that the constituents of compound verbs in Persian can be

interrupted by a modifier can be taken as evidence for proponents of the syntactic approach to noun incorporation, yet the fact that the nominal constituent of the compound verbs in Persian cannot be coreferent with the pronoun that follows the compound verb can be considered as evidence for supporters of the lexical approach to noun incorporation. More experimental studies must be done to investigate this issue. What was shown by the results of the studies reported in this dissertation seems to be more compatible with the lexical approach.

As mentioned earlier in this chapter, there are two major approaches to compound verb processing, mainly syntactic and lexical. The syntactic approach was discussed in the previous section through Folli et al.'s (2005) study on Persian compound verbs. In the next section, we will discuss and examine Goldberg's (2004) lexical approach to compound verb processing.

4. 1. 2. Goldberg: The Host and the Light Verb (2004)

Goldberg (2004) treats Persian compound verbs as a class of systematically related constructions, which are represented in the lexicon. She proposes that the Persian complex predicate, which consists of a nonverbal element (which she calls "the host") and a light verb, is a construction that is represented in the lexicon. She asserts that it is learned and stored as a piece of linguistic knowledge.

However, she does not discuss whether the compound verb is stored as its constituents or as a whole-word. Goldberg (2004) distinguishes between complex predicates and simple predicates by using the criterion of "separability." This criterion

holds for the simple predicates, but not for the complex ones. She gives the following example to clarify her point.

(29)

a. Ali mard-raa zad (simple verb)

Ali man-OM hit-3SG

‘Ali hit the man.’

b. Ali baa Baabak harf zad (complex predicate)

Ali with Babak word hit-3SG

‘Ali talked with Babak.’

(Goldberg, 2004:4)

Goldberg explains that complex predicates such as the one in (29b), resist separation of the nonverbal and verbal constituents. However, as pointed out before, this insertion is possible, but it results in the transformation of an intransitive compound verb into a transitive simplex verb, which is followed by its direct object. In fact, if a modifier (as illustrated in Examples (6-9) is added, it interrupts the compound and converts it into a simple verb, as illustrated in Example (30) below.

(30)

a. harf na-zan

words NEG-hit-1SG

‘Don’t talk.’

b. harf-e moft na-zan
words-EZ free NEG-hit-1SG

‘Don’t talk nonsense.’

Moreover, Goldberg (2004) proposes that, despite the generalizations made for the future tense marker as intervening between the host and the light verb (as in 31a), these generalizations are in fact construction specific, and no other auxiliary can interrupt the components of a compound verb. However, the following example illustrates that this is not the case, and that other auxiliaries *can* interrupt the components of compound verbs (as in 31b). Yet, as discussed earlier, this will result in the transformation of the compound verb into a simplex verb.

(31)

a. zamin xaah-ad xord
ground want-3SG ate-3SG

‘He will fall.’

b. zamin baayad bo-xor-i taa be-fahm-i
ground must SUB-eat-2SG until SUB-understand-2SG

‘You have to fail to gain understanding.’

Indeed, it seems that the semantic features of the compound verb in Persian can neither be solely attributed to the host, nor can it be exclusively associated with the light verb. It is in fact the combination of the two constituents of the compound that determines the semantics of the compound. The results of the studies reported in this dissertation appear to indicate that the constituents of the opaque and transparent compound verbs are both stored and simultaneously retrieved while processing, except for the verbal constituent of the transparent compound verb, which takes longer to be retrieved due to competing alternatives effect. Therefore, it is possible to hold both constituents responsible for determining the semantic information of the whole compound.

To this point, Goldberg (2004) seems to support a lexicalist approach. However, when it comes to the syntactic properties of complex properties, she appears to support Baker's (2006) idea that the noun as well as the Tense and Aspect precede the verb, whereas Agreement follows the verb. Consider the following example, where this idea is represented.

(32)

man	hamishe	injaa	zamin	mi-xor-am
I	always	here	ground	DUR-eat-1SG

'I always fall here.'

The compound verb in (32) is *zamin xordan* 'to fall,' where the nominal part is *zamin* 'ground,' and the *mi* 'progressive marker' before the verbal part represents the Tense as

well as the imperfective Aspect. The verbal stem is *xor* ‘eat,’ which is followed by *am*, the ‘first person singular verb ending’ representing Agreement.

As for the lexicality or syntacticality of compound verbs, Goldberg (2004) employs a conservative approach, stating that perhaps both definitions apply since on the one hand, Persian complex predicates allow nominalization, and on the other hand, their constituents can be separated.

The results of the present study seem to support Goldberg’s (2004) lexicalist approach. Constituent priming effect for both the verbal and the nominal constituents are observed at the subconscious level, i.e. before semantic and syntactic information is calculated. Hence it seems that compound verb processing in Persian occurs prelexically. In addition, as illustrated in the counterexamples given in the previous section, if the constituents of compound verbs are separated, then the compound verb transforms into a simplex verb and its internal argument, i.e., the direct object. Furthermore, Goldberg’s calling the nominal constituent as “the host” seems to be supported by the results of the present study as indicated by the competing alternative effect for the verbal element, but not for the nominal element. Further evidence comes from the results of studies on aphasic patients, who retain the nominal element, but omit the verbal constituent. Therefore, it seems that the nominal constituent *is* rightly labeled as “the host” by Goldberg (2004).

In the next section, we will discuss how compound verb constituents are combined to form a compound verb.

4. 2. Constituents of compound verbs

In the previous section, we discussed various syntactic and lexical approaches to Persian compound verbs. In what follows, we will examine different views on Persian compound verb constituents as well as how these constituents are combined in order to form a compound verb. We will begin by discussing noun incorporation and combination, which seem to be the two processes involved in compound verb formation in Persian. As mentioned earlier in this chapter, in incorporation, a nominal that functions as the direct object of a transitive verb loses its grammatical endings to incorporate with the verb to form a compound verb (e.g., *qazaa-xordan* ‘food-to eat’ *to eat*), and the end result is usually an intransitive transparent compound verb. However, in combination; a noun, a prepositional phrase, an adverb, an adjective or a noun phrase combines with the verb to form a compound verb (e.g., *qasam-xordan* ‘oath-to eat’ *to swear*), and the end result is usually a transitive or non-transitive idiomatic compound verb. At the end of the next section, we will examine the criteria for distinguishing between compound verbs and syntactic phrases.

4. 2. 1. Noun Incorporation

As mentioned earlier in this section, some attribute the noun-verb compounds to noun incorporation, where the noun is incorporated into the verb (Megerdoomian, 2004, 2005; among others). There are two approaches to Noun Incorporation (NI), namely morphological and syntactic.

The morphological approach to NI is mapped with the lexical approach to compound verbs. It considers NI to be the outcome of the pre-syntactic or lexical compounding of a noun and a verbal stem.

The syntactic approach to NI is, by contrast, in line with the syntactic approach to compound verbs, and holds syntax responsible for moving a noun into a verb to form a single word.

The results of the present study seem to be compatible with the lexical approach to NI as indicated by the constituent priming effects under masked priming conditions, which occur prelexically before the syntactic and semantic information is calculated. In fact, as discussed in previous chapters, one of the shortcomings of masked priming technique is its tackling the processing pre-lexically and orthographically. In other words, semantic and syntactic integration seems to occur only if both the prime and the target reach consciousness (Forster, 2003). Under masked priming conditions, where the prime presentation duration is only 50 ms, the prime does not reach consciousness. That is why participants are not aware of the prime and only make a decision whether the target is a word or a nonword. The results of the present study revealed constituent priming at the subconscious level, which is before semantic and syntactic information is calculated; hence it seems that compound verb processing in Persian occurs prelexically. If compound verb processing in Persian were not done prelexically but rather post-lexically and syntactically, we would not have had constituent priming effect at the subconscious level. In other words, at the subconscious level, the compound verb would have been processed as a whole and not as its constituents. This is because these constituents would have been expected to merge at the conscious level. Since, in the present study, constituent priming

was observed in both opaque and transparent compound verbs, it seems that both types of compound verb formation processes, i.e., combination and incorporation are applied pre-lexically at the subconscious level.

In addition, for N-V incorporation to be a syntactic process, the end result must be fully compositional (as in Ojibwe morphological merge discussed in Mathieu, forthcoming), but in Persian, the N-V compounds are mostly relatively compositional.

In fact, when a nominal, like *email* is incorporated in the verb *zadan*, to form the novel compound *email-zadan*, the compound is listed/fixed in Persian lexicon, as many other already existing similar compounds with the same verb, but different nominal. The compound verb *email-zadan* contains a borrowed nonverbal constituent, with a transparent meaning, and a Persian semi-functional verb as its verbal constituent. However, the verbal constituent, which means ‘to hit’ has little to do with ‘sending an email’. In other words, the verbal constituent is not transparent. Transparency level of a compound is determined by the transparency of its constituents; therefore, the compound verb *email-zadan* is not fully transparent or compositional.

The novel compound making, which is the substitution of the nominal element of an already fixed/listed N-V compound verb can be compared to the neologisms made by patients with Aphasia. These patients make neologisms that demonstrate the compound information is intact, and what is substituted is in fact a lexical item from the competing alternatives available at the time of processing.

Noun incorporation is productive in Persian, following the definition Baker (2006) gives for productivity, which might involve any member of a non-closed (unbound) set of

nouns. We can make novel compounds by incorporating loan words into a Persian light verb as in the following examples.

(33)

ruy-e in kilik kon
on-EZ this click do-2SG
'Click on this.'

(34)

beh-et imeil mi-zan-am
to-2SG.CL email DUR-hit-1SG
'I will email you.'

One possibility that is mentioned in a number of studies (Massam, 2001; Ghomeshi, 2003; Mathieu, 2006; among others) is that the assumed compound verbs might merely be instances of pseudo-incorporation. This is a verb phrase formation by means of syntactic merge, such that the direct object does not move outside of the minimal VP. As a result, it remains close to the verb in a "very tight syntactic phrase" (Massam, 2001).

However, in Persian, it seems that there is no case of pseudo-incorporation because the compound constituents are recognized prelexically before the syntactic operations like *move* can be applied. In addition, the nominal constituent of the Persian compound verbs does not have any grammatical endings (the postposition *ra*, the indefinite marker *-i*, the plural suffix *-ha*, the possessive pronominal suffix *-am*).

It must be noted that as we discussed earlier in this chapter, while noun incorporation is the process to form transparent compound verbs in Persian, combination is the process which is used to form opaque compound verbs in Persian. For the noun incorporation to occur, there are certain conditions that need to be met. For example, for the noun to be incorporated into a verb, their semantic information needs to be matched. This calculation seems to increase the processing load, which is represented by the longer reaction time to recognize the verbal constituent of the transparent compound verb compared to that of the opaque compound verbs. However, in combination, the nominal and the verbal constituents are simply combined to form an idiomatic or opaque compound verb; therefore, the verbal constituent of the opaque compound verb is recognized faster than that of the transparent compound verb in Persian.

Another difference between incorporation and combination, as discussed earlier, is that noun-verb compound verbs that are formed as a result of incorporation have a corresponding transitive verb plus direct object. However, unlike the noun-verb compound verb, this corresponding structure seems to be a syntactic phrase. The difference between these two structures is illustrated in the following examples.

(35)

- a. *Ali gazaa xord. xub bud
 Ali food_i ate-3SG. good was-3SG_i
 *‘Ali ate. It was good.’
- b. Ali gazaa-ro xord. xub bud
 Ali food_i-OM ate. good was-3SG_i

‘Ali ate the food. It was good.’

(36)

a. *age ziarat paa bed-e mi-r-im. xeili xub-e
if pilgrimage foot_i give-3SG DUR-go-2PL very good-3SG_i
*‘If we have a chance to go on a pilgrimage, it is very good.’

b. *age ziarat paa-ro bed-e mi-r-im. xeili
if pilgrimage foot_i-OM give-3SG DUR-go-2PL. very
xub-e
good-3SG_i
*‘If we have a chance to go on a pilgrimage, it is very good.’

In above examples, two properties of syntactic versus lexical approaches to noun incorporation have been depicted. Example (35a) illustrates a transparent noun-verb compound verb that has been formed as a result of noun incorporation. Therefore, it has a corresponding syntactic phrase of transitive verb plus its direct object in Example (35b). As illustrated in these examples, the nominal constituent in the transparent noun-verb compound verb cannot be coreferent with the pronoun following the transparent compound verb (35a), whereas in the syntactic phrase, the direct object can be coreferent with the pronoun that follows the verbal phrase (35b). Example (36a) illustrates an opaque noun-verb compound verb that has been formed as a result of combination. Therefore, it does not have a corresponding syntactic phrase of transitive verb plus its direct object as illustrated in Example (36b). Furthermore, as illustrated in Example (36a), the nominal constituent in

the opaque noun-verb compound verb cannot be coreferent with the pronoun following the opaque compound verb.

Other than the two compound word formation processes of noun incorporation and combination to form Persian compound verbs, a verbal and a nominal element can be merged through syntactic operations, the result of which would be a syntactic phrase. Below, several approaches to compound verbs within some studies are discussed. The first study by Dressler (2006) helps us distinguish between compound verbs and syntactic phrases.

4. 2. 2. Dressler: Productivity in Compound Words (2006)

Dressler (2006) states that compound words are defined variously in different theories. They are generally loosely defined as “a grammatical combination of words that is of lexical items or lexemes, to form new words” (Dressler, 2006:24). He then goes on to mention some of the properties that may be used to identify compound words.

Following Dressler (2006), we will now test what we have so far identified as compound verbs in this study, applying his criteria for the properties of compounds.

The first criterion is that compound constituents belong to major lexical categories, and so do our compound constituents, which are noun-verb combinations. Second, he introduces two measures by which compounds can be distinguished from syntactic phrases. The first is to change the linear order, which is possible in syntactic phrases but not in compounds. This measure seems to hold for Persian noun-verb compound verbs as illustrated in the following examples.

(37)

a. xeili qazaa poxt-i / *poxt-i qazaa

very food cooked-2SG / * cooked-2SG food

‘You have cooked a lot of food.’

b. xeili qazaa-ro poxt-i / poxt-i qazaa-ro

very food-OM cooked-2SG / cooked-2SG food-OM

‘You have over-cooked the food.’

As illustrated in (37a) and (37b), the nominal and the verbal constituents of the compound verb cannot be reversed, whereas the transitive verb and its direct object can be reversed without affecting the meaning of the verbal phrase.

The second measure Dressler (2006) introduces is the impossibility of inserting another word between the members of a compound. As discussed earlier in this chapter, the insertion of another lexical item between the constituents of Persian compound verbs would result in the transformation of the compound verb into a syntactic phrase that includes a transitive verb and its direct object.

(38)

a. Ahmad kotak xord (intransitive compound verb)

Ahmad beating ate-3SG

‘Ahmad was beaten.’

b. Ahmad	kotake	bad-i	xord (transitive simple verb)
Ahmad	beating	bad-IND	ate-3SG

‘Ahmad was badly beaten.’

In the above examples, although (38a) is an intransitive compound verb, the existence of a modifier between the two constituents of the compound verb results in its becoming a transitive simple verb rather than a compound verb in Example (38b).

Another property mentioned by Dressler (2006) to differentiate compounds from syntactic phrases is prosody, which is the pattern of stress and intonation in a language. However, this measure would not work for Persian since, in this language, the stress falls on the noun, both in syntactic phrases and in compounds.

(39)

zendaan	oftaad	chon	zan-esh-o	kosht
jail	fell-3SG	because	wife-3SG.CL-OM	killed-3SG

‘He was imprisoned because he killed his wife.’

(40)

vaghti	zamin	xord-3SG	gerye	kard
when	ground	ate	crying	did-3SG

‘When she fell, she cried.’

In (39), *zendaan* ‘jail’ and *zanesho* ‘his wife’ are not in compounds but rather in syntactic phrases, since *zanesho* ‘his wife’ is the direct object of *kosht* ‘killed’ and *zendaan* ‘jail’ is the indirect object of *oftaad* ‘fell’. However, they both take the primary stress.

In (40), *zamin* ‘ground’ and *gerye* ‘crying’ are nominal parts of compound verbs, and they both take the primary stress, too. Therefore, there is no prosodic distinction between compound verbs and their parallel syntactic phrases.

The fact that some of Dressler’s (2006) classifications for compound verb properties can be applied for Persian and some cannot is an indication that different languages must be addressed differently, and what works for one language may not work for the other. Similarly, the results of the present study are not compatible with the results of other experimental studies on compound word processing in other Indo-European languages, such as English and French (Fiorentino, 2006; Longtin et al., 2003; among others). The reason for this discrepancy must be sought in the structure of the Persian language and other morphologically rich languages, like German, which reached similar conclusions to what we observed in this dissertation (Smolka et al., 2010; among others).

The definition that Dressler (2006) adopts for productivity is the ability of speakers of a language to subconsciously coin new formations. Persian compound verbs are consistent with this definition, as evidenced by the loan nouns that are incorporated into Persian verbs as well as by the novel combinations speakers make with existing nouns and verb stems.

Dressler (2006) states that compounding rules are most productive in loan words. This kind of compounding is extensively used in pidgin languages spoken by first

generation of immigrants. This highly productive compound formation is shown in (41) and (42).

(41)

Parviz	hama-ro	criticize	mi-kon-e
Parviz	everyone-OM	criticize	DUR-do-3SG

‘Parviz criticizes everyone.’

(42)

ye	kiss	bede
one	kiss	give-2SG

‘Give me a kiss.’

The interesting fact about this kind of compounding is that these loan nouns are selective in the verbs they choose as their light verb. This is another reason why the verbal part of Persian compound verbs is more compatible with the semi-functional verbs in the Algonquian literature, which behave like functional predicates regarding their syntactic properties, yet like lexical predicates regarding their thematic properties. Consider the examples below.

(43)

a. email	zadan
email	to-hit

‘to email’

b. click kardan

click to-do

‘to click’

c. shave kardan

shave to-do

‘to shave’

d. kiss daadan

kiss to-give

‘to give a kiss’

e. bluff zadan

bluff to-hit

‘to bluff’

Let us discuss these examples one by one to see if a rule can be generated that accounts for the selection of the light verb by the nominal constituent. In (43a), *email zadan* literally means ‘email to hit’. The reason for this selection might be due to the fact that other communication means such as *telephone* also take this verb, so speakers tend to follow the rules that are already established in the language. In the case of (43d), the Persian

equivalent *bus daadan* ‘kiss to give’ seems to influence speakers to use the same existing compound verb formation rule. In (43e), *bluff zadan* ‘to bluff’ evokes similar though not equivalent phrases such as *mesaal zadan* ‘example to hit’ (meaning ‘to give an example’). Therefore, Persian speakers would use the same light verb in parallel constructions. Examples (43b) and (43c) have no counterparts in Persian, so speakers tend to employ the most commonly used light verb, *kardan*, which means ‘to do’. This holds for a good number of other loan words, including *scan*, *print*, *trust*, etc. These examples show that the nominal constituent is selective in choosing the verb to incorporate or to combine with.

Another property that Dressler (2006) assigns to compounds is their being subordinate compounds, meaning that the non-head is both semantically and structurally subordinate to the head. However, since Persian is a head-final language and is written from right to left, the head (i.e., the verbal part) falls on the left side. Therefore, when processing Persian compound verbs, the parser will encounter the noun or the non-head first. This might be the reason why in transparent compound verbs in the present study, a longer time was observed to make a decision about the verbal element compared to the nominal element.

The last topic concerning compounds discussed by Dressler (2006) is transparency. He adopts Frege’s (1953) principle of compositionality, and states that actual compounds are never fully transparent. Therefore, *ghazaa-xordan* ‘food-to eat’ is considered relatively transparent or non-idiomatic since the meanings of the constituents lead us to the meaning of the compound, whereas *qasam-xordan* ‘to swear,’ literally ‘oath-to eat’ or *farib-xordan* ‘to be deceived,’ literally ‘deception-to eat,’ is considered relatively opaque or idiomatic since it violates the principle of compositionality. In other words, knowing the meanings of

the components of a compound does not help us to understand what the combination of its constituents means.

In this section, we distinguished between compound verbs and syntactic phrases. We tested the constituents of Persian compound verbs used in the present dissertation in light of Dressler's (2006) criteria for recognizing a compound word as well as the properties of compound words. The Persian compound verbs used in the present study seem to fit in most of the criteria introduced by Dressler (2006) except for compound stress, which was discussed above. These differences do not reject Dressler's (2006) system of compound word recognition, but rather indicate that the idiosyncratic properties of the language under investigation should be taken into account when applying the system in different languages.

Taking into account the language specific idiosyncratic properties, Butt (2003) introduces several language dependent tests for recognizing a compound verb that is composed of a nonverbal element and a light verb. She distinguishes light verbs from auxiliaries by comparing them historically, stating that, unlike auxiliaries, light verbs have historically been stable for thousands of years. Butt (2003) declares that the light verb is always identical to a main verb in form, yet it is the syntactic environment that decides whether a given verb is a main verb or a light verb.

Butt (2003) also distinguishes between old and modern light verbs. She links the opacity of some compound verbs to their verbal constituent being a modern light verb. "However, for some preverbs, the meanings are less transparent (non-compositional) and the use of these preverbs is associated with semantic notions of forcefulness, completion, inception, etc. This is immediately reminiscent of the semantics associated with the

modern light verb” (Butt, 2003:17). This classification holds for Persian as compound verbs in the Old and Middle Persian texts use very limited sets of light verbs, and almost all of them are transparent.

Butt (2003) also states that the light verb tends to determine the *Aktionsart* or lexical aspect of the compound construction. However, the following examples illustrate that this observation does not hold for Persian.

(44)

a. unaa Ali-o daar zad-an (telic)

they Ali-OM pole hit-3PL

‘They hanged Ali.’

*b. unaa Ali-o baraye yek-moddat daar zadan (telic)

they Ali-OM for a-while pole hit-3PL

‘They hanged Ali for a while.’

(45)

a. zaaher man-o gul mi-zan-e (atelic)

appearance I-OM fool DUR-hit-3SG

‘I am fooled by the appearance.’

b. zaaher man-o baraye yek-moddat gul

appearance I-OM for a-while fool

mi-zan-e (atelic)

DUR-hit-3SG

‘I am fooled by the appearance for a while.’

The above examples not only contradict Butt’s view, but they also undermine Folli et al.’s classification of compound verbs. Examples (44) and (45) have the same verbal constituent, yet different nominal constituents. The compound verb in (44) is telic as it has an endpoint and it cannot be used with a time-span adverbial, while the compound verb in (45) is atelic for it does not have an endpoint and it can be used with a time-span adverbial. This goes against Butt’s statement and Folli et al.’s (2005) claim that if the nonverbal constituent of the compound verb in Persian is a noun, the compound verb is atelic (activity), unless the noun is eventive, in which case the compound verb would be telic (accomplishment). Example (44) does not contain an eventive noun, yet it is telic for it has a natural endpoint, whereas (45) is atelic. Therefore, it seems that the combination of the nominal and verbal constituent determines the *aktionsart* rather than one of the constituents per se.

In fact, verb representation encompasses three main components: (1) the core meaning, which is the semantic event encoded by the verb, (2) the thematic information, which determines the number of arguments of the event in addition to the specific roles they play, and (3) the subcategorization component, which determines which of these arguments is mandatory and which optional, as well as how they are encoded grammatically as the subject, object, or oblique object (Pinker, 1989; Jackendoff, 1990; among others). This last component is even more complicated for Persian compound verbs since some noun-verb compounds include their objects and some do not. For example, *ghazaa-xordan* “to eat” includes the object in (46), whereas *ahamiat-daadan* “to care

about” needs an oblique object in (47), and *rox-daadan* “to take place” does not require an object at all in (48). As mentioned earlier in this chapter, one of the differences between the two compound verb formation processes, incorporation and combination, is that incorporation (which leads to transparent compounds) almost always results in an intransitive compound verb, while combination (which results in opaque compounds) might lead to a transitive or an intransitive compound verb.

(46) Transparent compound verb as a result of incorporation

man	ghazaa	xord-am	<i>(intransitive)</i>
I	food	ate-1SG	

‘I ate food.’

(47) Relatively opaque compound verb as a result of combination

man	be	to	ahamiat	daad-am
I	to	you	importance	gave-1SG

‘I cared about you.’

(48) Opaque compound verb as a result of combination

yek	tasaadof	rox	daad	<i>(intransitive)</i>
one	accident	face	gave-3SG	

‘An accident happened.’

Therefore, as illustrated in (49) through (51), compound verbs with similar verbal constituents yet different nominal constituents can have different subcategorization frames based on their semantic transparency and formation process.

(49)

<man> _{agent}	<kaado> _{theme}	daad-am
<I> _{agent}	<kaado> _{theme}	gave-1SG

‘I gave a gift.’

(50)

<man> _{agent}	<be to> _{goal}	ahamiat	daad-am
<I> _{agent}	<to you> _{goal}	importance	gave-1SG

‘I cared about you.’

(51)

<yek-tasaadof> _{agent}	rox	daad
<an accident> _{agent}	face	gave-3SG

‘An accident happened.’

Therefore, even the subcategorization frame, which is determined by the verb in main verbs, is determined by the combination of the nominal and verbal constituents rather than by the verbal constituent alone.

Another issue raised by Butt (2003) is the extent of nominal and verbal constituents' contribution to the event semantics of the compound verb. In Persian, however, there is a difference between the transparent and opaque compound verbs in this regard. The semantics of transparent and opaque compounds seem to be different due to the "type-shifting effect," which refers to the process whereby the semantic type of a complement of a verb changes to conform to the verb's requirements. For instance, an NP with the semantic type of *entity* might change to an NP with the semantic type of *proposition*, as illustrated in (52) below.

(52)

The author began the book.

In this sentence, the semantic type of the NP complement, *the book*, which is an entity, changes to that of a proposition, which denotes an activity performed with the book (see Jackendoff, 1997; Pustejovsky, 1995; among others). This type-shifting effect is observed in opaque compound verbs in Persian, but not in transparent ones. For example, *rang* 'colour' in *rang-kardan* 'to trick', in Example (54) below, which is an entity, coerces to a proposition when it is used as the NP complement of an opaque compound verb. However, when *rang* 'colour' is used as the NP complement of a transparent compound verb, it retains its semantic type of an entity.

(53)

un man-o rang kard

he I-OM colour did-3SG

‘He tricked me.’

(54)

un divaar-o rang zad

he wall-OM colour hit-3SG

‘He painted the wall.’

Rang ‘colour’ in (53) is not an entity but rather, together with *kard* ‘did,’ represent an embedded proposition, which is literally ‘someone being coloured’, and figuratively ‘someone being tricked’, whereas *rang* ‘colour’ in (54) is an entity even after merging with the verbal element *zad* ‘hit’. The discrepancy between the transparent and opaque compound verbs is reflected in the results of the current study by the numerically smaller priming effect of the verbal constituent compared to the nominal constituent in the transparent compound verbs, but not in the opaque compound verbs.

To sum, the results of the present study suggest that some compound verbs in Persian can be formed by incorporation and some by combination. The technique used in the present study was masked priming, and masked priming reveals the mental processes at the prelexical stage, before the syntactic and semantic information is calculated. Therefore, it can be argued that: (1) both semantically transparent compound verbs in Persian (which are the result of incorporation), and (2) semantically opaque compound verbs in Persian (which are the result of combination), are formed prelexically. Hence, the overall evidence reflected in the results of the experimental studies discussed in Chapter 3 as well as the

counter-examples discussed in Chapter 4 seem to point towards a lexicalist approach to Persian compound verb processing.

In this chapter, we discussed the syntax and semantics of Persian compound verbs in the light of the results of the experimental studies reported in this dissertation. In the next chapter, we will discuss these results and their contribution to the fields of psycholinguistics and complex predicate.

CHAPTER 5

GENERAL DISCUSSION

Persian is an interesting language to observe in order to investigate lexical representations since it belongs to the same language family as English, French and German do. Thus, it possesses the concatenative morphology of Indo-European languages. Yet it is different from many of these in its morphological richness and productivity as demonstrated by the productivity of its compound verbs discussed in the previous chapter.

In this chapter, we will have a general discussion on the findings of the two experiments discussed in Chapter 4. We will then discuss the contributions of these findings to psycholinguistics in Section 5.1. In Section 5.2, we will review some studies on the processing of idiomatic expressions in English. The processing of idiomatic expressions is relevant to our study because Persian compound verbs are similar to English idiomatic expressions, in that, both are composed of more than one word, each of which contribute to the meaning of the whole. Then in Section 5.3, we will discuss the contribution of the present study to the complex predicate field.

The results of the present study will enable us to compare our results with the results of experimental studies on the processing of complex and compound verbs in other concatenative languages to see if the same conclusions will be derived or not. As reported in Chapter 4, the results of the current study seem to be more compatible with the results of

similar priming experiments in morphologically rich languages like German (Smolka et al., 2010; among others) than the result of priming experiments in morphologically less rich languages like English or French (Fiorentino, 2006; Longtin et al., 2003; among others).

The results of the current study revealed several findings as: (1) compound verbs in Persian are decomposed into their constituents at early stages of processing; (2) at early stages of processing, decomposition is based on purely orthographic similarity; (3) although both transparent and opaque compound constituents are facilitated while processing, transparency seems to have an impact on processing. This is because, at early stages of processing, the nominal constituent of semantically transparent compound verbs shows stronger priming effects than their verbal constituent. This is unlike the opaque compound verbs, where both the nominal and the verbal constituents are equally primed; and (4) there is a competing alternative effect or parallel input effect for the verbal constituent of the transparent compound verb. This effect is revealed by the increase in the processing load resulting in slower facilitation for the verbal constituent compared to the nominal constituent.

These findings are compatible with several studies in the literature. For example, the first finding (i.e., compound verbs in Persian are decomposed into their constituents at early stages of processing) has been claimed for many concatenative languages, like English and French for both morphologically complex (Longtin et al., 2003; among others) and compound words (Fiorentino, 2006; among others). The second finding (i.e., at early stages of processing decomposition is based on purely orthographic similarity) has been reported in other experimental studies on complex and compound words (Diependaele et al., 2005; Feldman, 2000; among others). The third finding was that although both

transparent and opaque compound constituents are facilitated while processing, transparency seems to have an impact on processing at early stages of processing. This finding is compatible with studies that consider two routes for complex and compound word processing based on the semantic transparency (Schreuder and Baayen, 1995; Baayen et al., 1997; Baayen, 1992; among others). The fourth finding (i.e., there is competing alternative effect for the verbal constituent of the transparent compound verb as revealed by the increase in the processing load resulting in slower facilitation for the verbal constituent compared to the nominal constituent) has also been claimed in several studies on complex and compound word processing (Kuperman et al., 2010; and Newman et al., 2010; among others).

In sum, the results of the experiments reported in this dissertation, revealed both a constituency effect and a transparency effect under a masked-priming paradigm. In addition, the smaller size of priming effect of the verbal constituent compared to the nominal constituent in the transparent condition was argued to seem to be the result of competing alternatives of the verbal constituent. In fact, the results appear to show that during lexical processing of compound verbs, in the early stages of processing called the prelexical stage, the parser is only sensitive to orthographic relationship. It must be noted that we do not reject the role of morphology in processing complex and compound words but rather agree with Meunier and Longtin (2007) that at the prelexical stage of processing, morphological segmentation operates on an orthographic basis. This is followed by the lexical stage where the decomposed constituents will be reappraised for the semantic and syntactic information.

The findings of the present study are also compatible with the models of complex and compound word processing, which hold that syntactic and semantic computations would increase the processing load as illustrated by the smaller facilitation for the verbal constituent of the transparent compound verbs. This is compatible with Kuperman et al.'s (2010) classification of the subprocesses in complex word processing: (1) recognition of the constituents; and (2) inhibition of competing members, where the processing costs of constituents with smaller families or competing alternatives is smaller than the processing costs of constituents with larger families. The constituents of transparent compound verbs in Persian are one example.

In the next section, we will discuss the contribution of the current study to the psycholinguistics field.

5. 1. Contribution of the study to the psycholinguistics field

As discussed in Chapter 2, there are three main theories of compound word processing: (1) decompositional hypothesis, which holds that compound words are accessed via their constituents (Taft and Forster, 1975);

(2) whole-word or full-list hypothesis, which holds that compound words are stored and processed as whole words (Butterworth, 1983); and

(3) dual access theory, which supports morphological decomposition for some compound words and whole-word for others (Schreuder and Baayen, 1995; Baayen et al., 1997; among others).

All of these theories are morphologically-based, yet there are some alternative theories. Convergence theory, for example, which is based on a distributed connectionist

model (Seidenberg and Gonnerman, 2000), does not hold morphology solely responsible for the relation between the complex/compound word and its constituents. It rather considers it to be a graded inter-level representation that reflects correlations among orthography, phonology and semantics.

The present study is compatible with the convergence theory because at early stages of processing, morphological relationship does not seem to be necessary for decomposition. At the prelexical level, orthographic relation seems to be the basis of decomposition. Of course, the constituent priming effects in the transparent and opaque conditions imply that morphological relations *are* considered in processing. In addition, the fact that priming effects in transparent prime-target pairs and opaque prime-target pairs were different shows that semantic information is considered as well. Therefore, it seems that orthographic and semantic as well as morphological relations together have an impact on the constituent priming effects in compound verb processing. This idea is compatible with the graded representation of morphology in the convergence theory.

Crucially, the present study suggests new evidence that the parser looks to segment any morpheme or pseudo-morpheme that it can identify in the word when processing it. This finding is supported by Libben et al.'s (1999) study on English novel compounds (such as *clamprod*), in which both *clamp+rod* and *clam+prod* segmentations were observed. In other words, the parser is actively searching for meaningful segments to decompose while processing a word.

Although most studies found stronger priming effects for transparent polymorphemic words than opaque polymorphemic words (e.g., Longtin et al., 2003; Rastle et al., 2004; Fiorentino & Poeppel, 2007; Kazanina et al., 2008; among others),

some studies in the literature which have studied a different language or employed a different technique, have not revealed a stronger priming effect for the transparent compounds. For example, Smolka et al. (2008) investigated the processing of German prefixed verbs under different SOA's and concluded that morphological processing is not modulated by semantic transparency. They found similar morphological priming effects for the base verbs, such as *kommen* 'come' in semantically transparent prefixed verbs, such as *mitkommen* 'come along' as well as semantically opaque prefixed verbs, such as *unkommen* 'perish.' Likewise, Devlin et al. (2004), who used an event-driven fMRI (functional magnetic resonance imaging) approach, to investigate morphological and semantic effects in compound word processing, reported that the behavioural priming effect for opaque and pseudo-derived pairs (slipper-slip) was identical to the priming effect for transparent compounds (teacher-teach). Therefore, it seems that complex and compound word processing is affected by the language under investigation, the kind of stimuli, the SOA's used and the technique employed.

Among the nonlinguistic factors that affect processing, linearity effect, priming technique effect and frequency effect were discussed in chapter 2. Linearity effect is challenged by Smolka et al. (2008). They compared German, a linear language, to Arabic, a nonlinear language, arguing that morphological richness rather than linearity, determines processing routes. The results of the present study support this idea because although Persian is a linear language, it does not closely follow the literature on other linear languages like those reported for English or French. However, Persian and German are more similar, in that, they are both linear, and they are both morphologically rich.

The results of the current study imply that the compound verb as well as each constituent of the compound verb is linked to a different lemma, while all represented by one lexeme. At the lemma stage, transparent and opaque compounds are different, in that, the transparent compound activates not only its nominal and verbal constituents but also the competing alternative verbal constituents. This is reflected in the smaller priming effects observed for the verbal constituent of the transparent compound verbs. For example, the opaque compound verb (*rox-daadan* ‘to happen’ *face-to give*) is linked with these lemmas: *happening*, *face* and *giving*. The transparent compound verb (*kaado-daadan* ‘to give gifts’ *gift-to give*) on the other hand is linked with more lemmas, i.e.,: *gift*, *giving*, *buying*, *doing*, *receiving*, etc. The conceptual level must be examined through an unmasked priming experiment on Persian compound verb processing in a future study. However, one can stipulate from other unmasked priming studies on polymorphemic word processing that at this level, the transparent compound will be accessed as its constituents, unlike the opaque compound and the orthographic overlap condition (Longtin et al., 2003; among others). These three levels are depicted in Figure 5. 1. below.

Figure 5. 1.

The processing of opaque and transparent compound verbs

	<u>Opaque</u>	<u>Transparent</u>	<u>Form</u>	<u>Recognized at</u>
Conceptual level	<i>rox-daadan</i>	<i>kaado-daadan</i>	<i>xandidan</i>	<i>conscious level</i>
	to happen	gift-to give	to laugh	
		gift		
		to give		
Lemma level	<i>rox-daadan</i>	<i>kaado-daadan</i>	<i>xandidan</i>	<i>subconscious level</i>
	to happen	gift-to give	to laugh	
	face-	gift-	-	
	-to give	-to give	-to see	
		-to buy		
		-to do		
		-to receive		
			
Lexeme level	<i>rox-daadan</i>	<i>kaado-daadan</i>	<i>xandidan</i>	<i>stimulus level</i>
	face-to give	gift-to give	to laugh	

As illustrated in Figure 5.1, there are three levels of compound word processing. The first level is the lexeme level, which is what is seen as the stimulus and has either phonological

or orthographic representations based on the task. At this level, simple verbs as well as opaque and transparent compound verbs are similar in having one lexeme. The second level is the lemma level, which is processed subconsciously. At this level the simple verbs as well as the opaque compound verbs have a whole-word representation as well as a constituent representation. The transparent verbs have a whole-word representation, a constituent representation, and all the competing constituent alternatives. Lemmas are activated when their semantic conditions are met. These then activate their corresponding syntactic specifications. This is where Meunier and Longtin's (2007) reappraisal or Libben's (2006) mismatch of activation occurs (see Chapter 2).

The third level is the conceptual level, which is only accessed under unmasked conditions. Under masked conditions, the parser has enough time to activate the compound and its constituents, as well as the pseudo-constituent in the orthographic overlap condition.

Studies on aphasic patients can be used as further evidence for the noun-verb compound verb processing. However, such studies are not unanimous in the nominal or verbal prominence as indicated by discrepancies between nominal or verbal omissions by the aphasic patients. In addition, there have not been many studies on aphasic patients in Persian. Nilipour (1989, 2000) and Nilipour and Raghibdoust (2001) reported a reliance on nouns rather than verbs. Their results were compatible with Semenza et al.'s (1997) and Mondini et al.'s (2004) studies on aphasic patients in Italian where the omissions of verbal constituents were much higher than the omissions of the nominal constituents in verb-noun compounds. The findings of the present study appear to confirm these results. More specifically, under masked conditions, the nominal constituent is primed more significantly

than the verbal constituent in the transparent condition compared to other conditions. This stronger priming effect can be taken as an indication of the prominence of the nominal constituent as it is retrieved faster than the verbal constituent.

In addition, the results of this research seem to further support the results of a study done on Persian compound nouns, replicating Longtin et al.'s (2003) conditions involving transparent compound nouns, opaque compound nouns and orthographic compound nouns. Nojournian, Shabani-Jadidi and Tangestanifar (2006) investigated the processing of multimorphemic nouns in Persian. The researchers replicated Longtin et al.'s (2003) study on French compound nouns. The task employed was lexical decision making under a masked priming paradigm. The participants were sixteen native speakers of Persian. The conditions were similar to those in Longtin et al.'s (2003) study: (1) transparent (e.g., *sar-angosht-SAR* 'finger tip - HEAD'); (2) opaque (e.g., *sanjaab-SANJ* 'squirrel/MEASURE'); and (3) orthographic (e.g., *badraghe-BADR* 'seeing off-MOON'). The results revealed a strong priming effect for the transparent condition and a marginal priming effect for the opaque and orthographic conditions. This is compatible with the results of the present study, which reveal that at early stages of processing, orthography appears to be the basis of decomposition while semantic transparency could enhance the priming effect.

In the next section, we will compare the processing of opaque compound verbs and the processing of idiomatic expressions.

5. 2. Processing of idiomatic expressions

Compound verbs in Persian are compatible with idiomatic expressions in English, in that, both are composed of more than one word, each of which contribute to the meaning of the

whole. Just like idiomatic expressions, compound verbs in Persian are between two ends of a continuum, moving between completely compositional (transparent) to completely idiomatic (opaque). The present study investigated the processing of transparent (non-idiomatic) and opaque (idiomatic) compound verbs in Persian. Opaque compound verbs are non-compositional and idiomatic. Therefore, it is relevant to compare them to other studies in the literature on the processing of idiomatic expressions.

The study of idioms is central to the psychological investigations of language due to their pervasiveness, creativity, and ease. However, idioms are a challenge to the compositional models of language processing. Investigating idiom processing provides invaluable insights into the processing relationships existing between syntax and semantics. Their non-literal status causes dissociations between these two levels. There are two approaches to idiom processing, namely bottom-up and top-down. If idiom processing is bottom-up, then the syntactic processor will process the idiom literally. If the processing of idioms is top-down, then the semantic processor will cancel the syntactic input in order to produce the figurative meaning of the idiom. Therefore, the processing system will not only be involved in bottom-up processing but also in top-down processing (as illustrated in Figure 5.1). The results of the present study suggest that, in Persian, compound verbs as well as pseudo-complex verbs (simple verbs containing a pseudo-morpheme introduced as the third condition in the present study) are broken down into their comprising constituents. However, as suggested by the stronger facilitation of the nominal constituent and the weaker facilitation of the verbal constituent in the transparent condition compared to the opaque and orthographic conditions, it can be implied that the semantic information

is being calculated in the reappraisal stage. Hence, it is supporting a top-down processing which entails a bottom-up processing as well.

Swinney and Cutler (1979) conducted two Phrase Classification experiments to examine the nature of access, storage, and comprehension of idiomatic phrases. Since classification times were significantly faster for idioms (e.g., *see the light*) than for their matched non-idiom (e.g., *get the light*) control phrases, they concluded that the data supported a Lexical Representation Hypothesis for the processing of idioms, which holds that idioms are stored and accessed from the lexicon in the same manner as any other word. According to this view, upon the occurrence of the first word in the idiom string, both the idiomatic and the literal meanings of the idiomatic phrase are activated (Foss & Jenkins, 1973).

However, this argument does not seem adequate because in their stimuli, *light* is the shared word, yet it comes last. It is not clear what they mean by "... upon the occurrence of the first word in the idiom string, both the idiomatic and the literal meanings of the idiomatic phrase are activated" (Swinney and Cutler, 1979). The first word in these two phrases is merely a verb with no indication of the idiom, yet in our study, the compound verbs begin with the noun that can activate either the literal or the idiomatic expression.

The opposite view to this approach is called the Idiom List Hypothesis. This hypothesis holds that idioms are stored in and accessed from a special list which is not part of the normal lexicon. Hence an idiom mode of processing is activated when processing idioms. An important condition on the Idiom List Hypothesis is that a literal analysis always precedes an idiomatic one while processing. The results of our study do not appear

to be compatible with the Idiom List Hypothesis because as revealed by the results, orthographic overlap and opaque prime-target pairs demonstrate equally significant priming effects. This does not seem to support the existence of a special list for the idioms in the lexicon since opaque compound verbs and pseudo-complex verbs yielded the same size of constituent priming effects in the experiments reported in this dissertation.

Gibbs et al. (1989) examined three kinds of idioms (literal, semi-idiomatic and idiomatic) in order to investigate idiom processing. Their results showed that idiomatic phrases, which were non-compositional, were verified significantly more slowly than the literal phrases, which were compositional. These results are compatible with early decompositional theories and suggest that the first route is to decompose the idiom and subsequent to that, the whole-word representation route is taken. The results of the present study are compatible with this view because significant priming effects were observed for the constituents of both idiomatic and non-idiomatic compound verbs. This suggested that the decomposition takes place at very early stages of processing. However, different languages are likely to be compatible with different theories of processing idiomatic expressions since the frequency of these expressions in a language as well as the productivity of forming such expressions in a language may well play a role in how these expressions are processed. In the next section, we will discuss the contribution of the current study to the complex predicate field in the Persian linguistics domain.

5. 3. Contribution of the study to the complex predicate field

As discussed in Chapter 4, noun-verb compound verbs in Persian have been considered either as a syntactic phrase or as a lexical compound verb. The syntactic approach to Persian compound verb formation (e.g. Folli et al., 2005, among others) entails that the

syntactic category of a lexical element is determined only by the syntactic context in which it appears. In other words, the syntactic properties of the verb determine the position and interpretation of each argument in the verb phrase.

The lexical approach to Persian compound verb formation (e.g. Goldberg, 2007, among others), on the other hand, entails that the syntactic category of a word is lexically specified. There are two versions to the lexical approach to Persian compound verb formation: strong version, which holds that mental lexicon encompasses words, roots, affixes, word-formation rules, and subcategorization frame (information about the arguments), and weak version, which holds that mental lexicon includes only atomic roots (such as sound-meaning pairings).

The results of the current study suggest that both transparent and opaque compound verb constituents are primed under the masked-priming paradigm. This indicates that compound constituents are recognized prelexically. This seems to be compatible with a projectionist approach to compound verbs as the results indicate that the processing of Persian compound verbs operates on an orthographic basis at the prelexical stage of processing, followed by calculating the semantic and syntactic information (in line with Meunier and Longtin's hypothesis, 2007).

The results of the present study seem to be compatible with the results of other studies that used similar primes and masked-priming conditions, with priming durations between 32-66 ms, which observed facilitation due to pure orthographic similarity without morpheme-like endings. For example, primes like *tinsel* facilitated the recognition of a target like *TIN* (Diependaele et al., 2005; Feldman, 2000; Giraudo & Grainger, 2000; Rastle et al., 2000; Segui & Grainger, 1990; among others). In other words, at very early stages of

processing, orthographic priming occurs regardless of semantic or morphological relationship.

The results of the current study do not appear to be compatible with studies on English and French polymorphemic words that found priming effects for the constituents of morphologically related prime-target pairs (excluding for a purely orthographic relationship) (Longtin et al., 2003; Fiorentino et al, 2007; among others). This discrepancy may be due to the morphology of Persian language. Persian belongs to the same language family as English, French and German do and thus possesses the concatenative morphology of Indo-European languages. Yet, it is different from many Indo-European languages in its morphological richness and productivity as demonstrated by the productivity of Persian compound verbs discussed in Chapter 4.

Persian compound verbs are said to be formed either by combination or through incorporation (Dabir-Moghaddam, 1997). Combination entails that a noun, an adjective, an adverbial phrase, a prepositional phrase, or a complex nominal phrase is combined with a verb to form a compound verb in Persian. Incorporation, on the other hand, entails that a nominal element that functions as the direct object loses its grammatical endings to be incorporated into the verb. Incorporation also entails that some prepositional phrases that function as adverbs lose their prepositions and incorporate into the verb. However, both combination and incorporation processes produce noun-verb compound verbs in Persian (Dabir-Moghaddam, 1997). The results of the present study suggest that some compound verbs in Persian can be formed by incorporation and some by combination. Although both opaque and transparent compound verbs prime their constituents, we observed a greater priming effect for the nominal constituent than the verbal constituent in transparent

compound verbs. We also observed equal priming effects for the nominal and verbal constituents in opaque compound verbs in Persian. In other words, the nominal and verbal constituents in the opaque compound verb are recognized at the same time (25 ms) and so do the pseudo-constituent in the pseudo-complex verb. Yet, the nominal and verbal constituents in the transparent compound verb are recognized at the different times (40 ms for the noun and 17 ms for the verb). Therefore, it can be argued that both semantically transparent compound verbs in Persian (which are the result of incorporation), and semantically opaque compound verbs in Persian (which are the result of combination), are formed prelexically. Incorporation involves computations, such as the selection of competing alternatives for the verbal constituent in transparent compound verbs in Persian. These computations are reflected by an inhibitory effect of competing alternatives for the verbal constituent and the increase in the processing load. The increase of processing load due to computing competing alternatives has been discussed in a number of studies on complex and compound word processing (see Manouilidou, 2006; Kuperman et al., 2010; and Newman et al., 2010; among others).

Since the technique used in the present study was masked priming, and masked priming reveals the mental processes at the prelexical stage, before the syntactic and semantic information is calculated, the constituent effect and the competing alternative effects seem to support a lexicalist approach to compound verb processing in Persian. The fact that the constituents of compound verbs in Persian can be interrupted by a modifier can be taken as evidence for proponents of the syntactic approach to noun incorporation, yet the fact that the nominal constituent of the compound verbs in Persian cannot be coreferent with the pronoun that follows the compound verb can be considered as evidence

for supporters of the lexical approach to noun incorporation. More experimental studies must be done in order to investigate this issue.

Indeed, our results are compatible with Kuperman et al.'s (2010) classification of two subprocesses in complex word processing: (1) recognition of the constituents; and (2) inhibition of competing members. Kuperman et al. (2010) argue that the processing costs of constituents with smaller families or competing alternatives -- such as the constituents of the verbal constituent in the opaque compound verbs in Persian -- is smaller than the processing costs of constituents with larger families -- such as the verbal constituent in the transparent compound verbs in Persian. In fact, as discussed earlier, opaque compound verbs are the result of combination, whereas transparent compound verbs are the result of incorporation. Most compound verbs produced by combination are idiomatic and thus considered fixed or frozen expressions. This limits them to smaller families or competing alternatives when it comes to processing. Hence combination is less productive than incorporation.

For example, in order to form a transparent compound verb, *kaado* 'gift' can select from among different verbs, such as - *gereftan* 'to get a gift', - *kardan* 'to wrap a gift', - *daadan* 'to give a gift', - *xaridan* 'to buy a gift,' - *bordan* 'to take a gift.' Therefore, it takes the parser longer to select from among these competing alternatives. This results in an increase in the processing load. However, in order to form the opaque compound verb *qasam xordan* 'to swear', *qasam* 'oath' has only one option: *xordan* 'to eat' since opaque compounds are idiomatic and fixed expressions.

In this chapter, we discussed how the findings of the current study could contribute to further understanding of the issues investigated in similar studies within the

psycholinguistics domain, the idiomatic expressions domain, and the complex predicate domain. In the next chapter, we will conclude the thesis with suggestions for further research in the domain of compound verb processing in Persian.

CHAPTER 6

CONCLUSION

In this dissertation, we have investigated the on-line processing of Persian compound verbs under the masked-priming paradigm. We chose compound verbs so that we could compare our results with the findings of other experimental studies on complex and compound word processing. We sought to determine whether similar conclusions would be reached or not. In addition, there are controversial theories of Persian compound verbs in the Persian linguistics domain. This dissertation attempts to provide an answer for some of these controversial issues (see the discussion on the structure of Persian compound verbs in Chapter 4). The results of the current study are compatible with the body of research on complex and compound word processing, mainly convergence theory (Seidenberg and Gonnerman, 2000), that consider morphology to be an inter-level representation, reflecting correlations among orthography, phonology and semantics. Our results are also compatible with studies that consider orthography to be the basis of decomposition at the prelexical stage (Meunier and Longtin, 2007). The discrepancy between the results of priming experiments on Persian (Nojournian et al., 2006; and the present study) or German (Smolka et al., 2010) on the one hand and English (Fiorentino, 2006) and French (Longtin et al., 2003) on the other hand can be due to the morphological richness of the language

under investigation. Morphological richness of a language is determined by the frequency and productivity of the compounding process in that language. Persian, as discussed in Chapter 4, has a highly productive compounding system and compound verbs are more common than their corresponding simple verbs.

It was also revealed in the current study that the verbal constituent in transparent compound verbs is primed less significantly than the nominal constituent. This indicates an increase in the processing load. We argued that this increase in the processing load could be due to the competing alternative effect (see Manouilidou, 2006; Kuperman et al., 2010; Newman et al., 2010; among others).

As far as the structure of compound verbs is concerned, the results of the current study provide evidence for the incorporation/combination dichotomy of compound verbs in Persian. It indicates that transparent verbs are the result of incorporation, whereas opaque verbs are the result of combination. As discussed earlier, combination and incorporation are the two compound word formation processes involved in making Persian compound verbs (Dabir-Moghaddam, 1997). Combination entails that the nominal constituent is combined with the verbal constituent to form a compound verb in Persian. Incorporation, on the other hand, entails that the nominal constituent that functions as the direct object loses its grammatical endings and incorporates into the verb. In fact, both lexical processes of compound verb formation in Persian that is combination (which results in opaque compound verbs) and incorporation (which results in transparent compound verbs) occur prelexically. However, incorporation involves computations, such as the selection of competing alternatives for the verbal constituent in transparent compound

verbs in Persian. This is reflected by an inhibitory effect of competing alternatives for the verbal constituent and the increase in the processing load.

The results of the present study revealed that the nominal constituent of transparent compound verbs show a higher priming effect compared to the verbal constituent. This is compatible with the results of experimental studies on compound verb processing in aphasic patients (Nilipour and Raghibdoust, 2001; among others). In these studies, the omission of verbal constituents was much higher than the omission of nominal constituents in noun-verb compounds. Since the nominal element is the non-head yet the initial constituent, this first-word effect cannot be accounted for by the head-effect (see Jarema et al., 1999; among others). Rather, it can be accounted for by the position effect (see Fiorentino, 2006; among others).

In conclusion, the present study is by no means definitive. The experiments in this study can be replicated with other participants under other conditions using other priming techniques. In addition, the processing of compound verbs can be compared to the processing of other compound words in Persian as well as to the processing of compound verbs in other languages. Research on the mental lexicon might be at an early stage of development, but experimental research on the structure of the Persian language is at an even earlier stage of development. It is hoped that this study will be followed by many more studies in this field.

Appendix A

A. 1. Lexical decision task

The lexical decision task is a procedure that is used in many psychology and psycholinguistics experiments. The basic procedure involves measuring how fast people classify stimuli as words or nonwords. In psycholinguistics research, the lexical decision task is used in various experimental techniques. For example, in the unmasked visual priming experimental technique, the participants are instructed that they will see pairs of letter strings. What they need to do is decide as quickly and as accurately as possible whether the second letter string is a word or a non-word by pressing the WORD or the NONWORD button on the keyboard.

In the masked priming experimental technique, participants are instructed that they will see a string of letters on the screen in each trial. What they are required to do is to decide as fast and as accurately as possible if each of these strings of letters is a word or not by pressing the WORD or the NONWORD buttons on the keyboard.

Although the lexical decision task is considered not very natural from the participants' perspective, it is an easy, yet powerful technique to indirectly examine word processing in a language. In the present study, the participants were told that the experiment is a Reaction Time test so that the purpose of the study would be shielded, and the experiment would become less artificial to the participants.

Using various software, such as the DMDX software, the reaction times as well as the accuracies of lexical decisions made are measured from the onset of the target display on the screen. In addition, not only correct responses, but also incorrect responses are used as data in the psycholinguistics research. In fact, some scholars (e.g., Taft, 1979; among

others) use the incorrect responses to measure the sublexical structures in word recognition. For example, the reaction times of the incorrect responses that are able to fool the word recognition system are longer than the completely nonword ones. Furthermore, some other scholars (e.g., Buchanan et al., 2003; among others) use nonwords for specific purposes to reveal something about sublexical structures in word recognition.

Of course there are problems with the lexical decision task as there are with any other task. For example, the lexical decision task cannot be considered as a perfect measure for word recognition because it always involves a mixture of words and nonwords. This can enable the participants to develop some kind of strategies to distinguish words from nonwords in a lexical decision task.

Another problem with the lexical decision task is the extraneous factors that might control the decisions made by the participants. For instance, a nonword that is similar to a word might be recognized as a word, or the second language of the participants might interfere in their response. For instance, a string of letters might not form a word in the language under investigation but it might have a corresponding word in one of the languages the participant knows; thus, inciting the participant to enter a false positive response.

The third problem with the lexical decision task is the interference of frequency effect. Frequency is said to have an effect on the word recognition. In addition, the two dependent variables assessed in lexical decision tasks (reaction time and accuracy) might be used for examining the same underlying processes, yet they tap into different aspects of the recognition process (Santee & Egeth, 1982; among others).

A. 2. Masked priming

Different kinds of masked priming techniques have been developed and adopted in psycholinguistics research. Evett and Humphreys (1981) developed a four-field paradigm as (mask-prime-target-mask), in which both the target and the prime were presented very briefly. In this paradigm, the dependent variable was the accuracy of target identification. The results yielded by this technique were not very reliable as both words and nonwords would yield the same results. The reason is that due to the very brief presentation of both the prime and the target, they are fused and not legible (Forster, 1993). Therefore, Forster and Davis (1984) developed the three-field (mask-prime-target) paradigm to use in masked priming experiments. Forster and Davis' (1984) masked priming technique is referred to as the 'sandwich' technique, in that, the prime is sandwiched between a forward pattern mask (#####) and the target stimulus, which is a backward mask, thus making the prime invisible. Therefore, the prime never reaches consciousness, and any observed priming effect cannot be due to any conscious understanding of the relationship between the prime and the target stimulus. In masked priming techniques that involve lexical decision tasks, the participants are required to make a lexical decision about the target.

Initially, Forster and Davis (1984) used a dummy word as the forward mask, but later it was replaced by hash marks since it was easier and it would not interfere with the target. As for the prime-target distinction, the prime is usually presented in lower case letters, whereas the target is presented in upper case letters so that they are physically distinct from one another. The hash marks are used so that any chance of fusion between the prime and the target is eliminated. In the present study, since there is no lower or upper

case distinction in Persian alphabet, the prime-target distinction was made by writing the targets in bold and with bigger fonts compared to the primes.

Unlike Evett and Humphreys's (1981) four-field paradigm, in which the prime and the target are both presented very briefly, in Forster and Davis's (1984) three-field paradigm, the prime duration varies from 20 to 67 milliseconds. Of course, at prime duration of 60-67 ms, participants might notice the prime, but cannot identify it (Forster and Davis, 1984; Forster et al, 1987). At the prime duration of 50 ms and lower, it is impossible to even notice the prime. In the present study the prime duration was 50 ms, and none of the participants reported that they had noticed the primes.

There are different kinds of prime-target relationship, such as: (1) repetition priming (e.g., *flower-FLOWER*), (2) form priming (e.g., *flower-PLOWER*), (3) semantic priming (e.g., *flower-VASE*), (4) morphological priming (*flower-FLOWERY*), and (4) translation priming (e.g. *flower-FLEUR*). In priming experiments, the priming effect of the prime on the acceleration of identification of the target is compared to that of a totally unrelated control prime-target pair (e.g., *slowly-FLOWER*). This unrelated control pair can be of different degrees of relatedness as the lexical status of the control prime does not have any effect on priming the control target (Perea and Rosa, 2000). It has even been suggested that the control prime can be replaced by uninterruptible characters (e.g., \$\$\$\$\$\$\$) (Davis, 2003).

Like any other technique, masked priming is not without shortcomings. One criticism to masked priming could be that it might tackle processing pre-lexically and orthographically, and not lexically. However bilingual and cross-language priming effects challenge this criticism because in such experiments, the priming effect has been reported

between translation equivalents in languages with completely different orthographic and phonologic system, such as Hebrew and English (Gollan et al., 1997), or Chinese and English (Jiang and Forster, 2001). Therefore, the priming effect observed must be occurring at a lexical or even at a higher level. The results of the present study, however, provide evidence for the soundness of this criticism as revealed by the orthographic priming effects reported in Chapter 3.

Forster (2004) explains the priming effect in two possible scenarios. The first scenario explains priming as entry opening, which means that information is extracted from the entry more quickly if it has already been primed. He integrates the entry opening account to his *bin model* of lexical access (Forster, 1999). According to the *bin model* of lexical access, lexical entries are categorized into subcategories or bins based on orthographic similarities. In addition, lexical entries can perfectly match with the word that is being processed or closely matched to it, or totally irrelevant. According to Forster (1999), the perfectly matched and the closely matched entries are tentative candidates when processing the word. The search continues until the end of the bin is reached and the appropriate entry is activated. This can account for the acceleration of lexical decision making in related primes. Since the prime completes the entry opening process, it will then make it easier for the target to do its own entry opening if the prime and the target match perfectly or closely. The second scenario to account for the priming effect is the savings effect. It considers the entry opening costly for the parser. Unlike the entry opening scenario, the savings effect speeds up lexical decision making in related primes. Since the prime initiates the entry opening process, it will then be taken on by the target. Hence, processing time is saved and the priming effect is observed. Either of these scenarios could

hold true based on the language under investigation, the priming technique used, and other extraneous factors.

Appendix B

Stimuli for Experiment 1

Relatively Transparent Prime-Target Condition

Related prime	Unrelated Prime	Target	Relatedness¹²
بیرون آمدن	سفر کردن	بیرون	7
birun-amadan	safar-kardan	birun	
<i>outside-to come</i>	<i>travel-to do</i>	<i>outside</i>	
‘to come out’	‘to travel’	‘outside’	
پایین افتادن	دروغ گفتن	پایین	7
pain-oftadan ¹³	doruq-goftan	pain	
<i>down-to fall</i>	<i>lie-to tell</i>	<i>down</i>	
‘to fall down’	‘to lie’	‘down’	
کادو دادن	بالا رفتن	کادو	7
kaado-dadan	bala-raftan	kaado	
<i>gift-to give</i>	<i>up-to go</i>	<i>gift</i>	
‘to give gifts’	‘to go up’	‘gift’	

¹² The Relatedness column represents the mean relatedness rating (1: semantically least related - 7: semantically most related) for each related prime-target pair.

¹³ In the stimuli lists, one letter has been used to represent long vowels, unlike in the text, where /aa/ represents the long vowel and /a/ represents the short vowel.

بالا آمدن	نگاه کردن	بالا	7
bala-amadan	negah-kardan	bala	
<i>up-to come</i>	<i>look-to do</i>	<i>up</i>	
'to come up'	'to look'	'up'	
هدیه دادن	پایین پریدن	هدیه	7
hedie-dadan	pain-paridan	hedie	
<i>present-to give</i>	<i>down-to jump</i>	<i>present</i>	
'to give presents'	'to jump down'	'present'	
جوش در آوردن	قصه گفتن	جوش	7
juS-daravardan ¹⁴	qese-goftan	juS	
<i>pimple-to bring out</i>	<i>story-to tell</i>	<i>pimple</i>	
'to grow pimples'	'to tell stories'	'pimple'	
لباس در آوردن	نماز خواندن	لباس	7
lebas-daravardan	namaz-xandan	lebas	
<i>clothes-to bring out</i>	<i>prayers-to read</i>	<i>clothes</i>	
'to take off clothes'	'to say prayers'	'clothes'	
مو در آوردن	غذا خوردن	مو	7
mu-daravardan	qaza-xordan	mu	

¹⁴ In the stimuli lists, the symbol /S/ is used to represent the /š/ sound, while in the text, the symbol /sh/ was used.

<i>hair-to bring out</i>	<i>food-to eat</i>	<i>hair</i>	
'to grow hair'	'to eat'	'hair'	
پیراهن دوختن	صورت شستن	پیراهن	7
pirahan-duxtan	surat-Sostan	pirahan	
<i>dress-to sew</i>	<i>face-to wash</i>	<i>dress</i>	
'to sew dresses'	'to wash face'	'dress'	
پنبه زدن	احوال پرسیدن	پنبه	7
panbe-zadan	ahval-porsidan	panbe	
<i>cotton-to hit</i>	<i>state-to ask</i>	<i>cotton</i>	
'to hit cotton'	'to greet'	'cotton'	
توپ انداختن	بالا رفتن	توپ	7
tup-andaxtan	bala-raftan	tup	
<i>ball-to throw</i>	<i>up-to go</i>	<i>ball</i>	
'to throw ball'	'to go up'	'ball'	
پول باختن	بیرون آمدن	پول	7
pul-baxtan	birun-amadan	pul	
<i>money-to lose</i>	<i>outside-to come</i>	<i>money</i>	
'to lose money'	'to come out'	'money'	

غذا بردن	کتک زدن	غذا	7
qaza-bordan	kotak-zadan	qaza	
<i>food-to take</i>	<i>beat-to hit</i>	<i>food</i>	
'to take food'	'to beat up'	'food'	
کاغذ بریدن	گریه کردن	کاغذ	7
kaqaz-boridan	gerye-kardan	kaqaz	
<i>paper-to cut</i>	<i>cry-to do</i>	<i>paper</i>	
'to cut paper'	'to cry'	'paper'	
روبان بستن	فرار کردن	روبان	7
ruban-bastan	farar-kardan	ruban	
<i>ribbon-to tie</i>	<i>escape-to do</i>	<i>ribbon</i>	
'to tie a ribbon'	'to escape'	'ribbon'	
امید داشتن	حمله کردن	امید	7
omid-daStan	hamle-kardan	omid	
<i>hope-to have</i>	<i>attack-to do</i>	<i>hope</i>	
'to hope'	'to attack'	'hope'	
لباس دوختن	پوست کنندن	لباس	7
lebas-duxtan	pust-kandan	lebas	
<i>clothes-to sew</i>	<i>skin-to detach</i>	<i>clothes</i>	

'to sew clothes'	'to peel'	'clothes'	
شام خوردن	حمام کردن	شام	7
Sam-xordan	hamam-kardan	Sam	
<i>dinner-to eat</i>	<i>bath-to do</i>	<i>dinner</i>	
'to eat dinner'	'to take a bath'	'dinner'	
آب خوردن	غذا پختن	آب	7
ab-xordan	qaza-poxtan	ab	
<i>water-to drink</i>	<i>food-to cook</i>	<i>water</i>	
'to drink water'	'to cook food'	'water'	
مهمانی دادن	خانه خریدن	مهمانی	7
mehmani-dadan	xane-xaridan	mehmani	
<i>party-to give</i>	<i>house-to buy</i>	<i>party</i>	
'to throw a party'	'to buy a house'	'party'	
خانه خریدن	جمع کردن	خانه	7
xane-xaridan	jame-kardan	xane	
<i>house-to buy</i>	<i>pile-to do</i>	<i>house</i>	
'to buy a house'	'to gather'	'house'	
سخنرانی دادن	کادو آوردن	سخنرانی	7

soxanrani-dadan	kaado-avardan	soxanrani	
<i>lecture-to give</i>	<i>gift-to bring</i>	<i>lecture</i>	
‘to give a lecture’	‘to bring a gift’	‘lecture’	
جواب دادن	سبزی فروختن	جواب	7
javab-dadan	sabzi-foruxtan	javab	
<i>answer-to give</i>	<i>herbs-to sell</i>	<i>answer</i>	
‘to answer’	‘to sell herbs’	‘answer’	
رنگ زدن	آواز خواندن	رنگ	7
rang-zadan	avaz-xandan	rang	
<i>paint-to hit</i>	<i>song-to sing</i>	<i>paint</i>	
‘to paint’	‘to sing’	‘paint’	
درد داشتن	مشروب خوردن	درد	7
dard-daStan	maSrub-xordan	dard	
<i>pain-to have</i>	<i>alcoholic drink-to drink</i>	<i>pain</i>	
‘to have pain’	‘to drink alcohol’	‘pain’	
پول داشتن	چای خوردن	پول	7
pul-daStan	Cai-xordan	pul	
<i>money-to have</i>	<i>tea-to drink</i>	<i>money</i>	
‘to have money’	‘to drink tea’	‘money’	

پول برداشتن	چوب زدن	پول	7
pul-bardaStan	Cub-suzandan	pul	
<i>money-to pick up</i>	<i>wood-to burn</i>	<i>money</i>	
'to withdraw money'	'to burn wood'	'money'	
لحاف دوختن	غذا چشیدن	لحاف	7
lahaf-duxtan	qaza-CeSidan	lahaf	
<i>blanket-to sew</i>	<i>food-to taste</i>	<i>blanket</i>	
'to sew blankets'	'to taste food'	'blanket'	
شلوار دوختن	آدم کشتن	شلوار	7
Salvar-duxtan	adam-koStan	Salvar	
<i>pants-to sew</i>	<i>man-to kill</i>	<i>pants</i>	
'to sew pants'	'to kill someone'	'pants'	
بشکن زدن	خانه ساختن	بشکن	7
beSgan-zadan	xane-saxtan	beSgan	
<i>finger snapping-to hit</i>	<i>house-to build</i>	<i>finger snapping</i>	
'to snap one's fingers'	'to build a house'	'finger snapping'	
چای ریختن	دوا خوردن	چای	7
Cai-rixtan	dava-xordan	Cai	

<i>tea-to pour</i>	<i>medicine-to eat</i>	<i>tea</i>	
'to pour tea'	'to take medicine'	'tea'	
پیانو زدن	نقاشی کردن	پیانو	7
piano-zadan	naqaSi-kardan	piano	
<i>piano-to hit</i>	<i>painting-to do</i>	<i>piano</i>	
'to play the piano'	'to paint'	'piano'	
هدیه دادن	حسرت کشیدن	هدیه	7
hedie-dadan	hasrat-keSidan	hedie	
<i>present-to give</i>	<i>envy-to pull</i>	<i>present</i>	
'to give a present'	'to envy'	'present'	
چاه کندن	وضو گرفتن	چاه	7
Cah-kanadan	vozu-gereftan	Cah	
<i>well-to dig</i>	<i>ablution-to get</i>	<i>well</i>	
'to dig a well'	'to perform one's ablutions'	'well'	
چاله کندن	خواب دیدن	چاله	7
Cale-kandan	xab-didan	Cale	
<i>ditch-to dig</i>	<i>dream-to see</i>	<i>ditch</i>	
'to dig a ditch'	'to have a dream'	'ditch'	

نقاشی کشیدن	بافتنی بافتن	نقاشی	7
naqaSi-keSidan	baftani-baftan	naqaSi	
<i>painting-to draw</i>	<i>knitting-to knit</i>	<i>painting</i>	
'to paint, to draw'	'to knit'	'painting'	
ساز زدن	کادو آوردن	ساز	7
saz-zadan	kaado-avardan	saz	
<i>musical instrument-to hit</i>	<i>gift-to bring</i>	<i>musical instrument</i>	
'to play musical instruments'	'to bring a gift'	'musical instrument'	
مو کشیدن	فریب دادن	مو	7
mu-keSidan	farib-dadan	mu	
<i>hair-to pull</i>	<i>deception-to give</i>	<i>hair</i>	
'to pull one's hair'	'to deceive'	'hair'	
ابرو برداشتن	راست گفتن	ابرو	7
abru-bardaStan	rast-goftan	abru	
<i>eyebrow-to pick up</i>	<i>truth-to tell</i>	<i>eyebrow</i>	
'to pluck one's eyebrow'	'to tell the truth'	'eyebrow'	
مو زدن	کاغذ بریدن	مو	7
mu-zadan	kaqaz-boridan	mu	
<i>hair-to hit</i>	<i>paper-to cut</i>	<i>hair</i>	

'to give or have a haircut'

'to cut paper'

'hair'

Relatively Opaque Prime-Target Condition

Related prime	Unrelated Prime	Target	Relatedness
بار آمدن	رخ دادن	بار	1
bar-amadan	rox-dadan	bar	
<i>load-to come</i>	<i>face-to give</i>	<i>load</i>	
'to be brought up'	'to happen'	'load'	
راه افتادن	زور آمدن	راه	1
rah-oftadan	zur-amadan	rah	
<i>way-to fall</i>	<i>strength-to come</i>	<i>way</i>	
'to set off'	'to feel not like doing sth'	'way'	
رخ دادن	بار آمدن	رخ	1
rox-dadan	bar-amadan	rox	
<i>face-to give</i>	<i>load-to come</i>	<i>face</i>	
'to happen'	'to be brought up'	'face'	
زور آمدن	دم زدن	زور	1
zur-amadan	dam-zadan	zur	
<i>strength-to come</i>	<i>breath-to hit</i>	<i>strength</i>	
'to feel not like doing sth'	'to say a word'	'strength'	

بالا آوردن	دبه درآوردن	بالا	1
bala-avardan	dabe-daravardan	bala	
<i>up-to bring</i>	<i>jar-to take out</i>	<i>up</i>	
'to throw up'	'to make excuses'	'up'	
دبه درآوردن	زور شنیدن	دبه	1
dabe-daravardan	zur-Senidan	dabe	
<i>jar-to take out</i>	<i>strength-to hear</i>	<i>jar</i>	
'to make excuses'	'to be oppressed'	'jar'	
دم درآوردن	زور آمدن	دم	1
dom-daravardan	zur-amadan	dom	
<i>tail-to take out</i>	<i>strength-to come</i>	<i>tail</i>	
'to be rude'	'to feel not like doing sth'	'tail'	
شاخ درآوردن	مو برداشتن	شاخ	1
Sax-daravardan	mu-bardaStan	Sax	
<i>horn(of animals)-to take out</i>	<i>hair-to pick up</i>	<i>horn(of animals)</i>	
'to be very surprised'	'to be cracked(of bones)'	'horn(of animals)'	
لب دوختن	شاخ درآوردن	لب	1
lab-duxtan	Sax-daravardan	lab	
<i>lip-to sew</i>	<i>horn(of animals)-to take out</i>	<i>lip</i>	

‘to be silent’	‘to be very surprised’	‘lip’	
چشم زدن	دم در آوردن	چشم	1
CeSm-zadan	dom-daravardan	CeSm	
<i>eye-to hit</i>	<i>tail-to take out</i>	<i>eye</i>	
‘to cast an evil eye on sb’	‘to be rude’	‘eye’	
جا انداختن	چشم زدن	جا	1
ja-andaxtan	CeSm-zadan	ja	
<i>place-to throw</i>	<i>eye-to hit</i>	<i>place</i>	
‘to fix a dislocation’	‘to cast an evil eye on sb’	‘place’	
دل باختن	نم کشیدن	دل	1
del-baxtan	nam-keSidan	del	
<i>heart-to lose</i>	<i>moist-to pull</i>	<i>heart</i>	
‘to fall in love’	‘to shrink’	‘heart’	
بو بردن	جا انداختن	بو	1
bu-bordan	ja-andaxtan	bu	
<i>smell-to take</i>	<i>place-to throw</i>	<i>smell</i>	
‘to discover a secret’	‘to fix a dislocation’	‘smell’	
دل بریدن	کمر بستن	دل	1

del-boridan	kamar-bastan	del	
<i>heart-to cut</i>	<i>waist-to tie</i>	<i>heart</i>	
‘to love no more’	‘to decide firmly’	‘heart’	
کمر بستن	دل بریدن	کمر	1
kamar-bastan	del-boridan	kamar	
<i>waist-to tie</i>	<i>heart-to cut</i>	<i>waist</i>	
‘to decide firmly’	‘to love no more’	‘waist’	
مگس پراندن	سق زدن	مگس	1
magas-parandan	saq-zadan	magas	
<i>fly(insect)-to fly sth</i>	<i>palate of the mouth-to hit</i>	<i>fly(insect)</i>	
‘not to flourish(business)’	‘to gnaw on sth’	‘fly(insect)’	
چشم دوختن	چشم داشتن	چشم	1
CeSm-duxtan	CeSm-daStan	CeSm	
<i>eye-to sew</i>	<i>eye-to have</i>	<i>eye</i>	
‘to stare’	‘to hope’	‘eye’	
جوش خوردن	چشم خوردن	جوش	1
juS-xordan	CeSm-xordan	juS	
<i>weld-to eat</i>	<i>eye-to eat</i>	<i>weld</i>	
‘to be welded’	‘to be affected by evil eye’	‘weld’	

چشم خوردن	پا دادن	چشم	1
CeSm-xordan	pa-dadan	CeSm	
<i>eye-to eat</i>	<i>foot-to give</i>	<i>eye</i>	
'to be affected by evil eye'	'to be feasible'	'eye'	
پا دادن	دست کشیدن	پا	1
pa-dadan	dast-keSidan	pa	
<i>foot-to give</i>	<i>hand-to pull</i>	<i>foot</i>	
'to be feasible'	'to give up on sth'	'foot'	
ناز خریدن	پا دادن	ناز	2
naz-xaridan	pa-dadan	naz	
<i>demur-to buy</i>	<i>foot-to give</i>	<i>demur</i>	
'to take beloved demur well'	'to be feasible'	'demur'	
میدان دادن	نخ دادن	میدان	1
meidan-dadan	nax-dadan	meidan	
<i>roundabout-to give</i>	<i>thread-to give</i>	<i>roundabout</i>	
'to let sb do what he wants'	'to seduce'	'roundabout'	
نخ دادن	کش رفتن	نخ	1
nax-dadan	keS-raftan	nax	

<i>thread-to give</i>	<i>rubberband-to go</i>	<i>thread</i>	
'to seduce'	'to steal'	'thread'	
نظر زدن	کوه کندن	نظر	1
nazar-zadan	kuh-kandan	nazar	
<i>view-to hit</i>	<i>mountain-to dig</i>	<i>view</i>	
'to cast an evil eye on sb'	'to work hard'	'view'	
چشم داشتن	دست برداشتن	چشم	1
CeSm-daStan	dast-bardaStan	CeSm	
<i>eye-to have</i>	<i>hand-to pick up</i>	<i>eye</i>	
'to hope'	'to give up'	'eye'	
دست داشتن	پاپوش دوختن	دست	1
dast-daStan	papuS-duxtan	dast	
<i>hand-to have</i>	<i>shoe-to sew</i>	<i>hand</i>	
'to play a role in a plot'	'to defame sb'	'hand'	
دست برداشتن	چشم داشتن	دست	1
dast-bardaStan	CeSm-daStan	dast	
<i>hand-to pick up</i>	<i>eye-to have</i>	<i>hand</i>	
'to give up'	'to hope'	'hand'	

پاپوش دوختن	جان کندن	پاپوش	1
papuS-duxtan	jan-kandan	papuS	
<i>shoe-to sew</i>	<i>soul-to dig</i>	<i>shoe</i>	
'to defame sb'	'to die hard'	'shoe'	
کیسه دوختن	زبان ریختن	کیسه	1
kise-duxtan	zaban-rixtan	kise	
<i>bag-to sew</i>	<i>tongue-to pour</i>	<i>bag</i>	
'to abuse sb financially'	'to bootlick'	'bag'	
زور زدن	چوب زدن	زور	1
zur-zadan	Cub-zadan	zur	
<i>strength-to hit</i>	<i>wood-to hit</i>	<i>strength</i>	
'to try very hard'	'to be awkwardly kind to sb'	'strength'	
زبان ریختن	زور زدن	زبان	1
zaban-rixtan	zur-zadan	zaban	
<i>tongue-to pour</i>	<i>strength-to hit</i>	<i>tongue</i>	
'to bootlick'	'to try very hard'	'tongue'	
چوب زدن	خط دادن	چوب	1
Cub-zadan	xat-dadan	Cub	
<i>wood-to hit</i>	<i>line-to give</i>	<i>wood</i>	

'to be awkwardly kind to sb'	'to lead sb'	'wood'	
خط دادن	جان کندن	خط	1
xat-dadan	jan-kandan	xat	
<i>line-to give</i>	<i>soul-to dig</i>	<i>line</i>	
'to lead sb'	'to die hard'	'line'	
جان کندن	آبرو ریختن	جان	1
jan-kandan	aberru-rixtan	jan	
<i>soul-to dig</i>	<i>honor-to pour</i>	<i>soul</i>	
'to die hard'	'to dishonor sb'	'soul'	
کوه کندن	دست کشیدن	کوه	1
kuh-kandan	dast-keSidan	kuh	
<i>mountain-to dig</i>	<i>hand-to pull</i>	<i>mountain</i>	
'to work hard'	'to give up'	'mountain'	
دست کشیدن	بالا آوردن	دست	1
dast-keSidan	bala-avardan	dast	
<i>hand-to pull</i>	<i>up-to bring</i>	<i>hand</i>	
'to give up'	'to throw up'	'hand'	
سق زدن	کوه کندن	سق	1

saq-zadan	kuh-kandan	saq	
<i>palate of the mouth-to hit</i>	<i>mountain-to dig</i>	<i>palate of the mouth</i>	
‘to gnaw on sth’	‘to work hard’	‘palate of the mouth’	
نم کشیدن	دم زدن	نم	1
nam-keSidan	dam-zadan	nam	
<i>moist-to pull</i>	<i>breath-to hit</i>	<i>moist</i>	
‘to shrink’	‘to say a word’	‘moist’	
مو برداشتن	نم کشیدن	مو	1
mu-bardaStan	nam-keSidan	mu	
<i>hair-to pick up</i>	<i>moist-to pull</i>	<i>hair</i>	
‘to crack(of bone)’	‘to shrink’	‘hair’	
دم زدن	راه افتادن	دم	1
dam-zadan	rah-oftadan	dam	
<i>breath-to hit</i>	<i>way-to fall</i>	<i>breath</i>	
‘to say a word’	‘to set off’	‘breath’	

Orthographically Overlapping Prime-Target Condition

Related prime	Unrelated Prime	Target	Relatedness
پنداشتن	گداختن	پند	1
pendaStan	godaxtan	pand ¹⁵	
'to assume'	'to burn and melt'	'advice'	
دریدن	رسیدن	در	1
daridan	residan	dar	
'to tear up(animals)'	'to reach'	'door'	
فکندن	شستن	فک	1
fekandan	Sostan	fak	
'to throw'	'to wash'	'jaw'	
خارانندن	نشانندن	خار	1
xarandan	neSandan	xar	
'to scratch'	'to seat'	'thorn'	
چراندن	پوشیدن	چرا	1
Carandan	puSidan	Cera	

¹⁵ Please note that in Persian, vowels, especially short vowels, are not written. Therefore, *pendaStan* contains *pand*. In other words, although the vowel is different, orthographically it is identical to the first part of *pendaStan*.

'to take a herd to graze'	'to wear'	'why'	
پراندن	ماندن	پر	1
parandan	mandan	par	
'to fly(an airplane)'	'to stay'	'feather'	
باریدن	افتادن	بار	1
baridan	oftadan	bar	
'to rain'	'to fall'	'load'	
گردیدن	رقصیدن	گرد	1
gardidan	raqsidan	gard	
'to turn'	'to dance'	'dust'	
دوشیدن	پرسیدن	دوش	1
duSidan	porsidan	duS	
'to milk'	'to ask'	'shower'	
پریدن	مالیدن	پر	1
paridan	malidan	pari	
'to jump'	'to rub'	'fairy'	
خریدن	ایستادن	خر	1

xaridan	istadan	xar	
'to buy'	'to stand'	'donkey'	
شمردن	سوزاندن	شمر	1
Semordan	suzandan	Semr	
'to count'	'to burn'	'Shemr (an mean person)'	
فریفتن	لاسیدن	فری	1
fariftan	lasidan	Feri	
'to deceive'	'to flirt'	'Feri(Fereidun)'	
افسردن	پیچاندن	افسر	1
afsordan	piCandan	afsar	
'to sadden'	'to twist'	'police officer'	
لغزیدن	کشیدن	لغز	1
laqzidan	keSidan	loqoz	
'to slip'	'to pull'	'riddle'	
خریدن	شتافتن	خر	1
xaridan	Setaftan	xar	
'to buy'	'to hurry'	'donkey'	

سریدن	چلاندن	سر	1
soridan	Celandan	sar	
'to slide'	'to squeeze'	'head'	
ریختن	رساندن	ری	1
rixtan	resandan	rey	
'to pour'	'to give sb a ride'	'Ray(city)'	
باختن	تابیدن	باخ	1
baxtan	tabidan	bax	
'to lose'	'to shine'	'Bach'	
مردن	شدن	مرد	1
mordan	Sodan	mard	
'to die'	'to become'	'man'	
تنیدن	دادن	تن	1
tanidan	dadan	tan	
'to weave(caterpillar)'	'to give'	'body'	
دمیدن	پرسیدن	دم	1
damidan	porsidan	dom	
'to blow'	'to ask'	'tail'	

چاییدن	گرفتن	چای	1
Caidan	gereftan	Cai	
'to catch a cold'	'to get'	'tea'	
چاپیدن	خندیدن	چاپ	1
Capidan	xandidan	Cap	
'to rob'	'to laugh'	'publishing'	
شنیدن	ریختن	شن	1
Senidan	rixtan	Sen	
'to hear'	'to pour'	'sand'	
خمیدن	گرویدن	خم	1
xamidan	geravidan	xom	
'to bend'	'to convert'	'jar'	
رسیدن	تاباندن	رس	1
residan	tabandan	ros	
'to reach'	'to cast light on'	'red clay'	
چپیدن	خیساندن	چپ	1
Cepidan	xisandan	Cap	
'to hide hurriedly'	'to soak'	'cross-eyed person'	

انباشتن	شکستن	ان	1
anbaStan	Sekastan	an	
'to pile up'	'to break'	'stool'	
مالیدن	افتادن	مال	1
malidan	oftadan	mal	
'to rub'	'to fall'	'possessions'	
شناختن	رساندن	شنا	1
Senaxtan	resandan	Sena	
'to recognize'	'to give sb a ride'	'swimming'	
نوشتن	مردن	نوش	1
neveStan	mordan	nuS	
'to write'	'to die'	'cheers(when drinking)'	
دواندن	خیساندن	دوا	1
davandan	xisandan	dava	
'to make sb/sth run'	'to soak'	'medicine'	
گداختن	کاستن	گدا	1
godaxtan	kastan	geda	

'to burn and melt'	'to decrease'	'beggar'	
بوسیدن	بلعیدن	بو	1
busidan	baliidan	bu	
'to kiss'	'to swallow'	'smell'	
شستن	چیدن	شست	1
Sostan	Cidan	Sast	
'to wash'	'to cut'	'thumb'	
بالیدن	رفتن	بال	1
balidan	raftan	bal	
'to boast'	'to go'	'wing'	
پرسیدن	گریاندن	پر	1
porsidan	geryandan	par	
'to ask'	'to make sb cry'	'feather'	
فریفتن	دوختن	فر	1
fariftan	duxtan	fer	
'to deceive'	'to sew'	'curl'	
ربودن	راندن	رب	1

robudan

'to steal'

randan

'to drive'

rob

'tomato paste'

Appendix C

Stimuli for Experiment 2

Relatively Transparent Prime-Target Condition

Related prime	Unrelated Prime	Target	Relatedness
بیرون آمدن	کتاب خواندن	آمدن	7
birun-amadan	ketab-xandan	amadan	
<i>outside-to come</i>	<i>book-to read</i>	<i>to come</i>	
'to come out'	'to read books'	'to come'	
پایین افتادن	دروغ گفتن	افتادن	7
pain-oftadan	doruq-goftan	oftadan	
<i>down-to fall</i>	<i>lie-to tell</i>	<i>to fall</i>	
'to fall down'	'to lie'	'to fall'	
کادو دادن	بالا رفتن	دادن	7
kaado-dadan	bala-raftan	dadan	
<i>gift-to give</i>	<i>up-to go</i>	<i>to give</i>	
'to give gifts'	'to go up'	'to give'	
بالا آمدن	غذا پختن	آمدن	7

bala-amadan	qaza-poxtan	amadan	
<i>up-to come</i>	<i>food-to cook</i>	<i>to come</i>	
‘to come up’	‘to cook’	‘to come’	
هدیه آوردن	شانه زدن	آوردن	7
hedie-avardan	Sane-zadan	avardan	
<i>present-to give</i>	<i>comb-to hit</i>	<i>to bring</i>	
‘to give presents’	‘to comb’	‘to bring’	
جوش درآوردن	دروغ شنیدن	درآوردن	7
juS-daravardan	doruq-Senidan	daravardan	
<i>pimple-to bring out</i>	<i>lie-to hear</i>	<i>to grow, to bring out</i>	
‘to grow pimples’	‘to hear lies’	‘to grow, to bring out’	
لباس درآوردن	نماز خواندن	درآوردن	7
lebas-daravardan	namaz-xandan	daravardan	
<i>clothes-to bring out</i>	<i>prayers-to read</i>	<i>to take off, to bring out</i>	
‘to take off clothes’	‘to say prayers’	‘to take off, to bring out’	
مو درآوردن	غذا خوردن	درآوردن	7
mu-daravardan	qaza-xordan	daravardan	
<i>hair-to bring out</i>	<i>food-to eat</i>	<i>to grow, to bring out</i>	
‘to grow hair’	‘to eat’	‘to grow, to bring out’	

پیراهن دوختن	صورت شستن	دوختن	7
pirahan-duxtan	surat-Sostan	duxtan	
<i>dress-to sew</i>	<i>face-to wash</i>	<i>to sew</i>	
‘to sew dresses’	‘to wash face’	‘to sew’	
پنبه زدن	احوال پرسیدن	زدن	7
panbe-zadan	ahval-porsidan	zadan	
<i>cotton-to hit</i>	<i>state-to ask</i>	<i>to hit</i>	
‘to hit cotton’	‘to greet’	‘to hit’	
توپ انداختن	بیرون رفتن	انداختن	7
tup-andaxtan	birun-raftan	andaxtan	
<i>ball-to throw</i>	<i>outside-to go</i>	<i>to throw</i>	
‘to throw ball’	‘to go out’	‘to throw’	
پول باختن	برف آمدن	باختن	7
pul-baxtan	barf-amadan	baxtan	
<i>money-to lose</i>	<i>snow-to come</i>	<i>to lose</i>	
‘to lose money’	‘to snow’	‘to lose’	
غذا بردن	کتک زدن	بردن	7
qaza-bordan	kotak-zadan	bordan	

<i>food-to take</i>	<i>beat-to hit</i>	<i>to take</i>	
'to take food'	'to beat up'	'to take'	
کاغذ بریدن	باران آمدن	بریدن	7
kaqaz-boridan	baran-amadan	boridan	
<i>paper-to cut</i>	<i>rain-to come</i>	<i>to cut</i>	
'to cut paper'	'to rain'	'to cut'	
روبان بستن	قصه گفتن	بستن	7
ruban-bastan	qese-goftan	bastan	
<i>ribbon-to tie</i>	<i>story-to tell</i>	<i>to tie</i>	
'to tie a ribbon'	'to tell a story'	'to tie'	
امید داشتن	خواب دیدن	داشتن	7
omid-daStan	xab-didan	daStan	
<i>hope-to have</i>	<i>dream-to see</i>	<i>to have</i>	
'to hope'	'to have a dream'	'to have'	
لباس دوختن	نگاه کردن	دوختن	7
lebas-duxtan	negah-kardan	duxtan	
<i>clothes-to sew</i>	<i>look-to do</i>	<i>to sew</i>	
'to sew clothes'	'to look'	'to sew'	

شام خوردن	روزه گرفتن	خوردن	7
Sam-xordan	ruze-gereftan	xordan	
<i>dinner-to eat</i>	<i>fast-to get</i>	<i>to eat</i>	
'to eat dinner'	'to fast'	'to eat'	
آب خوردن	لباس پوشیدن	خوردن	7
ab-xordan	lebas-puSidan	xordan	
<i>water-to drink</i>	<i>clothes-to wear</i>	<i>to drink</i>	
'to drink water'	'to wear clothes'	'to drink'	
مهمانی دادن	سبزی فروختن	دادن	7
mehmani-dadan	sabzi-foruxtan	dadan	
<i>party-to give</i>	<i>herbs-to sell</i>	<i>to give</i>	
'to throw a party'	'to sell herbs'	'to give'	
مهمانی دادن	سبزی فروختن	دادن	7
xane-xaridan	kaado-gereftan	xaridan	
<i>house-to buy</i>	<i>gift-to get</i>	<i>to buy</i>	
'to buy a house'	'to get a gift'	'to buy'	
سخنرانی دادن	راست گفتن	دادن	7
soxanrani-dadan	rast-goftan	dadan	
<i>lecture-to give</i>	<i>truth-to tell</i>	<i>to give</i>	

'to give a lecture'	'to tell the truth'	'to give'	
جواب دادن	دوش گرفتن	دادن	7
javab-dadan	duS-gereftan	dadan	
<i>answer-to give</i>	<i>showers-to get</i>	<i>to give</i>	
'to answer'	'to take a shower'	'to give'	
رنگ زدن	صبر کردن	زدن	7
rang-zadan	sabr-kardan	zadan	
<i>paint-to hit</i>	<i>waiting-to do</i>	<i>to hit</i>	
'to paint'	'to wait'	'to hit'	
درد داشتن	آب خوردن	داشتن	7
dard-daStan	ab-xordan	daStan	
<i>pain-to have</i>	<i>water-to drink</i>	<i>to have</i>	
'to have pain'	'to drink water'	'to have'	
پول داشتن	فکر کردن	داشتن	7
pul-daStan	fekr-kardan	daStan	
<i>money-to have</i>	<i>think-to do</i>	<i>to have</i>	
'to have money'	'to think'	'to have'	
پول برداشتن	بوس دادن	برداشتن	7

pul-bardaStan	bus-dadan	bardaStan	
<i>money-to pick up</i>	<i>kiss-to give</i>	<i>to pick up, to take</i>	
‘to withdraw money’	‘to give a kiss’	‘to pick up, to take’	
لحاف دوختن	زندگی کردن	دوختن	7
lahaf-duxtan	zendegi-kardan	duxtan	
<i>blanket-to sew</i>	<i>life-to do</i>	<i>to sew</i>	
‘to sew blankets’	‘to live’	‘to sew’	
شلوار دوختن	آدم کشتن	دوختن	7
Salvar-duxtan	adam-koStan	duxtan	
<i>pants-to sew</i>	<i>man-to kill</i>	<i>to sew</i>	
‘to sew pants’	‘to kill someone’	‘to sew’	
بشگن زدن	خانه ساختن	زدن	7
beSgan-zadan	xane-saxtan	zadan	
<i>finger snap-to hit</i>	<i>house-to build</i>	<i>to hit</i>	
‘to snap one’s fingers’	‘to build a house’	‘to hit’	
چای ریختن	بازی کردن	ریختن	7
Cai-rixtan	bazi-kardan	rixtan	
<i>tea-to pour</i>	<i>play-to do</i>	<i>to pour</i>	
‘to pour tea’	‘to play’	‘to pour’	

پیانو زدن	چاه کنندن	زدن	7
piano-zadan	Cah-kandan	zadan	
<i>piano-to hit</i>	<i>well-to dig</i>	<i>to hit</i>	
'to play the piano'	'to dig a well'	'to hit'	
هدیه دادن	گریه کردن	دادن	7
hedie-dadan	gerye-kardan	dadan	
<i>present-to give</i>	<i>cry-to do</i>	<i>to give</i>	
'to give a present'	'to cry'	'to give'	
چاه کنندن	کوشش کردن	کنندن	7
Cah-kandan	kuSeS-kardan	kandan	
<i>well-to dig</i>	<i>effort-to do</i>	<i>to dig</i>	
'to dig a well'	'to make an effort'	'to dig'	
چاله کنندن	دم کردن	کنندن	7
Cale-kandan	dam-kardan	kandan	
<i>ditch-to dig</i>	<i>brew-to do</i>	<i>to dig</i>	
'to dig a ditch'	'to brew'	'to dig'	
نقاشی کشیدن	لباس بافتن	کشیدن	7
naqaSi-keSidan	lebas-baftan	keSidan	

<i>painting-to draw</i>	<i>knitting-to knit</i>	<i>to draw</i>	
'to paint, to draw'	'to knit'	'to draw'	
ساز زدن	میز چیدن	زدن	7
saz-zadan	miz-Cidan	zadan	
<i>musical instrument-to hit</i>	<i>gift-to bring</i>	<i>to hit, to play</i>	
'to play musical instruments'	'to bring a gift'	'to hit, to play'	
مو کشیدن	صدا کردن	کشیدن	7
mu-keSidan	seda-kardan	keSidan	
<i>hair-to pull</i>	<i>voice-to do</i>	<i>to pull</i>	
'to pull one's hair'	'to call'	'to pull'	
ابرو برداشتن	شعر گفتن	برداشتن	6
abru-bardaStan	Sear-goftan	bardaStan	
<i>eyebrow-to pick up</i>	<i>poem-to tell</i>	<i>to pick up</i>	
'to pluck one's eyebrow'	'to compose poetry'	'to pick up'	
مو زدن	لباس دوختن	زدن	7
mu-zadan	lebas-duxtan	zadan	
<i>hair-to hit</i>	<i>clothes-to sew</i>	<i>to hit</i>	
'to give or have a haircut'	'to sew clothes'	'to hit'	

Relatively Opaque Prime-Target Condition

Related prime	Unrelated Prime	Target	Relatedness
بار آمدن	کتاب خواندن	آمدن	1
bar-amadan	ketab-xandan	amadan	
<i>load-to come</i>	<i>book-to read</i>	<i>to come</i>	
'to be brought up'	'to read a book'	'to come'	
راه افتادن	دروغ گفتن	افتادن	1
rah-oftadan	doruq-goftan	oftadan	
<i>way-to fall</i>	<i>lie-to tell</i>	<i>to fall</i>	
'to set off'	'to tell a lie'	'to fall'	
رخ دادن	بالا رفتن	دادن	1
rox-dadan	bala-raftan	dadan	
<i>face-to give</i>	<i>up-to go</i>	<i>to give</i>	
'to happen'	'to go up'	'to give'	
زور آمدن	غذا پختن	آمدن	1
zur-amadan	qaza-poxtan	amadan	
<i>strength-to come</i>	<i>food-to cook</i>	<i>to come</i>	
'to feel not like doing sth'	'to cook food'	'to come'	

بالا آوردن	شانه زدن	آوردن	1
bala-avardan	Sane-zadan	avardan	
<i>up-to bring</i>	<i>comb-to hit</i>	<i>to bring</i>	
'to throw up'	'to comb'	'to bring'	
دبه درآوردن	دروغ شنیدن	درآوردن	1
dabe-daravardan	doruq-Senidan	daravardan	
<i>jar-to take out</i>	<i>lie-to hear</i>	<i>to take out</i>	
'to make excuses'	'to be lied to'	'to take out'	
دم درآوردن	نماز خواندن	درآوردن	1
dom-daravardan	namaz-xandan	daravardan	
<i>tail-to take out</i>	<i>prayers-to read</i>	<i>to take out</i>	
'to be rude'	'to say prayers'	'to take out'	
شاخ درآوردن	غذا خوردن	درآوردن	1
Sax-daravardan	qaza-xordan	daravardan	
<i>horn(of animals)-to take out</i>	<i>food-to eat</i>	<i>to take out</i>	
'to be very surprised'	'to eat'	'to take out'	
لب دوختن	صورت شستن	دوختن	1
lab-duxtan	surat-Sostan	duxtan	

<i>lip-to sew</i>	<i>face-to wash</i>	<i>to sew</i>	
'to be silent'	'to wash one's face'	'to sew'	
چشم زدن	احوال پرسیدن	زدن	1
CeSm-zadan	ahval-porsidan	zadan	
<i>eye-to hit</i>	<i>state-to ask</i>	<i>to hit</i>	
'to cast an evil eye on sb'	'to greet'	'to hit'	
جا انداختن	بیرون رفتن	انداختن	1
ja-andaxtan	birun-raftan	andaxtan	
<i>place-to throw</i>	<i>outside-to go</i>	<i>to throw</i>	
'to fix a dislocation'	'to go outside'	'to throw'	
دل باختن	برف آمدن	باختن	1
del-baxtan	barf-amadan	baxtan	
<i>heart-to lose</i>	<i>snow-to come</i>	<i>to lose</i>	
'to fall in love'	'to snow'	'to lose'	
بو بردن	کتک زدن	بردن	1
bu-bordan	kotak-zadan	bordan	
<i>smell-to take</i>	<i>beat-to hit</i>	<i>to take</i>	
'to discover a secret'	'to beat up'	'to take'	

دل بریدن	باران آمدن	بریدن	1
del-boridan	baran-amadan	boridan	
<i>heart-to cut</i>	<i>rain-to come</i>	<i>to cut</i>	
'to love no more'	'to rain'	'to cut'	
کمر بستن	قصه گفتن	بستن	1
kamar-bastan	qese-goftan	bastan	
<i>waist-to tie</i>	<i>story-to tell</i>	<i>to tie</i>	
'to decide firmly'	'to tell a story'	'to tie'	
چشم داشتن	خواب دیدن	داشتن	1
CeSm-daStan	xab-didan	daStan	
<i>fly(insect)-to fly sth</i>	<i>dream-to see</i>	<i>to have</i>	
'not to flourish(business)'	'to have a dream'	'to have'	
چشم دوختن	نگاه کردن	دوختن	1
CeSm-duxtan	negah-kardan	duxtan	
<i>eye-to sew</i>	<i>look-to do</i>	<i>to sew</i>	
'to stare'	'to look'	'to sew'	
جوش خوردن	روزه گرفتن	خوردن	1
juS-xordan	ruze-gereftan	xordan	
<i>weld-to eat</i>	<i>fast-to get</i>	<i>to eat</i>	

'to be welded'	'to fast'	'to eat'	
چشم خوردن	لباس پوشیدن	خوردن	1
CeSm-xordan	lebas-puSidan	xordan	
<i>eye-to eat</i>	<i>clothes-to wear</i>	<i>to eat</i>	
'to be affected by evil eye'	'to wear clothes'	'to eat'	
پا دادن	سبزی فروختن	دادن	1
pa-dadan	sabzi-foruxtan	dadan	
<i>foot-to give</i>	<i>herbs-to sell</i>	<i>to give</i>	
'to be feasible'	'to sell herbs'	'to give'	
ناز خریدن	کادو گرفتن	خریدن	1
naz-xaridan	kaado-gereftan	xaridan	
<i>demur-to buy</i>	<i>gift-to get</i>	<i>to buy</i>	
'to take beloved demur well'	'to get a gift'	'to buy'	
میدان دادن	راست گفتن	دادن	1
meidan-dadan	rast-goftan	dadan	
<i>roundabout-to give</i>	<i>truth-to tell</i>	<i>to give</i>	
'to let sb do what he wants'	'to tell the truth'	'to give'	
نخ دادن	دوش گرفتن	دادن	1

nax-dadan	duS-gereftan	dadan	
<i>thread-to give</i>	<i>shower-to get</i>	<i>to give</i>	
‘to seduce’	‘to take a shower’	‘to give’	
نظر زدن	صبر کردن	زدن	1
nazar-zadan	sabr-kardan	zadan	
<i>view-to hit</i>	<i>waiting-to do</i>	<i>to hit</i>	
‘to cast an evil eye on sb’	‘to wait’	‘to hit’	
چشم داشتن	آب خوردن	داشتن	1
CeSm-daStan	ab-xordan	daStan	
<i>eye-to have</i>	<i>water-to drink</i>	<i>to have</i>	
‘to hope’	‘to drink water’	‘to have’	
دست داشتن	فکر کردن	داشتن	1
dast-daStan	fekr-kardan	daStan	
<i>hand-to have</i>	<i>thought-to do</i>	<i>to have</i>	
‘to play a role in a plot’	‘to think’	‘to have’	
دست برداشتن	بوس دادن	برداشتن	1
dast-bardaStan	bus-dadan	bardaStan	
<i>hand-to pick up</i>	<i>kiss-to give</i>	<i>to pick up</i>	
‘to give up’	‘to give a kiss’	‘to pick up’	

پاپوش دوختن	زندگی کردن	دوختن	1
papuS-duxtan	zendegi-kardan	duxtan	
<i>shoe-to sew</i>	<i>life-to do</i>	<i>to sew</i>	
'to defame sb'	'to live'	'to sew'	
کیسه دوختن	آدم کشتن	دوختن	1
kise-duxtan	adam-koStan	duxtan	
<i>bag-to sew</i>	<i>man-to kill</i>	<i>to sew</i>	
'to abuse sb financially'	'to kill sb'	'to sew'	
زور زدن	خانه ساختن	زدن	1
zur-zadan	xane-saxtan	zadan	
<i>strength-to hit</i>	<i>house-to build</i>	<i>to hit</i>	
'to try very hard'	'to build a house'	'to hit'	
زبان ریختن	بازی کردن	ریختن	1
zaban-rixtan	bazi-kardan	rixtan	
<i>tongue-to pour</i>	<i>play-to do</i>	<i>to pour</i>	
'to bootlick'	'to play'	'to pour'	
چوب زدن	چاه کنندن	زدن	1
Cub-zadan	Cah-kandan	zadan	

<i>wood-to hit</i>	<i>well-to dig</i>	<i>to hit</i>	
'to be awkwardly kind to sb'	'to dig a well'	'to hit'	
خط دادن	گریه کردن	دادن	1
xat-dadan	gerye-kardan	dadan	
<i>line-to give</i>	<i>cry-to do</i>	<i>to give</i>	
'to lead sb'	'to cry'	'to give'	
جان کندن	کوشش کردن	کندن	1
jan-kandan	kuSeS-kardan	kandan	
<i>soul-to dig</i>	<i>effort-to do</i>	<i>to dig</i>	
'to die hard'	'to make an effort'	'to dig'	
کوه کندن	دم کردن	کندن	1
kuh-kandan	dam-kardan	kandan	
<i>mountain-to dig</i>	<i>brew-to do</i>	<i>to dig</i>	
'to work hard'	'to brew'	'to dig'	
دست کشیدن	لباس بافتن	کشیدن	1
dast-keSidan	lebas-baftan	keSidan	
<i>hand-to pull</i>	<i>clothes-to knit</i>	<i>to pull</i>	
'to give up'	'to knit clothes'	'to pull'	

سق زدن	میز چیدن	زدن	1
saq-zadan	miz-Cidan	zadan	
<i>palate of the mouth-to hit</i>	<i>table-to set</i>	<i>to hit</i>	
'to gnaw on sth'	'to set the table'	'to hit'	
نم کشیدن	صدا کردن	کشیدن	1
nam-keSidan	seda-kardan	keSidan	
<i>moist-to pull</i>	<i>voice-to do</i>	<i>to pull</i>	
'to shrink'	'to call'	'to pull'	
مو برداشتن	شعر گفتن	برداشتن	1
mu-bardaStan	Sear-goftan	bardaStan	
<i>hair-to pick up</i>	<i>poem-to say</i>	<i>to pick up</i>	
'to crack(of bone)'	'to compose poetry'	'to pick up'	
دم زدن	لباس دوختن	زدن	1
dam-zadan	lebas-duxtan	zadan	
<i>breath-to hit</i>	<i>clothes-to sew</i>	<i>to hit</i>	
'to say a word'	'to sew clothes'	'to hit'	

Orthographically Overlapping Prime-Target Condition

Related prime	Unrelated Prime	Target	Relatedness
افروختن	چلانندن	فروختن	1
afruxtan	Celandan	foruxtan	
'to light up'	'to squeeze'	'to sell'	
افکنندن	بوییدن	کندن	1
afkandan	boidan	kandan	
'to cast, to throw'	'to smell'	'to detach'	
باریدن	شنیدن	ریدن	1
baridan	Senidan	ridan	
'to rain'	'to hear'	'to defecate'	
شمردن	ساختن	مردن	1
Semordan	saxtan	mordan	
'to count'	'to build'	'to die'	
گردیدن	باختن	دیدن	1
gardidan	baxtan	didan	
'to turn'	'to lose'	'to see'	

گرفتن	رساندن	رفتن	1
gereftan	resandan	raftan	
'to get'	'to give sb a ride'	'to go'	
نشستن	کردن	شستن	1
neSastan	kardan	Sostan	
'to sit'	'to do'	'to wash'	
افشردن	لیسیدن	فشردن	1
afSordan	lisidan	feSordan	
'to press'	'lick'	'to squeeze'	
اندوختن	گریستن	دوختن	1
anduxtan	geristan	duxtan	
'to gather'	'to cry'	'to sew'	
انگاشتن	رسیدن	نگاشتن	1
engaStan	residan	negaStan	
'to think'	'to reach'	'to write'	
پریدن	لهیدن	ریدن	1
paridan	lehidan	ridan	

‘to jump’	‘to press’	‘to defecate’	
پذیرفتن	رقصیدن	رفتن	1
paziroftan	raqsandān	raftan	
‘to accept’	‘to make sb/sth dance’	‘to go’	
پنداشتن	کوبیدن	داشتن	1
pendaStan	kubidan	daStan	
‘to assume’	‘to pound’	‘to have’	
دریدن	خواندن	ریدن	1
daridan	xandan	ridan	
‘to tear up(animals)’	‘to sing, to read’	‘to defecate’	
ربودن	کشتن	بودن	1
robudan	koStan	budan	
‘to steal’	‘to kill’	‘to be’	
فکندن	جوشیدن	کندن	1
fekandan	juSidan	kandan	
‘to cast’	‘to boil’	‘to detach’	
گریختن	وزیدن	ریختن	1

gorixtan	vazidan	rixtan	
'to escape'	'to blow(wind)'	'to pour'	
نگریستن	غلئیدن	گریستن	1
negaristan	qaltidan	geristan	
'to look'	'to roll'	'to cry'	
آکندن	رستن	کندن	1
akandan	rostan	kandan	
'to fill'	'to grow'	'to detach'	
چراندن	ترسیدن	راندن	1
Cerandan	tarsidan	randan	
'to take a herd to graze'	'to fear'	'to drive'	
بریدن	بلعیدن	ریدن	1
boridan	balidan	ridan	
'to cut'	'to boast'	'to defecate'	
پرسیدن	خارانندن	رسیدن	1
porsidan	xarandan	residan	
'to ask'	'to scratch'	'to reach'	

پراکندن	پلاسیدن	کندن	1
parakandan	palasidan	kandan	
'to scatter'	'to dither'	'to dig'	
پرتابیدن	چکاندن	تابیدن	1
partabidan	Cekandan	tabidan	
'to throw'	'to drop'	'to shine(sun)'	
پژمردن	پسندیدن	مردن	1
pajmordan	pasandidan	mordan	
'to dither(flowers)'	'to like'	'to die'	
پلاسیدن	پوشاندن	لاسیدن	1
palasidan	puSandan	lasidan	
'to dither'	'to make sb wear sth'	'to flirt'	
پیچیدن	رقصاندن	چیدن	1
piCidan	raqsandana	Cidan	
'to turn'	'to make sb/sth dance'	'to cut'	
خریدن	چاپیدن	ریدن	1
xaridan	Capidan	ridan	

‘to buy’	‘to rob’	‘to defecate’	
خندیدن	خواباندن	دیدن	1
xandidan	xabandan	didan	
‘to laugh’	‘to make sb sleep’	‘to see’	
دریدن	پختن	ریدن	1
daridan	poxtan	ridan	
‘to tear up(animals)’	‘to cook’	‘to defecate’	
خریدن	دانستن	ریدن	1
xaridan	danestan	ridan	
‘to buy’	‘to know’	‘to defecate’	
ربودن	آمدن	بودن	1
robudan	amadan	budan	
‘to steal’	‘to come’	‘to be’	
زردن	آوردن	ریدن	1
zeridan	avardan	ridan	
‘to talk nonsense’	‘to bring’	‘to defecate’	
سردن	آمیختن	ریدن	1

soridan	amixtan	ridan	
'to slide'	'to mix'	'to defecate'	
چریدن	آموختن	ریدن	1
Caridan	amuxtan	ridan	
'to graze'	'to learn'	'to defecate'	
افسردن	اندوختن	فسردن	1
afsordan	anduxtan	fesordan	
'to sadden'	'to gather'	'to disappoint'	
خوراندن	انگیختن	راندن	1
xorandan	angixtan	randan	
'to feed'	'to provoke'	'to drive'	
خاراندن	آویختن	راندن	1
xarandan	avixtan	randan	
'to scratch'	'to hang'	'to drive'	
پراندن	چسبیدن	راندن	1
parandan	Casbidan	randan	
'to fly sth'	'to stick'	'to drive'	

ترسیدن

tarsidan

'to fear'

آزمودن

azmudan

'to test'

رسیدن

residan

'to reach'

1

Appendix D

Sample Results of minF' Test

EXPERIMENT 2

Experiment 2b

Response Time.

A significant effect of condition by participants, by items, and by their combination was observed.

$$F_1(2, 78) = 40.425, \text{MSE} = 205.637, p < .001$$

$$F_2(2, 78) = 5.020, \text{MSE} = 2374.235, p = .01$$

$$\text{minF}'(2,97) = 4.46574, p = .01396 \text{ significant}$$

In the Condition x Relatedness interaction, no significant effect by participants, by items, and by their combination was observed.

$$F_1(2, 78) = 2.995, \text{MSE} = 164.225, p > .05$$

$$F_2(2, 78) = .937, \text{MSE} = 985.750, p > .05$$

$$\text{minF}'(2,122) = .7137, p = .4918 \text{ not significant}$$

In the planned comparisons, a significant effect of condition by participants, by items, and by their combination was observed for the opaque condition.

$$F_1(1, 78) = 9.850, \text{MSE} = 396.3002, p < .005$$

$$F_2(1, 78) = 10.519, \text{MSE} = 1255.498, p < .005$$

$$\text{minF}'(1,156) = 5.0868, p = .0255 \text{ significant}$$

In the planned comparisons, a significant effect of condition by participants, by items, and by their combination was observed for the orthographically overlapping condition.

$$F_1(1, 78) = 7.696, \text{MSE} = 643.414, p < .01$$

$$F_2(1, 78) = 6.159, \text{MSE} = 3388.822, p < .05$$

$$\text{minF}'(1,154) = 3.42112, p = .06628 \text{ significant}$$

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