

THE PSYCHOLINGUISTICS OF DERIVATIONAL DIRECTIONALITY: THE TRANSITIVE-UNACCUSATIVE ALTERNATION

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1 Introduction

General concepts denoting an eventuality can be linguistically expressed by various types of predicates. The eventuality concept of ‘closing’, for example, can be realized as a transitive verb, as an unaccusative verb, as a verbal passive, as an adjectival passive and as a middle:

Concept of ‘closing’:

- (1) Transitive: Mary closed the door.
- (2) Unaccusative: The door *closed*.
- (3) Verbal passive: The door was *closed* by Mary.
- (4) Adjectival passive: The boy looked at the *closed* door.
- (5) Middle: Expensive doors *close* elegantly.

In the literature, there is a wide consensus that the various grammatical shapes an eventuality-denoting concept can take, referred to as diatheses or voices, are derivationally related. It is therefore a widely held assumption that there is a systematic, rule-governed, connection between different diatheses of the same eventuality concept (Harley 1995; Levin & Rappaport 1995; Pesetsky 1995; Marantz 1997; Chierchia 2004; Reinhart & Siloni 2005; Ramchand 2006; Horvath & Siloni 2008; Pykkänen 2008; Koontz-Garboden 2009, among others).

Nevertheless, when a specific alternation between two diatheses is addressed, an important aspect of this systematic connection is at constant debate: is one alternate derived from the other or is it the case that both originate from a mutual source? If the former is correct, which is the basic alternate and which the derivationally complex one? Different models anchored within

diverse theoretical frameworks provide various conceptual, theoretical and distributional arguments to favor one derivational directionality route over the other.

The objective of this paper is to show that theory-independent psycholinguistic research can shed light on this debate. As the various views on derivational relationships were not formed to be purely theoretical entities but to constitute a model representation of psychologically real processes, I hold that derivational relationships should be reflected in speakers' perception. Accordingly, this research aims to provide insight into what alternate, if any, speakers perceive as derivationally more basic.

I present a cross-modal lexical priming study designed to examine how adult Hebrew speakers perceive derivational relationships. My empirical array for this purpose is the well-examined transitive-unaccusative alternation used here as a case study. Since the verbal morphology of Hebrew renders it ideal for this type of investigation (as will be detailed below), the targeted population was adult native Hebrew speakers. The results of this empirical examination suggest that transitive verbs are perceived as derivationally basic, while their unaccusative equivalents are perceived as derived.

This paper is structured as follows: Section 2 presents the transitive-unaccusative alternation and brings a brief overview of the theoretical models suggested to capture the relationship between these two diatheses. In section 3 I propose a general hypothesis regarding the contextual effect a basic alternate should have on the retrieval of the derivationally complex one and discuss its specific predictions with regard to the transitive-unaccusative alternation. Section 4 presents three experiments designed to test these predictions. Finally, in section 5 I discuss the conclusions and theoretical implications of the experimental results and suggest possible directions for future research.

2 Unaccusative Verbs and their Transitive Counterparts

2.1 Unaccusativity

Ever since the formulation of the unaccusative hypothesis by Perlmutter (1978), unaccusativity has been a topic of much research. The notion that the class of intransitive verbs includes two distinct sub-types, *unaccusative* verbs (*break, vanish, roll*, sometimes referred to as *inchoative* verbs) and *unergatives* verbs (*walk, run, sing*) was the target of many analyses within different frameworks and views of grammar.

A very general definition of unaccusative verbs is that they are intransitive verbs with a Theme argument that lack the ability to assign accusative case. Within the principles and parameters framework (Chomsky 1981), it is argued that their Theme argument initially merges as the verb's complement and arrives at the external argument's position by syntactic movement. Thus, while the subcategorization frame of unergative verbs is assumed to be [NP _] the one assumed for unaccusatives is [_ NP/CP] (Perlmutter 1978; Chomsky 1981; Burzio 1986; Chierchia 1989; Reinhart 1991; Borer 1994; Levin & Rappaport 1995; Pesetsky 1995; Reinhart 2002, 2010; Alexiadou et al 2004; Reinhart & Siloni 2005; among many others).

This analysis is supported by the fact that the subject of unaccusative verbs is crosslinguistically recognized as an internal argument by various internality-detecting diagnostics, while that of unergatives is diagnosed as externally mapped (see Belletti & Rizzi 1981; Pesetsky

1982; Borer and Grodzinsky 1986; Burzio 1986; Reinhart & Siloni 2005 among others, for diagnostics and judgments from English, Hebrew, Italian and Russian).

Further reinforcement for the unaccusative/unergative split comes from psycholinguistic and neurolinguistic studies: Friedmann, Taranto, Shapiro and Swinney (2008) found that the subject of unaccusative verbs, but not that of unergatives, is reactivated after the verb, which provides direct evidence in favor of the hypothesis that the former, but not the latter is internally mapped. Furthermore, according to neuroimaging research by Shetreet, Friedmann and Hadar (2010) different activation patterns reveal that the brain distinguishes between unaccusative and unergative verbs; an eye-tracking study by Lee and Thompson (2011) revealed that the processing of unaccusatives is distinct from that of unergatives among individuals with agrammatism as well as healthy subjects.

There are, of course, other views. One example is Van Valin (1990) who believes that unaccusativity should be given a semantic analysis and need not be encoded in the syntax (labeled by Levin and Rappaport 1995 a ‘semantic approach’). Another example is Sorace (1995, 2000), who argues for a completely different concept of unaccusativity. According to her view there isn't a distinct, unaccusative, subset of intransitive verbs, but an unaccusativity hierarchy scale, based on aspectual and thematic properties, with unaccusatives and unergatives on its edges and ambiguous intransitives in the middle.

The current research adopts the former view of unaccusativity, i.e. it assumes that unaccusatives are a distinct subtype of intransitives and that their unique characteristics are reflected in the syntactic mapping of their arguments.

2.2 The Transitive-Unaccusative Alternation

A prominent crosslinguistic fact about unaccusative verbs is that they tend to have a transitive alternate¹, a phenomenon I will refer to as the transitive-unaccusative alternation:

English:

- | | | |
|-----|-------------------------------------|----------------|
| (6) | a. The window broke. | (Unaccusative) |
| | b. The girl/stone broke the window. | (Transitive) |
| (7) | a. The ball rolled. | (Unaccusative) |
| | b. The girl/wind rolled the ball. | (Transitive) |

Hebrew:

- | | | |
|-----|--|----------------|
| (8) | a. ha-kadur hitgalgel
the-ball rolled
‘The ball rolled.’ | (Unaccusative) |
| | b. roza/ ha-ru'ax gilgela 'et ha-kadur
Roza/ the-wind rolled-TRANS ACC the-ball
‘Roza/the wind rolled the ball.’ | (Transitive) |
| (9) | a. ha-'agartal nafal
The-vase fell
‘The vase fell.’ | (Unaccusative) |

¹ As the transitive-unaccusative alternation, like other derivational alternations, exhibits sporadic derivational gaps, there are cases where an unaccusative verb does not have a transitive alternate in the vocabulary of a specific language. Some examples from English are *vanish*, *appear*, *wilt* and *flower*. For an extensive discussion, empirical investigation and analysis of these gaps see Horvath and Siloni 2005, Fadlon 2011.

- b. ha-tinok/kadur hipil 'et ha-'agartal (Transitive)
 The-baby/ball fall-TRANS ACC the-vase
 'The baby/ ball caused the vase fall.'

The transitive-unaccusative alternation inspired researchers to assume a derivational relationship between the two alternates (Levin & Rappaport 1995; Harley 1995; Pesetsky 1995; Marantz 1997, 2007; Reinhart 2002, 2010; Doron 2003; Reinhart & Sioni 2003, 2005; Chierchia 2004; Arad 2005; Alexiadou et al 2006; Ramchand 2006; Horvath & Sioni 2008, 2011; Pylkkänen 2008; Koontz-Garboden 2009 among many others).

The views regarding the nature of this relationship vary. Some theories consider both alternates to originate from a third, abstract, linguistic entity, while others consider one of the alternates to be derived from the other. I will refer to the former type of theories as *root-based theories* and to the latter as *transitive-to-unaccusative theories* and *unaccusative-to-transitive theories*, according to the direction of the derivation they suggest. In the following section, I present an overview of these three types of analyses.

2.3 Views of Directionality²

2.3.1 Root-Based Theories- No Directionality

According to *root-based* theories, the derivational relationship between unaccusatives and their transitive alternates is not the result of one of them being created from the other, but rather that they both originate from the same abstract root. Accordingly, these models provide a distinct structural representation for each alternate (as will be seen in Figure 1 below). In addition, root-based analyses share the assumption that the primitives mapped to the syntax are category neutral 'atomic roots' and functional heads/features, which merge together in the syntactic component, the only operative (computational) component of the grammar. These analyses thus adopt the assumptions about grammar made within the framework of Distributed Morphology (Halle & Marantz 1993; Marantz 1997) and other syntactocentric approaches, such as Borer (2003).

This type of analysis can be found in Arad's (2005) study of the morpho-syntax of Hebrew. Similarly to other root-based theories, Arad views the mental lexicon as populated by roots and functional features. Roots become words only after they have merged with a category determining head in the syntax. In the case of verbalized roots, their unaccusative or transitive properties are determined by the type of verbalizing head that attaches to them. Importantly, the relationship between the transitive and the unaccusative alternates associated with the same concept is viewed as the direct result of the fact that both originate from the same root. Schematized in figure 1 below, is the structure Arad (2005) proposes for alternating transitive-unaccusative pairs. Notice that the transitive alternate is a combination of the root with a transitive verbalizing head (V causative) and the unaccusative is a combination of the root with an unaccusative verbalizing head (V inchoative), thus neither of them is contained within the other:

² For another overview of various analyses for the transitive-unaccusative alternation, see Schäfer (2009).

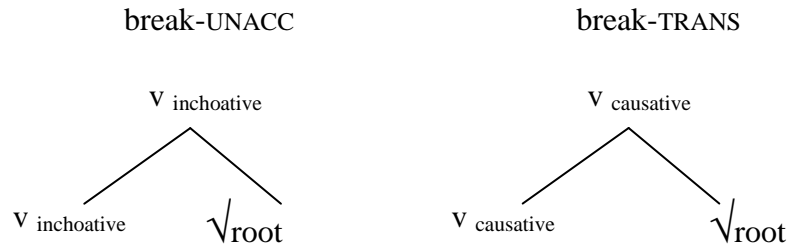


Figure 1

Root-based analyses are also suggested by Doron (2003), Harley (1995) and Marantz (1997, 2007). According to Doron (2003) verbal alternations originate from the same root, but differ with respect to the functional heads that attach to it. Harley (1995) and Marantz (1997, 2007) suggest that transitive *v*Ps are projected by a causative little-*v*, while unaccusative *v*Ps are projected by a distinct, unaccusative little-*v* which selects no external argument.

Another approach I choose to label root-based is offered by Alexiadou, Anagnostopoulou and Schäfer (2006), who classify their view as anti-derivational. Building on Kratzer (2004), they take [Voice [CAUS [Root]] to be the core structure of all change of state verbs (among which are unaccusatives and their transitive alternates), where CAUS introduces a causal relation between a causing event and the resultant state, while Voice is responsible for the introduction of the external argument. Roots are classified with regard to their encyclopedic semantics: agentive (*murder*), internally caused (*blossom*), externally caused (*destroy*), and unspecified cause (*break*). All types of roots combine with CAUS, and their external or internal causation property determines what types of Voice head (agentive, non agentive, no voice head) they can be combined with. Languages differ with respect to the possible CAUS-Voice combinations they allow, which results in crosslinguistic variation in verbal inventory. For example, an unaccusative verb created from an externally caused root ‘destroy’ and a non-agentive Voice head exists in Greek and Hebrew (*katasterfo* and *neheras*, respectively) but is absent from English and German, since non-agentive Voice can be used to create unaccusative verbs in the former languages but not in the latter.

Importantly, according to Alexiadou et al, the difference between unaccusatives and their transitive alternates is due to the specific Voice head attached to the root, which depends on both the root's encyclopedic meaning and the specific language. Thus, this analysis does not assume one alternate is derived from the other, nor does it suggest a fixed structure where one of the alternates is more basic; hence, it falls under the definition of root-based approaches presented above.

2.3.2 Unaccusative-to-Transitive Theories

I define *unaccusative-to-transitive theories* as analyses which view the unaccusative alternate as more basic than its transitive counterpart and provide the former with a structural representation embedded in that of the latter. Unaccusative-to-transitive approaches are suggested by Pesetsky (1995) and Ramchand (2006), who argue that the transitive alternate is the product of adding a cause element to an intransitive. According to Pesetsky (1995), unaccusatives are the basic forms and the derivation of their transitive alternates is created by an addition of a CAUS affix. In

Ramchand's (2006) system, the lexical entries of all verbs include some subset of the following categorial features that project inside the verb phrase: *v* (which is associated with the causation event and licenses external arguments), *V* (which specifies the nature of the process or change denoted by the verb and licenses the argument undergoing change) and *R* (which gives the 'telos' or 'the result state' of the event and licenses the argument that comes to hold the result state). The process responsible of the transitive-unaccusative alternation is 'causativization', which involves the addition of a *v* feature by a causal head in the syntax to lexical entries that do not already possess a *v* feature such as the unaccusative *break* [*V*, *R*], for example. The resulting structure is schematized in figure 2, a [*v*, *V*, *R*] structure which embeds the original intransitive [*V*, *R*] VP.

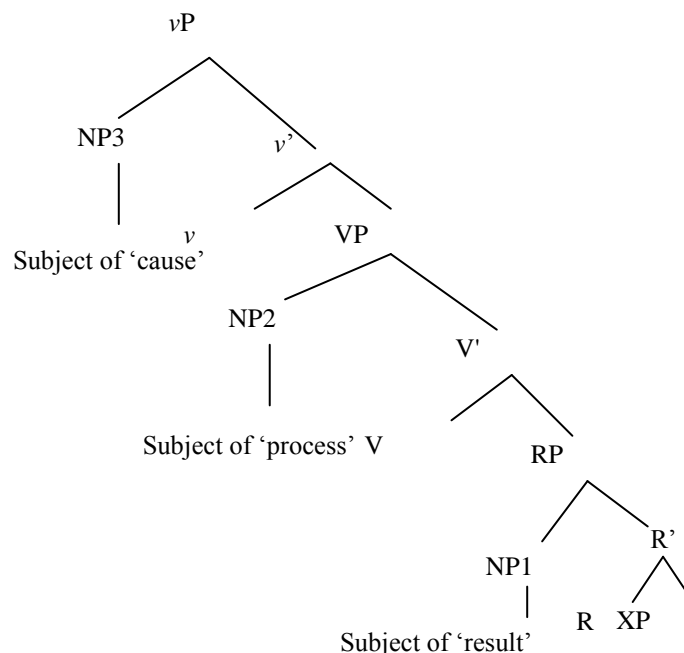


Figure 2

Another analysis I classify as unaccusative-to-transitive is Pylkkänen (2008). Pylkkänen suggests a uniform analysis for all types of transitive-intransitive alternations, including unergatives and transitives that alternate with a verb with an additional causative element. Pylkkänen herself argues that according to her analysis neither the transitive nor the intransitive variant is the basic form.

However, unlike root-based theories, Pylkkänen's analysis does not include a distinct verbalizing head that attaches to a root to create the unaccusative verb. The only structural difference between transitives and their unaccusative equivalents is the presence or absence of a Cause head in the derivation. Moreover, when an explicit structural representation of the transitive with a corresponding unaccusative is provided, it clearly presents an unaccusative VP that is embedded under a transitive 'causativized' *vP*³, as shown in figure 3:

³ The only detail in figure 3 not taken from Pylkkänen (2008) is the attachment site of the Theme argument.

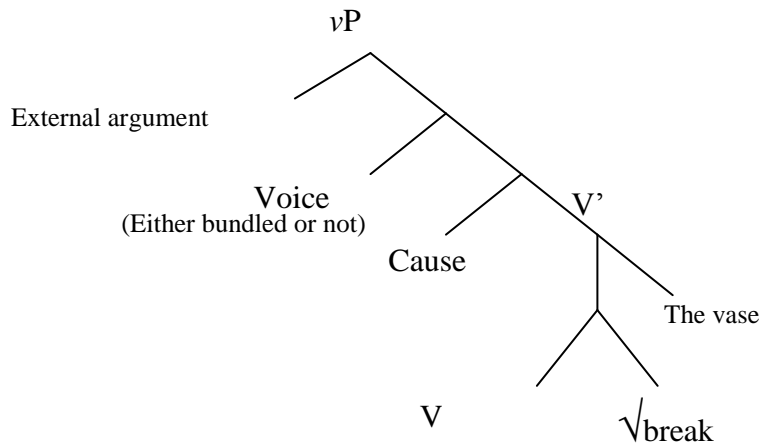


Figure 3

Finally, Rappaport-Hovav and Levin (2011) argue that alternating English verbs do not impose selectional restrictions on the subject of their transitive ('causative') variant while, for the Theme argument, it is possible to isolate a constant element of change (for example, 'open': removing an obstruction to allow access to a formerly inaccessible space). They propose that the latter is the only information these verbs lexicalized and that the properties of the transitive variant's subject are determined fully by the context. Accordingly, they provide this alternation with an unaccusative-to-transitive analysis which suggests that the transitive variant of these verbs is created by an addition of a Cause argument to the syntactic structure projected by their unaccusative variant.

2.3.3 Transitive-to-Unaccusative Theories

The third class of theories view the unaccusative alternate as derived from its transitive counterpart by manipulation on the input's external argument.

Chierchia (1989, 2004) views the relation between unaccusatives and their transitive alternates as the result of an operation on the transitive alternate's theta-grid, specifically, an operation of reflexivization that identifies the external and internal roles of the transitive alternate, forming a single, internally mapped argument that is later externalized via NP movement. Following Chierchia's view, Koontz-Garboden (2009) (henceforth K-G) suggests that at least in some languages, unaccusative verbs are created from their transitive alternates via 'anticausativization by reflexivization', a semantic operation which unifies the Theme participant and the cause participant of the transitive verb.⁴ The following is the semantic representation of

However, since Pykkänen repeatedly refers to it as a 'core argument' I believe it is rather safe to speculate that it is viewed as a part of the basic meaning of the root, thus not required to be introduced into the structure by an applicative functional head of some sort. In any case, the classification of this view as unaccusative-to transitive does not hinge on this detail.

⁴ Koontz-Garboden's analysis is somewhat morpho-phonologically driven. Thus he hesitates to argue that in languages where this alternation is not coded by overt morphology on the unaccusative verb (English, for example) unaccusatives are also derived by anticausativization.

the transitive Spanish *romper* ‘break’, and the semantic representation of its unaccusative alternate *romperse*, in which the cause participant *EFFECTOR* and the Theme participant *THEME* apply to the same individual:

- (10) a. Basic alternate: transitive *romper*
 $[[romper]] = \lambda x \lambda y \lambda s \lambda e [\exists v [\text{CAUSE}(v, e) \wedge \text{EFFECTOR}(v, y) \wedge \text{BECOME}(e, s) \wedge \text{THEME}(s, x) \wedge \text{not-whole}(s)]]]$
- b. Derivationally complex alternate: unaccusative *romperse*
 $[[romperse]] = \lambda x \lambda s \lambda e [\exists v [\text{CAUSE}(v, e) \wedge \text{EFFECTOR}(v, x) \wedge \text{BECOME}(e, s) \wedge \text{THEME}(s, x) \wedge \text{not-whole}(s)]]]$

Another transitive-to-unaccusative analysis is suggested by Levin and Rappaport (1995). This analysis considers the set of unaccusatives labeled ‘externally caused’ to be derived by lexical binding, an operation on the verb’s lexical semantic representation (LSR), which includes a causing sub-event and a central sub-event. As schematized in (11) below, lexical binding applies to the transitive lexical entry’s external cause in the mapping from LSR to argument structure, thus preventing the external argument’s placement in argument structure.

- (12) a. break. TRANS
 LSR: $[[x \text{ DO SOMETHING}] \text{ CAUSE } [y \text{ BECOME BROKEN}]]$
 Linking rules \downarrow
 Argument structure x $\langle y \rangle$
- b. break. INTRANS
 LSR: $[[x \text{ DO SOMETHING}] \text{ CAUSE } [y \text{ BECOME BROKEN}]]$
 \downarrow
 Lexical binding \emptyset
 Linking rules \downarrow
 Argument structure $\langle y \rangle$

Similarly to Chierchia (1989, 2004) the analysis of unaccusative verbs proposed by Reinhart (2002, 2010), Reinhart and Siloni (2003, 2005) and Horvath and Siloni (2008, 2011) argues that a manipulation of the transitive theta grid is the source of the relationship between unaccusatives and their transitive counterparts.

Following Pesetsky (1995), this view distinguishes between one-place unaccusatives and two-place unaccusatives. It suggests that while the latter are underived entries, one-place unaccusative verbs are derived from transitive verbs with a Cause external theta role: a theta role undefined with regard to mental state, which can therefore be assigned to either an animate or an inanimate argument.⁵

⁵ This contrasts with the Agent external theta role. For example, *open* assigns a Cause theta role to its external argument while *eat* assigns an Agent theta role to its external argument. Consequently, (I)a, which has an animate argument in the external position is grammatical while (II)b, which has an inanimate argument in this position is not. Importantly for this analysis, as shown in (II)c, verbs like *eat* (also *sing*, *paint* etc.) do not have an unaccusative alternate:

According to this view, then, transitive verbs with a Cause external role serve as input for the lexical operation of **d**ecausatization. This operation, as shown in (12), eliminates the transitive entry's external theta role (as well as its accusative case feature) altogether:

(12) Transitive: Vacc (θ Cause θ Theme) \rightarrow Unaccusative: V θ Theme

3 The Psycholinguistics of Derivational Directionality

As shown above, analyses that view unaccusatives and their transitive alternates as derivationally related, characterize the directionality of this relationship in one of the following three ways:

- (a) Both alternates are derived from a common source (*root-based* approaches)
- (b) The transitive alternate is formed via an operation which takes the unaccusative as input (*unaccusative-to-transitive* approaches)
- (c) The unaccusative alternate is formed via an operation that takes the transitive as input (*transitive-to-unaccusative* approaches)

The study I present below was designed with the aim of gaining insight into what alternate speakers perceive as the basic diathesis; thus it aims to investigate which of the above approaches to the directionality of the derivation provides a psychologically real model.

3.1 ICE: Hypothesis and Rationale

The empirical examination of (a)-(c) above was guided by the following hypothesis:

- (13) Input Contextual Effect (ICE):
Given a derivational relationship, the basic alternate serves as a better facilitator for the lexical retrieval of the derived alternate than vice versa.

According to the ICE hypothesis then, if the unaccusative *break* is the input for the derivational operation which creates the transitive *break*, a task requiring speakers to retrieve the transitive *break* (the derived alternate) after they were exposed to the unaccusative *break* (the basic alternate) should be easier than a task that calls for the retrieval of the unaccusative after speakers encountered the transitive, i.e. the basic diathesis will be a better context for the retrieval of the derived diathesis than the derived diathesis would be for the retrieval of the basic one.

The rationale behind this hypothesis is that if indeed one diathesis is created through a linguistic procedure performed on the other, an order of presentation reflecting the configuration of this procedure will have a contextual effect observably greater than the contextual effect of mere semantic, phonological or derivational relatedness.

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- (I) a. Max opened the door.
b. The wind opened the door.
- (II) a. Max ate the soup.
b.*The spoon ate the soup.
c.*The soup ate.

Derivational relationships between diatheses are a part of speakers' arsenal of linguistic mechanisms. As such, they are predicted to play a central role in the formation of new lexical items, the acquisition of these forms and most relevantly for our present purposes - their lexical storage and retrieval. A pair of diatheses presented to speakers in a manner which reflects the architecture of this relationship is therefore predicted to facilitate their performance in a linguistic task. In case this relationship is directional, providing speakers with the basic alternate as the context for the retrieval of the derived one will echo the relationship better than providing them with the derived alternate as the context for the retrieval of the basic one. In case this relationship is not directional, all other factors being equal, the two orders should yield the same performance pattern since none of them would constitute a better portrayal of this relationship.

3.2 Empirical Support

The implications of derivational relationships on lexical retrieval have long been the subject of many psycholinguistic studies aiming to tap the process of morphological decomposition upon lexical access (see McQueen and Cutler 1998 for a review). However, as these studies' object of interest is not derivational directionality, they tend to target alternations for which directionality is not controversial and usually do not include a comparative evaluation of the facilitating effects brought about by basic and derived alternates. Nonetheless, this body of work turns out to provide empirical support for the ICE hypothesis.

Stockall and Marantz (2006) conducted a psycholinguistic and neurolinguistic study which examined how the derivational relationship between English past tense irregular verbs (e.g., *gave, taught, swore, grew*, henceforth irregular Vs) and their corresponding 'stems' (e.g., *give, teach, swear, grow*) affects their lexical retrieval. The psycholinguistic element of this study consisted of two visual-priming experiments in which participants were asked to complete a lexical decision task regarding a visually presented target word or non-word which followed a visually presented prime.

Importantly for our present purposes, in the first experiment the prime words were irregular Vs and the target words were their corresponding stems (i.e., prime: *gave*, target: *give*) and in the second experiment the directionality of these items was reversed: the prime words were stems and the target words were irregular Vs (i.e., prime: *give*, target: *gave*). In other words, in Stockall and Marantz's first experiment the verbs were presented in a derived-basic order while in the second experiment the order was inverted to basic-derived. This was done since the author's prediction was not borne out by the results of the first experiment. They expected irregular V targets to always facilitate faster RTs to their corresponding stems compared to control conditions. However, this only occurred with high orthographic overlap prime-target pairs (i.e. *gave-give, grew-grow*), while low orthographic overlap prime-target pairs (i.e. *taught-teach, swore-swear*) did not facilitate faster reaction times.

Interestingly, the reversal of directionality in the second experiment revealed a different performance pattern: not only did the previously challenging low orthographic overlap pairs have suddenly significantly facilitated RTs compared to the control conditions, but also the facilitating effect for high overlap pairs was higher than the one observed in the previous experiment.

According to Stockall and Marantz, it could be that the reason irregular V (i.e. *taught, gave*) primes are not good facilitators for the retrieval of their corresponding stems (i.e. *teach, give*) is that an activation of this type of prime involves, in addition to an activation of the corresponding

stem, the activation of the rule which creates the irregular V. This might mean that when the stem is later reactivated by the target, the system is inclined to also access this rule again, which results in longer RTs as a consequence of having to override this inclination.

In summary, Stockall and Marantz's study provides theory-independent evidence for the ICE hypothesis. It targeted an alternation (stem-irregular V) for which directionality is not at debate and revealed that, as stated by the ICE hypothesis and explained above, basic alternates are better facilitators for the lexical retrieval of derived ones than vice versa.⁶

4 The Current Experiments

Assuming the ICE hypothesis then, given two derivationally related diatheses, a consistently superior efficiency of one diathesis to facilitate the lexical retrieval of the other can be seen as an indication that it is the basic one.

In the case of the transitive-unaccusative alternation, the three different views of directionality reviewed in section 2 make different predictions with regard to this hypothesis: If unaccusative-to-transitive theories provide the correct representation, we would expect the lexical retrieval of a transitive alternate after being provided with the unaccusative entry to be easier for speakers than the lexical retrieval of an unaccusative after being exposed to its transitive equivalent. If transitive-to-unaccusative approaches are on the right track, we would expect the opposite pattern to emerge. Finally, if root-based theories provide the correct model for the relationship between unaccusatives and their corresponding transitives, we would expect the two orders of presentation to pose an equal degree of difficulty.

To test these predictions, three cross-modal lexical priming experiments were conducted. In this type of design speakers are presented with an auditory prime word and afterwards with a target word or non-word, which appears on a computer screen. They are then required to complete a lexical decision task: press a certain key if the target string is a word and another if it is a non-word. Accuracy and RT are recorded and analyzed. This particular type of priming technique is labeled “cross-modal” to indicate that the prime and the target are presented to the participant via two distinct modalities. Cross-modality has been shown to be efficient in detecting underlying structural relationships, rather than perceptual effects of orthographic factors (see Frost et al 2000b for a review of various priming techniques). As such, this methodology is extremely suitable for the purposes of the current study. In experiment 1, presented immediately below, a cross-modal lexical priming design was used to compare speakers' RT to transitive-unaccusative prime-target combinations (henceforth: TU) with their RT to unaccusative-transitive prime-target combinations (henceforth UT). The basic structure of the experimental design was inspired by the work of Frost et al (1997, 2000a, 2000b).⁷

Note that the subject matter of this empirical examination is the structural relationships between abstract syntactic or lexical representations as opposed to structural relationships between morpho-phonological forms. Hence, in this context it is important to distinguish between semantic-thematic derivational relationships and morpho-phonological ones.

Morpho-phonologically speaking, Hebrew verbs are composed of consonantal roots and verbal patterns. Derivationally related diatheses share a root but very often differ with regard to

⁶ In section 5.1 I bring further independently motivated support for the ICE hypothesis.

⁷ I am extremely thankful to Michal Ben-Shachar (P.C.) who noticed that this design can be used to examine derivational directionality.

the verbal patterns they are associated with. For example, the tri-consonantal root s.g.r combined with the niC.Car verbal pattern creates the unaccusative *nisgar* ‘close.unacc’, while the corresponding transitive consists of the same root combined with the CaCaC pattern creating *sagar* ‘close.trans.’ Consequently, in Hebrew, as opposed to English for example, the transitive-unaccusative alternation is often coded by overt morphology. Thus, in most cases there is an overt distinction between unaccusatives and their corresponding transitives even without a linguistic context.

Nevertheless, neither Hebrew unaccusatives nor their transitive equivalents are associated with one specific verbal pattern. As a result, in some alternations the unaccusative form contains a prefix while the transitive form does not (e.g., *saraf* – *ni-sraf* ‘burn.trans’ – ‘burn.unacc’), which renders the transitive phonologically lighter (henceforth: a ‘simplex’), while in others (e.g., *hi-kpi* – *kafa* ‘freeze.trans’ – ‘freeze.unacc’) the transitive form contains an additional prefix hence is phonologically heavier than the unaccusative form (henceforth: a ‘complex’). Therefore, as will be detailed below, it is necessary and actually possible to defuse the factor of morpho-phonology and exclude it from biasing speaker performance.

4.1 Experiment 1

4.1.1 Participants

The group of participants consisted of 36 adult native Hebrew speakers, 27 female and 9 male. Their ages ranged between 19 and 30 and their mean age was 24.52. All the participants had at least 13 years of education. None had any linguistic education concerning the subject matter of this study.

4.1.2 Method

Stimuli

The experiment included three conditions: an experimental condition, a phonological control condition and a non-word fillers condition. All verbs appeared in past tense, third person singular masculine, which is the citation form of Hebrew verbs.

The experimental condition

This condition consisted of 34 morphologically distinct pairs of unaccusative verbs and their transitive equivalents presented in either TU or UT prime-target combinations: 12 of these were simplex-complex transitive-unaccusative pairs, 12 were complex-simplex transitive-unaccusative pairs, and 10 consisted of either simplex-simplex or complex-complex transitive-unaccusative pairs (e.g., *kiba* ‘turn-off.trans’ *kava* ‘turn-off.unacc’; *hi-dlik* ‘light.trans’ *ni-dlak* ‘light.unacc’, respectively). Unaccusatives were identified based on two Hebrew unaccusativity diagnostics: modification by a possessive dative and simple inversion (Borer & Grodzinsky 1986; Shlonsky 1997; Reinhart & Siloni 2005; Meltzer & Siloni 2013), as demonstrated in (14) and (15):

(14) Diagnostic: Possessive datives can only modify internal arguments

- a. ha-mexonit nisrefa le-dan
 the-car got-burnt to-Dan
 ‘Dan's car got burnt.’
- b. ha-ayfon nišbar le-lucie
 the-iPhone broke to-Lucie
 ‘Lucie's iPhone broke.’
- c. *ha-xatul hithapex le-dina
 the-cat rolled-over to-Dina
 (Does not mean: Dina's cat rolled-over)

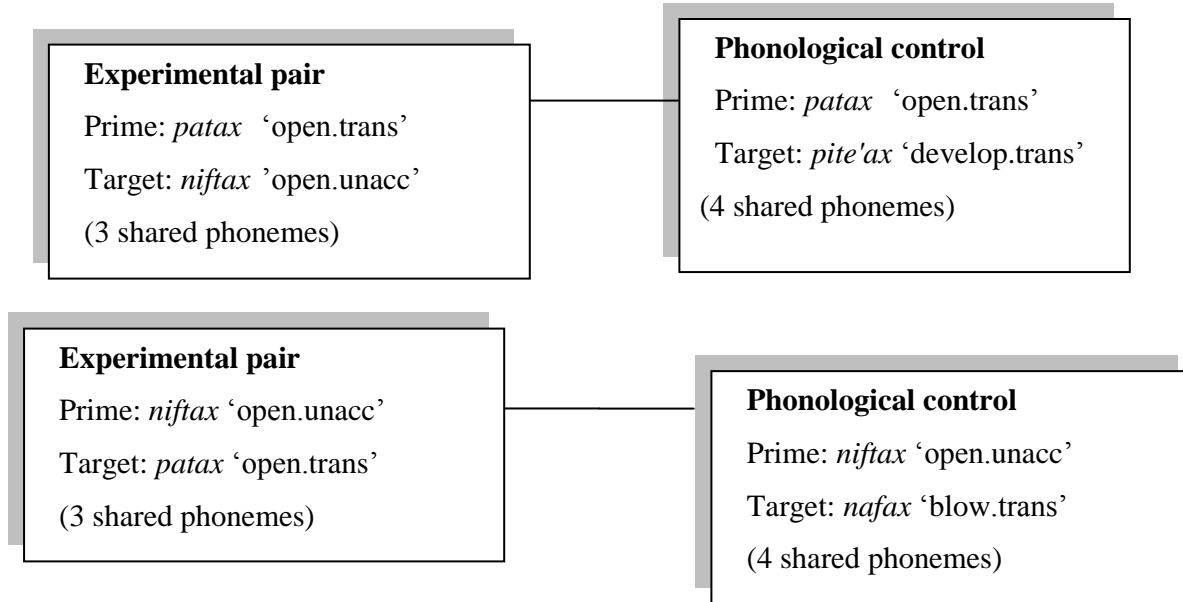
(15) Diagnostic: A verb can precede the subject in a predicate initial sentence (‘simple inversion’) only when the subject is an internal argument.

- a. nirtevu arba'a ayfonim
 got-wet four iPhones
 ‘Four iPhones got wet.’
- b. hitmotetu šney binyanim
 collapsed two buildings
 ‘Two buildings collapsed.’
- c. *šaru arba'a tenorim
 Sang four tenors

Unaccusative verbs and their transitive counterparts did not differ in frequency of occurrence, which was determined based on Frost and Plaut's (2005) word frequency database for printed Hebrew (Wilcoxon signed rank test $W(24) = -74$, $p = 0.3$). For the full list of stimulus items see appendix A.

The phonological control condition:

In order to enable a comparison between speakers' performance on pairs of verbs which exhibit a purely phonological relation to their performance on pairs of verbs which exhibit a valence-changing derivational relationship, the experiment included 68 phonological control pairs. Each of these items corresponded to one of the experimental prime-target pairs and included the same prime verb as the matching experimental item. The targets were chosen to duplicate only the phonological relation between the experimental prime and target. Accordingly, control targets shared with the prime a similar number of phonemes as the experimental target did, but denoted an unrelated eventuality. Figure 4 demonstrates how phonological control items were chosen to match the TU and UT versions of the experimental stimulus pair denoting the eventuality of ‘opening’:

Figure 4⁸

The non-word fillers condition

The non-word fillers condition consisted of 68 randomly chosen Hebrew verbs paired with 68 non-words composed in the form of Hebrew verbs.

Design

Each participant encountered 136 stimulus items, each consisting of a prime verb and a target verb: 17 experimental pairs in TU prime-target order; 17 experimental pairs in UT prime-target order; 17 unaccusative-phonological control prime-target pairs; 17 transitive-phonological control prime-target pairs; and 68 verb-non-word filler pairs.

In order to enable an analysis comparing speakers' performance per each type of prime-target combination, while guaranteeing that no participant encounters the same alternation twice, this experiment utilized a 2X2 Latin square design: participants were randomly divided into two groups of 18 members. The 17 TU experimental pairs presented to the first group were presented to the second group in UT order, and vice-versa. Phonological control stimulus items were presented to the group that did not encounter their corresponding experimental UT or TU stimulus items and ordered so that a control pair corresponding to a TU stimulus item was at least 10 items apart from the same pair presented in UT order, and vice versa.

Procedure

The experiment was constructed and run using E-prime 2.0 (PST Inc.) and an HP mini 10.1 inch screen netbook. Auditory primes were recorded by a female voice using an iTalk recorder application (Griffin technology for iPhone and iPad) and were trimmed as well as cleaned from background noises using Pro-tools editing software.

⁸ Notice that even though *patax* 'open.trans' and *piteax* 'develop.trans' share the consonantal root p.t.x, they each denote a different eventuality, whereas *patax* 'open-trans' and *niftax* 'open-unacc' both denote the eventuality of 'opening'.

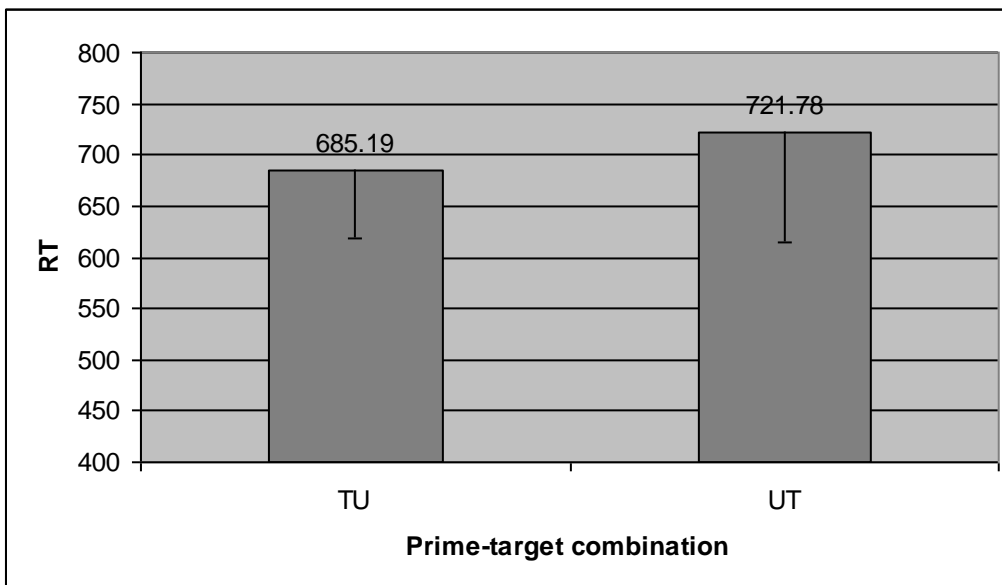
Participants were seated in a quiet room in front of the computer. They were instructed to listen to the prime and then press 1 if the item appearing on the screen is a word and 0 if it is a non-word. The instructions given to each participant orally also appeared on the computer screen. Once the participant hit the Enter key to confirm that he or she had understood the instructions and was ready to begin, a practice session consisting of 11 prime-target pairs has commenced. The 136 quasi-randomly ordered experimental, control and filler prime-target pairs appeared right afterwards.

Participants first heard the prime word while three asterisks appeared at the center of the screen. 750 ms later these symbols were replaced by the target string. Once the lexical decision was provided, the asterisks appeared again and the next auditory stimulus item has commenced.

4.1.3 Results

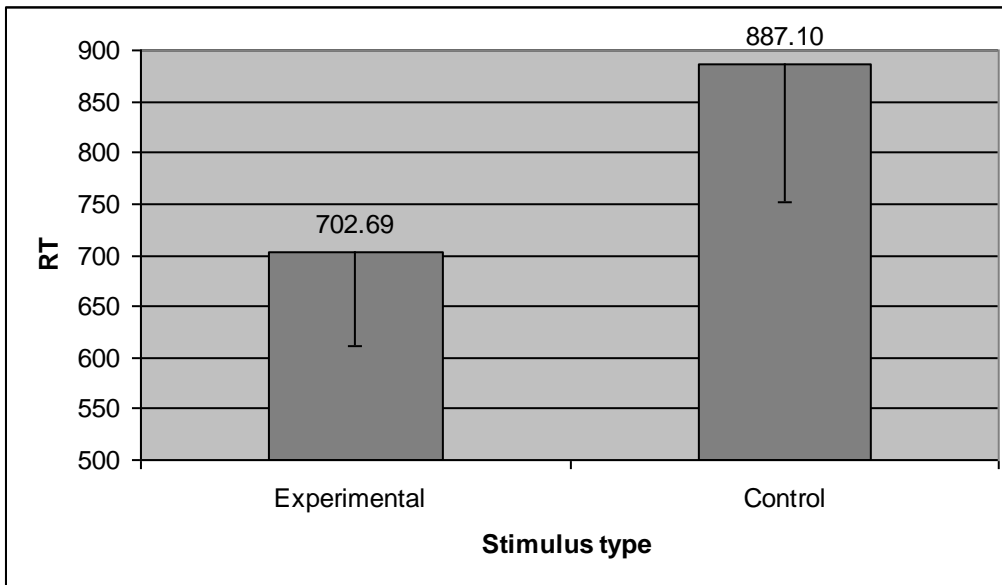
A t-test for correlated samples comparing average RTs in the case of transitive-unaccusative prime-target combinations with average RTs in the case of unaccusative-transitive prime-target combinations calculated across participants revealed a faster performance when the prime was a transitive and the target was an unaccusative (TU mean = 685.19 ms, SD = 66.44 ms Vs. UT mean = 721.78 ms, SD = 106.89 ms; $t(33) = 2.44$, $p = 0.02$). A comparison of averages calculated across items revealed the same pattern of performance (t-test for correlated samples $t(35) = 2.64$, $p = 0.012$).

Chart 1: Average RT per prime-target combination (error bars represent standard deviation calculated across participants)



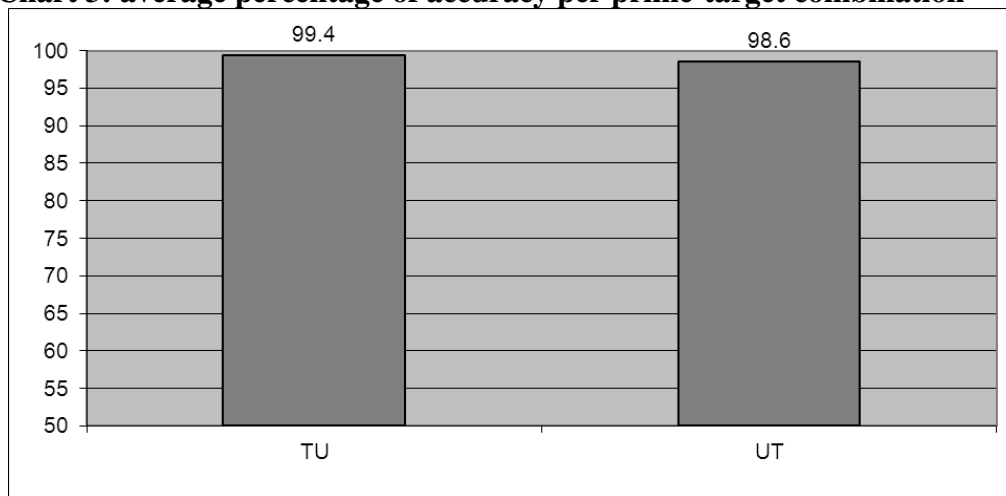
In addition, RTs for the experimental stimulus items were significantly faster than RTs for their matched phonological control pairs (experimental mean = 702.69 ms, SD = 91.9 ms Vs. control mean = 887.10 ms, SD = 135.2 ms, t-test for correlated samples: $t(67) = 9.9$, $p < 0.001$).

Chart 2: average RT by stimulus type (error bars represent standard deviation calculated across participants)

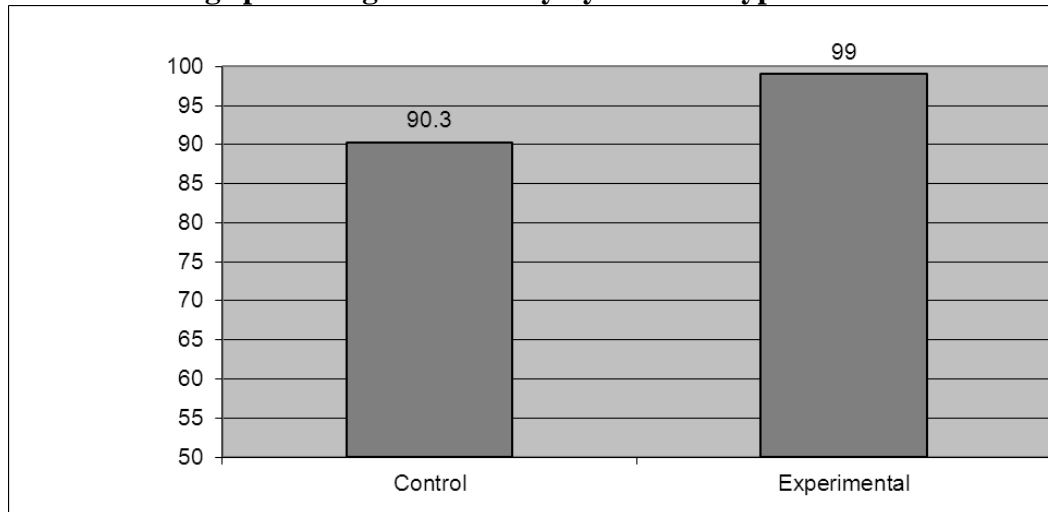


Finally, error rate for TU prime-target pairs was not significantly lower than error rate for UT prime-target pairs (TU mean= 0.6%, SD=1.6% vs. UT mean= 1.4%, SD = 2.7%; t-test for correlated samples $t(35) = 1.8, p = 0.17$).

Chart 3: average percentage of accuracy per prime-target combination



Error rate for the phonological control pairs was significantly higher than the error rates for both levels of the experimental condition (control mean = 9.9%, SD = 6.6%; t-test for correlated samples TU vs. control: $t(35) = 8.02, p < 0.001$, UT vs. control: $t(35) = 7.85, p < 0.001$).

Chart 4: average percentage of accuracy by stimulus type

4.1.4 Discussion

Assuming the ICE hypothesis, the RT pattern revealed by experiment 1 is consistent with transitive-to-unaccusative theories. Transitive primes have been shown to be better at facilitating the lexical retrieval of their corresponding unaccusatives than unaccusative primes are at facilitating the lexical retrieval of their corresponding transitives. Since in this study a faster performance pattern associated with a particular prime-target combination is taken as evidence that this combination represents the basic-derived order, this finding suggests that the derivationally basic alternate is the transitive while the derivationally complex one is the unaccusative. However, before we can draw this conclusion, an important aspect of the transitive-unaccusative alternation must be excluded as an underlying factor that might have influenced speakers' performance.

A central characteristic of the relationship between unaccusatives and their transitive counterparts is that the truth of a transitive proposition entails the truth of its corresponding unaccusative proposition (Parsons 1990; Reinhart & Siloni 2005, among others). For example, (16)a, which asserts that the wind rolled the ball, entails (16)b, which asserts that the ball rolled:

- (16) a. ha-ru'ax gilgela 'et ha-kadur (Transitive)
 the-wind rolled ACC the-ball
 'The wind rolled the ball.'
- b. ha-kadur hitgalgel (Uaccusative)
 the-ball rolled
 'The ball rolled.'

Given the above, there is a possibility that the results of experiment 1 are due to this entailment relation; specifically, that speakers found it easier to retrieve unaccusative targets after transitive primes were accessed because the retrieval of the transitive prime (e.g. *gilgel*- 'roll.trans') activated the truth conditional semantics associated with the proposition containing this verb (e.g., X rolled Y, which entails that Y rolled) and that this has consequently resulted in

facilitating the retrieval of the corresponding unaccusative (e.g., *hitgalgel*-‘roll.unacc’). In contrast, in the reverse prime-target combinations the unaccusative prime had no such facilitation effect for the retrieval of the corresponding transitive since the truth of the unaccusative proposition does not entail the truth of the corresponding transitive one.

In order to examine the potential relevance of this relationship for this particular task, a follow-up experiment examined pairs of verbs that exhibit the entailment relationship described above but are not derivationally related.⁹ If semantic entailment is indeed relevant for speakers' performance in a lexical decision task, they are predicted to perform better when the entailing verb is the prime and the entailed verb is the target. Hence, Experiment 2 compared speakers' performance with entailing-entailed prime-target pairs to their performance with entailed-entailing prime-target pairs.

4.2 Experiment 2

4.2.1 Participants

The group of participants consisted of 30 adult native Hebrew speakers, 22 female and 8 male. Their ages ranged between 20 and 43 and their mean age was 27.16. Participants' level of education and familiarity with linguistic theory was identical to that of the group of participants in experiment 1.

4.2.2 Method

Stimuli

Participants were presented with three types of stimulus items: an experimental condition, a control condition and a non-word fillers condition.

The experimental condition

The experimental condition consisted of 34 pairs of transitive verbs and their corresponding semantically entailed but not derivationally related intransitives presented to participants in both entailing-entailed (\rightarrow) and entailed-entailing (\leftarrow) orders. The pairs were chosen based on a pretest performed on 10 savvy speakers who were given a list of 49 pairs exhibiting these defining properties. Only pairs that were also judged as exhibiting this type of semantic entailment by 9 or more of the speakers were included in this experiment. Morphophonologically speaking, each member of a pair was associated with a distinct consonantal root. In addition, in each pair, at least one verb had a corresponding derivationally related transitive or intransitive alternate associated with the same consonantal root. This means that none of the pairs can be seen as an etymologically unrelated semantic equivalent which replaces the transitive/intransitive equivalent of a verb or ‘blocks’ it from occurring in the mental lexicon (for

⁹ I thank Tal Siloni (P.C) for noting that semantic entailment should be excluded as an underlying factor and suggesting that this empirical examination be conducted.

a discussion of the various aspects of this phenomenon, see Aronoff 1976, Parsons 1990 and Embick & Marantz 2008).

Two examples, whose English translation also exhibits the defining properties mentioned above, are *cinen* ‘chilled.trans’-*hitkarer* ‘cooled.intrans’ and *hidgish* ‘emphasized’ *balat* -‘got-prominent’.

Finally, in this case as well, morpho-phonological complexity and frequency of occurrence were balanced between entailing and entailed verbs ($W(24) = 87, p = 0.215$). For the full list of stimulus items see appendix B.

The control condition

The control condition consisted of 34 randomly chosen semantically and derivationally non-related transitive and intransitive verbs.

The non-word fillers condition

The non-word fillers condition consisted of the same non-word stimulus items used in experiment 1.

Design

Each participant encountered 136 stimulus items, each consisting of a prime verb and a target verb. The stimuli for each group included 17 experimental pairs in entailing-entailed prime-target order; 17 experimental pairs in entailed-entailing prime-target order; 34 control prime-target pairs; and 68 verb-non-word filler pairs.

As in experiment 1, a 2X2 Latin square design was utilized: participants were randomly divided into 2 groups of 15 and the 17 experimental pairs presented to the first group in entailing-entailed order were presented to the second group in entailed-entailing order, and vice-versa. Since there was no specific correspondence between control and experimental items, both groups of participants were presented with the same control items.

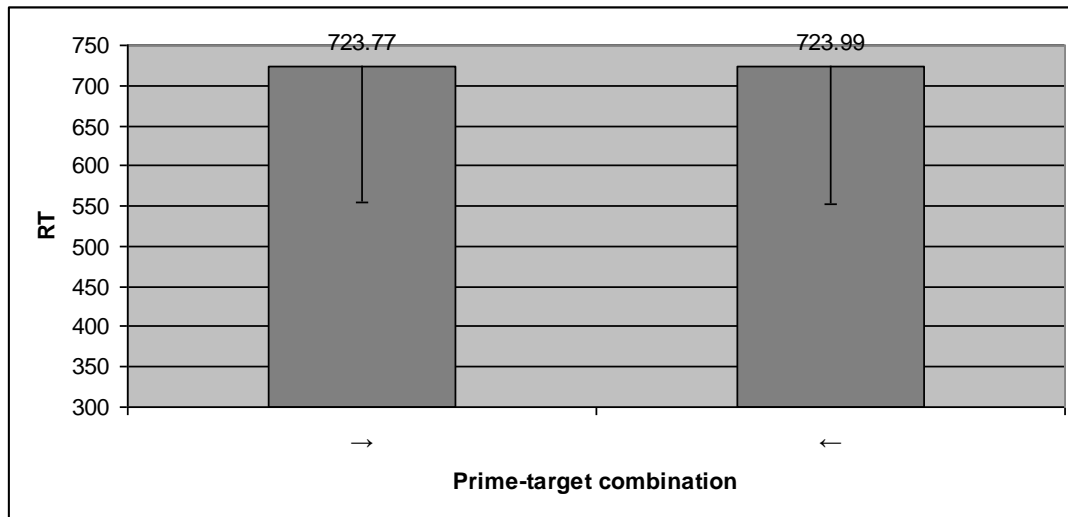
Procedure

The Procedure was identical to that of experiment 1.

4.2.3 Results

A t-test for correlated samples comparing average RTs for entailing-entailed prime-target combinations with average RTs for entailed-entailing prime-target combinations calculated across participants did not find participants' performance to be significantly different (entailing-entailed mean = 723.77 ms, SD = 169.67 ms Vs. entailed-entailing mean = 723.99 ms, SD = 170.66 ms, $t(33) = 0.008, p = 0.99$). A comparison of averages calculated across items revealed the same pattern of performance (t-test for correlated samples $t(29) = 0.013, p = 0.98$).

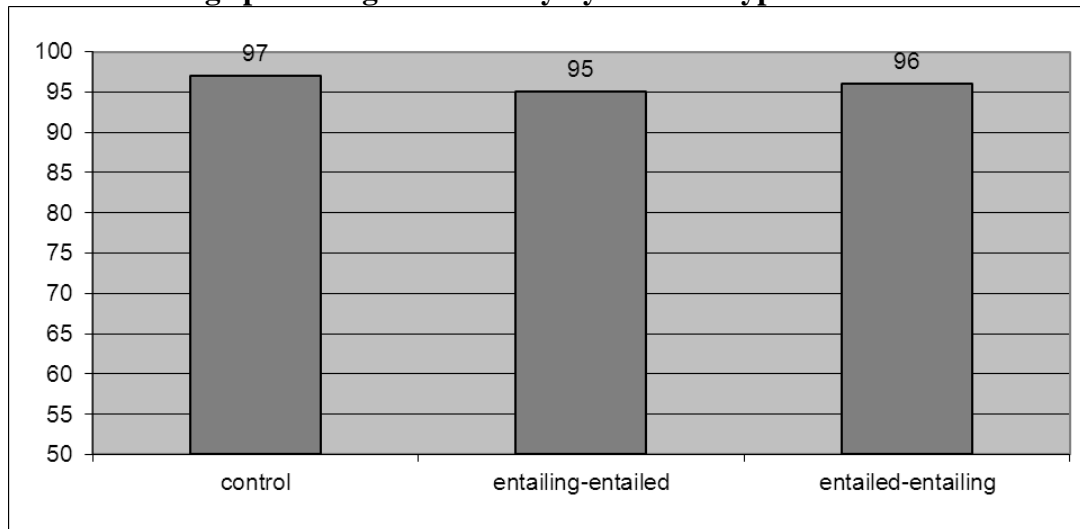
Chart 5: average RT by prime-target combination (error bars represent standard deviation calculated across participants)



In addition, no significant difference was found between average RTs for experimental items and average RTs for control items (experimental mean = 723.88 ms, SD = 163.42 ms vs. control mean = 707.06 ms, SD = 128.43 ms, t-test for correlated samples $t(29) = 1.32$, $p = 0.2$).

Finally, error rate for entailing-entailed pairs was not significantly different than error rate for entailed-entailing pairs (entailing-entailed mean = 5%, SD = 6% entailed-entailing mean = 4%, SD = 5%, t-test for correlated samples $t(29) = 0.81$, $p = 0.42$). A comparison between error rate for control items and error rate for both levels of the experimental condition revealed the difference between them to be non-significant as well (control mean = 3%, SD = 3%; t-test for correlated samples entailing-entailed vs. control: $t(29) = 1.52$, $p = 0.14$, entailed-entailing vs. control: $t(29) = 0.68$, $p = 0.5$).

Chart 6: average percentage of accuracy by stimulus type



4.2.4 Discussion

The comparison between entailed-entailing and entailing-entailed prime-target pairs conducted in experiment 2 revealed no significant difference between speakers' performance for the two types of stimuli. As this experiment was designed to isolate the variable of semantic entailment, the almost identical RT patterns for both levels of this variable suggest that semantic entailment is irrelevant for cross-modal lexical priming and can therefore be excluded as an underlying factor that might have influenced speakers' performance in experiment 1.

4.3 Experiment 3

As detailed in 4.1 above, the experimental items in experiment 1 were chosen in a manner that controlled their morpho-phonology and frequency of occurrence. However in order to unequivocally rule out the target verbs' morpho-phonology, frequency of occurrence or argument structure (number of arguments) as intervening underlying factors, an additional experiment was designed and conducted.¹⁰

As detailed immediately below, in experiment 3 participants were presented with the same target words included in experiment 1 without being exposed to a prime beforehand.

4.3.1 Participants

The group of participants consisted of 30 adult native Hebrew speakers, 16 female and 14 male. Their ages ranged between 23 and 40 and their mean age was 29.53. Participants' level of education and familiarity with linguistic theory was identical to that of the group of participants in experiment 1 and 2.

4.3.2 Method

Stimuli

Stimuli consisted of the 34 transitive verbs and their corresponding unaccusatives used in experiment 1, as well as the 68 non-words and the 68 phonological controls included in experiment 1, functioning in the current experiment as filler items. For the full list of transitives and unaccusatives items see appendix C.

Design

Each participant encountered 136 words: 17 unaccusative verbs; 17 transitive verbs; 34 existing filler verbs and 68 non-words.

Once again, participants were randomly divided into two groups of 15 members, each presented with a different set of items. The composition of each set maintained the following rule: the eventualities presented to group 1 in the transitive diathesis were presented to group 2 in the unaccusative diathesis and vice versa.

¹⁰ I thank Orna Peleg (P.C) for calling my attention to the necessity of this examination.

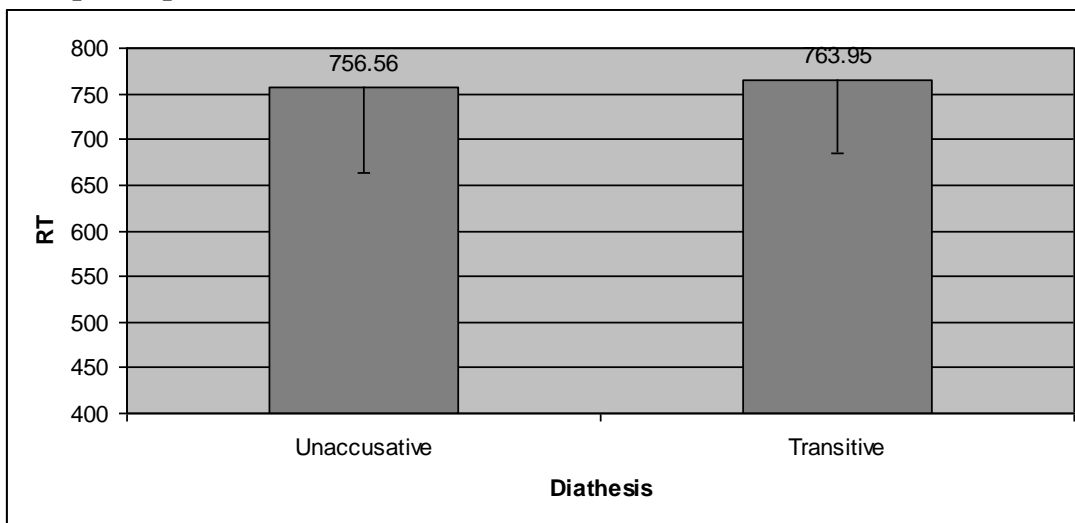
Procedure

The words and non-words were presented to speakers one after the other in the same order they were presented in experiment 1. Each item was separated from the next by a 3 second pause during which three asterisks appeared at the center of the screen. Participants were instructed to read the word that appear on the screen and press 1 if it exists and 0 if it does not. All other procedural details were identical to those of experiment 2, presented in 4.2.2 above.

4.3.3 Results

A t-test for correlated samples comparing average RTs for the transitive and unaccusative verbs calculated across participants did not find performance to be significantly different (unaccusative mean = 756.60 ms, SD = 92.41 ms Vs. transitive mean = 763.95 ms, $t(33) = 0.36$, $p = 0.72$). A comparison of averages calculated across items revealed the same pattern of performance (t-test for correlated samples $t(29) = 0.61$, $p = 0.545$).

Chart 7: average RT by stimulus type (error bars represent standard deviation calculated across participants)



Finally, error rate for transitive items was not significantly different than error rate for unaccusative items (unaccusative = 1 %, SD = 0.7%, transitive = 1%, SD = 0.6%, t-test for correlated samples $t(29) = 0.46$, $p = 0.65$).

Chart 8: average percentage of accuracy by stimulus type

4.3.4 Discussion

The experimental condition of the current experiment consisted of the transitive and the unaccusative verbs included in experiment 1. It was designed to compare speakers' RT in a lexical decision task in which the target word is an unaccusative verb to their RT in a lexical decision task in which the target word is the corresponding transitive. In contrast with experiment 1, in the current experiment participants did not listen to a prime word prior to the appearance of the target word on the screen. As reported above, an analysis of their performance reveals that, in contrast with the performance pattern observed in experiment 1, RTs to unaccusative targets were not significantly different from RTs to transitive targets.

This performance pattern indicates that the significantly shorter RTs in the case of transitive-unaccusative prime-target pairs observed in experiment 1 is not a reflection of the target's idiosyncratic features, or number of arguments (1 vs. 2), but due to the relationship between the transitive prime and the unaccusative target.

5 Conclusion and General Discussion

Given the results of experiment 1 and 2, the performance pattern revealed in experiment 3 is a clear indication that transitive primes facilitate the lexical retrieval of their corresponding unaccusatives better than unaccusative primes facilitate the lexical retrieval of their corresponding transitives.

According to the ICE hypothesis, the significantly shorter RT in the lexical decision task with transitive-unaccusative prime-target combination is due to its resemblance to the mental representation of the systematic relationship between these two diatheses. This mental representation, the results of experiment 1 suggest, defines the transitive verbs as the derivationally basic alternates from which unaccusative verbs are derived. Therefore, this performance pattern is consistent with transitive-to-unaccusative analyses and inconsistent both with unaccusative-to-transitive and with root-based analyses.

In addition, the significant difference found between the overall performance with pairs consisting of corresponding unaccusative and transitive verbs in both orders of presentation and pairs of verbs for which the relationship is purely phonological, or purely involves semantic entailment, provides new empirical evidence to reinforce the view that the relationship between unaccusatives and their transitive alternates is more than a result of phonological resemblance or entailment relation. This finding is a clear indication for the existence of a structural relationship between the abstract representations of these verbs, thus demonstrating psychological reality for the assumption of a derivational relationship between the transitive and the unaccusative diatheses.

5.1 Against an Alternative Interpretation

As detailed above, under the assumption of the ICE hypothesis, the performance patterns observed in experiment 1-3, suggest that unaccusative verbs are derived from their transitive counterparts. However, there is also an alternative way of interpreting these findings, which stems from a hypothesis I label here the ‘Output Hypothesis’:

(17) The Output Hypothesis:

Given a derivational relationship, the derived alternate would serve as a better facilitator for the lexical retrieval of the basic alternate than vice versa.

Similarly to ICE, The Output Hypothesis assumes that derivational relationships are reflected in speakers' perception, but postulates the opposite facilitation effect. It suggests that basic alternates are accessed during the computation of their derived counterparts. Hence that previous retrieval of a derived alternate would render the basic alternate highly accessible. Consequently, under the assumption of the Output Hypothesis, the fact that transitives were found to be better facilitators for the retrieval of their unaccusative counterparts than unaccusatives were for the facilitation of transitives, constitutes evidence that unaccusatives are the basic alternates from which transitives are derived; hence the observed performance pattern would be interpreted as consistent with unaccusative-to-transitive approaches.

There are however two reasons for rejecting this analysis of the results.

First is the existence of direct empirical evidence which contradicts the Output Hypothesis itself. Recall that the study by Stockall and Marantz (2006) presented in 3.2 targeted an alternation for which directionality is not at debate, namely the derivational relationship between verb stems and their corresponding past forms, and found that basic alternates are better at facilitating the lexical retrieval of their derived alternates than vice versa. As these findings are inconsistent with the Output Hypothesis they constitute a reason to abandon it.

Furthermore, as I explain immediately below, an Output-Hypothesis based reinterpretation of the current study's findings as consistent with unaccusative-to-transitive directionality would have to involve the ad-hoc assumption of an unknown processing mechanism.

As mentioned in section 2, unaccusative-to-transitive approaches analyze the derivational relationship between transitives and unaccusatives as reflecting the fact that the unaccusative VP is embedded under the transitive *v*P. Figure 5 illustrates this structural relationship:

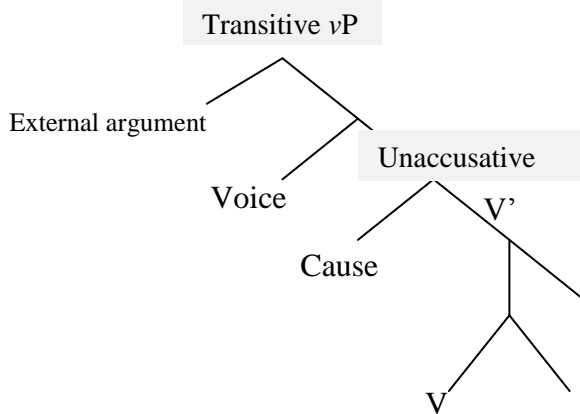


Figure 5

An analysis of the current study's results which assumes this type of derivation as well as the Output Hypothesis would suggest that transitives were observed to be better facilitators than unaccusatives since their lexical retrieval required the computation of the embedded unaccusative tree fragment. As a result, once the transitive alternate had been retrieved, the syntactic structure essential for the retrieval of the unaccusative was already formed, thus rendering the retrieval of the unaccusative verb a shorter process which, as illustrated in figure 6, only required the extraction of an already computed structural fragment:

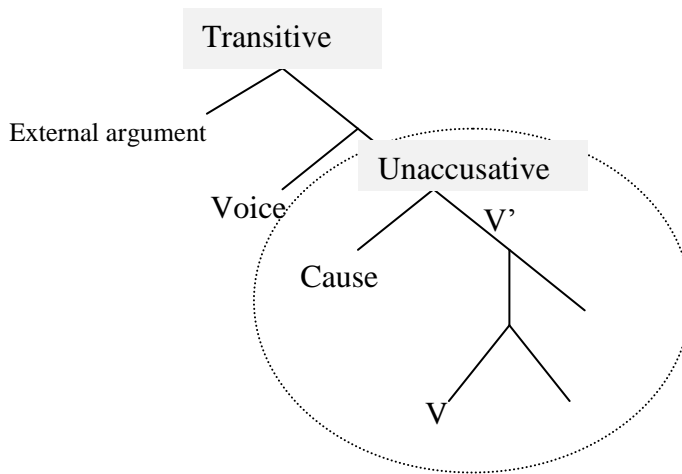


Figure 6

However, suggesting that this type of fragment extraction can take place requires the premise that it can be utilized for the retrieval of the unaccusative verb. This would entail the assumption of a processing mechanism which, as demonstrated in figure 7 below, is capable of removing the top of the structure to reveal the ready-made representation of the unaccusative form.

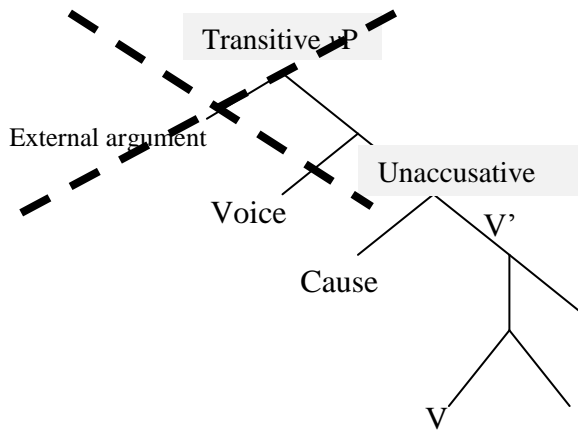


Figure 7

The assumption of this type of mechanism would be empirically unjustified and ad-hoc. Moreover, viewing such a process as facilitating speakers' performance, rather than inhibiting it, would be incompatible with the processing difficulties speakers are recurrently observed to experience when required to perform structural reanalysis (Frazier & Rayner 1982; Frazier 1987; Pritchett 1988, 1992; Ferreira & Clifton 1986; Ferreira & Henderson 1991; Altmann, Garnham & Dennis 1992, among many others). The plausible prediction would be, then, that an activation of the structure-disassembling mechanism demonstrated above would inhibit speakers' performance with transitive-unaccusative prime-target orders. As this is evidently inconsistent with the performance pattern observed in experiment 1, the assumption of this mechanism should be discarded.

The ICE hypothesis, on the other hand, states that the retrieval of the basic alternate would be a better facilitator for the retrieval of the derived one than vice versa. In the context of the unaccusative-to-transitive view, this means that, as demonstrated in figure 8 below, after the syntactic structure associated with the basic alternate prime have been computed, a retrieval of the derived alternate target would not have to involve a computation of its syntactic representation 'from scratch'. It would only require a completion of the derivation, namely the merging of additional functional head(s) on top of the already computed structure.

Therefore, as opposed to the ad-hoc extraction mechanism described above, the assumption of the ICE hypothesis together with unaccusative-to-transitive directionality would merely require assuming the mechanism of (external) merge (Chomsky 1995, 2000, 2001, 2013), a basic structure-building operation that takes computed structures and combines them with other elements into new ones:

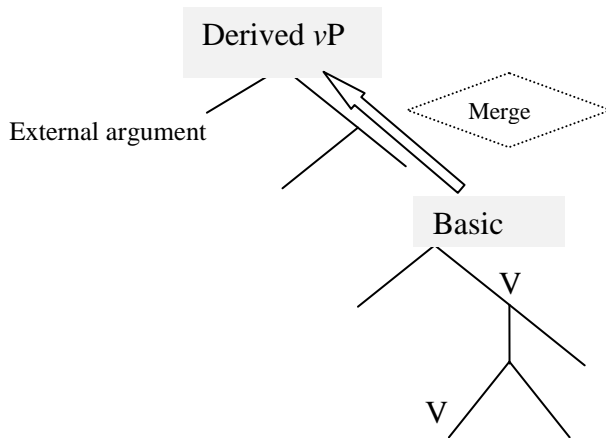


Figure 8

The ICE hypothesis is therefore compatible, in principle, with the unaccusative-to-transitive view, whereas the Output Hypothesis is not. Hence the Output Hypothesis considered above cannot be used to determine the validity of proposed unaccusative-to-transitive approaches, while the ICE hypothesis is indeed suitable for this purpose.

5.2 Future Research

As shown above, there are theoretical and empirical justifications for the assumption of the ICE hypothesis. Nevertheless, an experiment testing speakers' performance with regard to verbal alternations for which directionality is not at debate can provide further testing and validation for the assumption of ICE. If, in such a case, speakers' performance pattern turns out to indicate that basic-derived prime-target combinations result in faster RTs than derived-basic combinations, the assumption of the ICE hypothesis will receive additional support.

Suitable stimuli for such an examination would be the derivational relationships between transitive verbs and their corresponding reflexives and verbal passives demonstrated in (18) a-c:

- (18) a. ha-'ima **hilbiša** 'et ha-yalda (Transitive)
 the-mother dressed ACC the-girl
 'The mother dressed the girl.'
- b. ha-yalda **hulbeša** (al yedey ha-'ima) (Verbal passive)
 the-girl was-dressed (by the-mother)
 'The girl was dressed by the mother.'
- c. ha-yalda **hitlabša** (Reflexive)
 the-girl dressed
 'The girl dressed.'

Theorists that address these alternations are in agreement that the transitive verb is the basic alternate from which the other diatheses are derived (Grimshaw 1990; Kratzer 2000; Reinhart & Siloni 2004; Chierchia 2004; Koontz-Garboden 2009 among others). Accordingly, if basic alternates are indeed better facilitators than derived alternate, transitives (e.g., *hilbiša*) should be

observed to be better facilitators for the retrieval of their corresponding verbal passives (*hulbeša*) and reflexives (*hitlabaša*) than vice versa.

5.3 Methodological Implications

Apart from providing a glimpse into speakers' perception of the transitive-unaccusative alternation, the three experiments presented and discussed above constitute an exhaustive case-study demonstrating how derivational directionality can be psycholinguistically examined.

Interestingly, with regard to the specific derivational relationship at hand, this empirical examination revealed that on a par with transitive-to-unaccusative approaches Hebrew speakers perceive transitive verbs as basic and their unaccusative counterparts as derived.

This performance pattern is an indication that the ICE hypothesis, as well as the methodologies developed and elaborated to test its predictions, can provide a basis for further fruitful psycholinguistic examinations, whether studying how speakers of other languages perceive the transitive-unaccusative alternation or settling theoretical debates concerning the directionality of further derivational relationships.

References

- Alexiadou, Artemis, Elena Anagnostopoulou and Martin Everaert. 2004. Introduction. In *The unaccusativity puzzle*, ed. A. Alexiadou, E. Anagnostopoulou and M. Everaert. Oxford: Oxford University Press.
- Alexiadou, Artemis, Elena Anagnostopoulou and Florian Schäfer. 2006. The properties of anticausatives crosslinguistically. In *Phases of Interpretation*, ed. M. Frascarelli. Berlin: Mouton.
- Altmann, Gerry T.M., Alan Garnham and Yvette Dennis. 1992. Avoiding the garden path: Eye movements in context. *Journal of Memory and Language* 31:685–712.
- Anderson, Stephen R. 1992. *A-morphous morphology*. Cambridge University Press: Cambridge.
- Arad, Maya. 2005. *Roots and Patterns: Hebrew morpho-syntax*. Dordrecht: Springer.
- Aronoff, Mark. 1976. *Word formation in generative grammar*. Cambridge, Mass: MIT Press.
- Belletti, Adriana, and Luigi Rizzi. 1981. The Syntax of “ne”: Some theoretical implications. *The Linguistic Review* 1:117–154.
- Belletti, Adriana, and Luigi Rizzi. 1988. Psych-verbs and theta theory. *Natural Language and Linguistic Theory* 6:291–352.
- Borer, Hagit, and Yosef Grodzinsky. 1986. Syntactic cliticization and lexical cliticization: The case of Hebrew dative clitics. In *The syntax of pronominal clitics, Syntax and semantics 19*, ed. H. Borer, 175–217. New York: Academic Press.
- Borer, Hagit. 1994. The projection of arguments. In *Functional Projections*, ed. E. Benedicto and J. Runner. Amherst, Mass: GLSA.
- Borer, Hagit. 2003. Exo-skeletal vs. endo-skeletal explanations: syntactic projections and the lexicon. In *The nature of explanation in linguistic theory*, ed. J. Moore and M. Polinsky. Stanford CA: CSLI Publications.
- Burzio, Luigi. 1986. *Italian syntax*. Dordrecht: Reidel.

- Chierchia, Gennaro. 2004 (written in 1989). A semantics for unaccusatives and its syntactic consequences. In *The Unaccusativity Puzzle: Explorations of the Syntax-Lexicon Interface*, ed. A. Alexiadou, E. Anagnostopoulou, and M. Everaert. Oxford: Oxford University Press.
- Chomsky, Noam. 1970. Remarks on Nominalization. In *Readings in English Transformational Grammar*, ed. R. A. Jacobs and P. S. Rosenbaum. Waltham, MA: Blaisdell.
- Chomsky, Noam. 1981. *Lectures on Government and Binding*. Dordrecht: Foris.
- Chomsky, Noam. 1995. *The Minimalist Program*. Cambridge, Massachusetts/London: MIT Press.
- Chomsky, Noam. 2000. Minimalist inquiries: The framework. In *Minimalist inquiries: the framework Step by Step: Essays on Minimalist Syntax in Honor of in Howard Lasnik*, ed. R. Martin, D. Michaels and J. Uriagereka. Cambridge, MA: MIT Press.
- Chomsky, Noam. 2001. Derivation by phase. In M. Kenstowicz. ed.), *Ken Hale: A life in language*. Cambridge, MA: MIT Press.
- Chomsky, Noam. 2013. Problems of projection. *Lingua* 130: 33–49
- Doron, Edit. 2003. Agency and Voice: the Semantics of the Semitic templates. *Natural Language Semantics* 11:1–67.
- Embick, David, and Alec Marantz. 2008. Architecture and Blocking. *Linguistic inquiry* 39:1–53.
- Fadlon, Julie. 2011. Hidden entries: a Psycholinguistic study of derivational gaps. In *The Theta System: Argument Structure at the Interface*, ed. Martin Everaert, Marijana Marelj and Tal Siloni. Oxford: Oxford University Press.
- Ferreira, Frenanda, and Charles Clifton. 1986. The independence of syntactic processing. *Journal of Memory and Language* 25:348–368.
- Ferreira, Frenanda, and John M. Hendereson. 1991. The use of verb subcategorization information in syntactic parsing. In *Understanding Word and Sentence*, ed. G.B. Simpson, 305–330. North-Holland, Amsterdam: Elsevier.
- Fodor, Jerry. 1975. *The Language of Thought*. Cambridge, MA: Harvard University Press.
- Frazier, Lyn, and Keith Rayner. 1982. Making and correcting errors during sentence comprehension: Eye movements in the analysis of structurally ambiguous sentences. *Cognitive Psychology* 14:178–210.
- Frazier, Lyn. 1987. Sentence processing. In *Attention and Performance XII*, ed. M. Coltheart. Hillsdale, NJ: Erlbaum.
- Friedmann, Naama, Gina Taranto, Lewis P. Shapiro, and David Swinney. 2008. The leaf fell (the leaf): The online processing of unaccusatives. *Linguistic Inquiry*. 39:355–377.
- Frost Ram, Kenneth I. Forster and Avital Deutsch. 1997. What can we learn from the morphology of Hebrew: A masked priming investigation of morphological representation. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 23:829–856.
- Frost, Ram, Avital Deutsch and Kenneth I. Forster. 2000a. Decomposing morphologically complex words in a nonlinear morphology. *Journal of Experimental Psychology: Learning, Memory, and Cognition* 26:751–765.
- Frost, Ram, Avital Deutsch, Orna Gilboa, Michal Tannenbaum and William Marslen-Wilson. 2000b. Morphological priming: Dissociation of phonological, semantic, and morphological factors. *Memory and Cognition* 8:1277–1288.
- Frost, Ram, and Dave Plaut. 2005. The word-frequency database for printed Hebrew. <http://word-freq.mscc.huji.ac.il/index>.
- Grimshaw, Jane. 1990. *Argument Structure*. Cambridge, MA: MIT Press.
- Halle, Morris. 1973. Prolegomena to theory of word formation. *Linguistic Inquiry* 4:3–16.

- Halle, Morris, and Alec Marantz. 1993. Distributed morphology and the pieces of inflection. In *The view from Building 20: Essays in linguistics in honor of Sylvain Bromberger*, ed. K. Hale and S.J. Keyser. Cambridge, MA: MIT Press.
- Harley, Heidi. 1995. *Subjects, Events, and Licensing*. PhD dissertation, MIT
- Horvath, Julia, and Tal Siloni. 2008. Active lexicon: Adjectival and verbal passives. In *Generative Approaches to Hebrew Linguistics*, ed. G. Danon, S. Armon-Lotem, and S. Rothstein. Amsterdam: John Benjamins Publishers.
- Horvath, Julia, and Tal Siloni. 2011. Causatives across Components. *Natural Language and Linguistic Theory*. 29:657–704.
- Horvath, Julia, and Tal Siloni. to appear. The thematic phase and the architecture of grammar. In *Concepts, Syntax and their Interface*, ed. M. Everaert, M. Marelj, E. Reuland, and T. Siloni. Cambridge, MA: MIT Press.
- Jackendoff, Ray. 1975. Morphological and Semantic Regularities in the Lexicon. *Language* 51:639–67.
- Jaeggli, Osvaldo A. 1986. Passive. *Linguistic Inquiry* 17:587–622.
- Kay, Paul, and Willett Kempton. 1984. What is the Sapir-Whorf-Hypothesis?. *American Anthropologist* 86:65–79.
- Koontz-Garboden, Andrew. 2009. Anticausativization. *Natural Language and Linguistic Theory* 27:77–138.
- Kratzer, Angelika. 2000. Building statives. *Berkeley Linguistic Society* 26:385–399.
- Kratzer, Angelika. 2004. Building resultatives. In *Event arguments in syntax, semantics, and discourse*, ed. C. Maien-born and A. Wllstein-Leisten. Tübingen: Niemeyer.
- Lee, Jiyeon, and Cynthia K. Thompson. 2011. Real-time production of unergative and unaccusative sentences in normal and agrammatic speakers: An eyetracking study. *Aphasiology* 25:813–825.
- Levin, Beth, and Malka Rappaport. 1995. *Unaccusativity at the syntax-lexical semantics interface*. Cambridge, MA: MIT Press.
- Manzini, Rita. 1983. On control and control theory. *Linguistic Inquiry* 14:421–467.
- Marantz, Alec. 1997. No escape from syntax: Don't try morphological analysis in the privacy of your own lexicon. In *Proceedings of the 21st Annual Penn Linguistics Colloquium*, ed. A. Dimitriadis and L. Siegel. Philadelphia: University of Pennsylvania.
- Marantz, Alec. 2007. Phases and words. In *Phases in the theory of grammar*, ed. S.H Choe. Seoul: Dong In.
- Meltzer, Aya, and Tal Siloni. 2013. Unaccusativity in Hebrew. In *Encyclopedia of Hebrew Languages and Linguistics*. Brill.
- McQueen, James M., and Ann Cutler, A. 1998. Morphology in word recognition. In *Handbook of morphology*, ed. A. Spencer and A.M. Zwicky. Oxford: Blackwell Publishers.
- Neeleman, Ad and Hans Van de Koot. 2011. The linguistic Expression of Causation. In *The theta system: Argument Structure at the Interface*, ed. M. Everaert, M. Marelj and T. Siloni. Oxford: Oxford University Press.
- Parsons, Terence. 1990. *Events in the semantics of English: A study in subatomic semantics*. Cambridge, MA: MIT Press.
- Perlmutter, David. M. 1978. Impersonal passives and the Unaccusative Hypothesis. In *Proceedings of the 4th Annual Meeting of the Berkeley Linguistics Society*, 157–189. UC, Berkeley.
- Pesetsky, David. 1982. *Paths and Categories*. PhD Dissertation, MIT.

- Pesetsky, David. 1995. *Zero syntax: Experiencers and cascades*. Cambridge MA: MIT Press.
- Pinker, Steven. 1994. *The language instinct: The new science of language and mind*. Penguin Science.
- Pritchett, Bradley L. 1988. Garden path phenomena and the grammatical basis of language processing. *Language* 64:539–576.
- Pritchett, Bradley L. 1992. *Grammatical competence and parsing performance*. Chicago: Chicago University Press.
- Ramchand, Gillian C. 2006. *Verb meaning and the lexicon: A first phase syntax*. Unpublished manuscript, Universitetet i Tromsø.
- Rappaport-Hovav, Malka, and Beth Levin. 2011. Lexicon uniformity and the causative alternation. In *The Theta system: Argument structure at the interface*, ed. Everart, Martin, M. Marelj and T. Siloni. Oxford: Oxford University Press.
- Reinhart, Tanya. 1991. Lexical properties of ergativity. Lecture presented at the conference on Lexical Structure, Utrecht.
- Reinhart, Tanya. 1996. Syntactic effects of lexical operations: Reflexives and unaccusatives. In *OTS Working papers in Linguistics*, TL-97-002, University of Utrecht.
- Reinhart, Tanya. 2000. The theta system: syntactic realization of verbal concepts. In *OTS working papers in linguistics*, TL-00-01, University of Utrecht.
- Reinhart, Tanya. 2002. The theta system: an Overview. *Theoretical Linguistics* 28:229–290.
- Reinhart, Tanya, and Tal Siloni. 2003. Thematic arity operations and parametric variations. Unpublished manuscript, UiL-OTS and Tel-Aviv University.
- Reinhart, Tanya, and Tal Siloni. 2004. Against the unaccusative analysis of reflexives. In *The Unaccusativity Puzzle: Explorations of the Syntax–Lexicon Interface*, ed. A. Alexiadou, E. Anagnostopoulou, and M. Everaert. Oxford: Oxford University Press.
- Reinhart, Tanya and Tal Siloni. 2005. The lexicon-syntax parameter: reflexivization and other arity operations. *Linguistic Inquiry* 36:389–436.
- Reinhart, Tanya. 2010. The theta system: Unaccusative and experiencer derivations. Unpublished manuscript.. Revised by Tal Siloni.
- Shetreet, Einat, Naama Friedmann and Uri Hadar. 2010. The neural correlates of linguistic distinctions: Unaccusative and unergative verbs. *Journal of Cognitive Neuroscience* 22:2306–2315.
- Shlonsky, Ur. 1997. *Clause structure and word order in Hebrew and Arabic: An essay in comparative Semitic syntax*. New York: Oxford University press.
- Siloni, Tal. 2002. Active lexicon. *Theoretical Linguistics* 28:383–400.
- Siloni, Tal. 2009. Systematic gaps in nominalization: Active lexicon. Lecture presented at the conference on atoms and laws of the Noun Phrase, Utrecht.
- Sorace, Antonella. 1995. Acquiring linking rules and argument structures in a second language: The unaccusative/unergative distinction. *The current state of interlanguage: Studies in Honor of William E. Rutherford*, 153–175. Amsterdam: John Benjamins Publishing Company.
- Sorace, Antonella. 2000. Gradients in auxiliary selection with intransitive verbs. *Language* 76:859–890.
- Sperber, Dan, and Deirdre Wilson. 1997. The mapping between the mental and the public lexicon. In *Thought and language*, ed. P. Carruthers and J. Boucher. Cambridge: CUP.
- Schäfer, Florian. 2009. The Causative Alternation. *Language and Linguistics Compass* 3:641–681.

- Stockall, Linnaea, and Alec Marantz. 2006. A single route, full decomposition model of morphological complexity: MEG evidence. *The Mental Lexicon* 1:85–123.
- Van Valin, Robert. D. Jr. 1990. Semantic parameters of split intransitivity. *Language* 66:221–60.
- Williams, Edwin. 1985. PRO and the subject of NP. *Natural Language and Linguistic Theory* 3:297–315.
- Wolff, Phillip. 2003. Direct causation in the linguistic coding and individuation of causal events. *Cognition* 88:1–48.

Appendix A: verbs used in experiment 1

Experimental condition

Experimental condition	Transitive	Unaccusative	No. of shared phonemes (SP)	Translation
simplex-complex	rikex	hitrakex	5	softened
	ximem	hitxamem	5	heated
	kerer	hitkarer	4	cooled
	lixlex	hitlaxlex	4	soiled
	saraf	nisraf	4	burned
	motet	hitmotet	4	collapsed
	kimet	hitkamet	5	wrinkled
	patax	niftax	3	opened
	saxaf	nisxaf	4	swept
	cinen	hictanen	5	chilled
	šavar	nišbar	3	broke
	pizer	hitpazer	5	scattered
	complex-simplex	hicmiax	camax	4
hir'id		ra'ad	3	trembled
hifriax		parax	3	blossomed /blew
hikpi		kafa	1	froze
hitbia		tava	2	drowned
hinbit		navat	2	sprouted
hizrim		zaram	2	poured/flowed
he'if		af	2	flew
higbir		gavar	2	rose
hiv'ir		ba'ar	1	burnt (arson)
simplex-simplex	heni'a	na	2	moved
	hirtit	ratat	2	vibrated
	kiba	kava	2	turned-off
complex-complex	šikex	šaxax	3	alleviated
	hidlik	nidlak	4	turned-on
	hixšil	nixšal	3	tripped
	he'erim	ne'eram	4	stacked
	hifsik	nifsak	4	stopped

hirtiv	nirtav	4	made/got-wet
he'elim	ne'elam	4	made/ vanished
hixxid	nixxad	3	made/got- extinct
hixliš	nexlaš	3	weakened

Average: 3.265

Phonological control condition							
prime	target	SP	Experimental SP/ control SP	prime	target	SP	Experimental SP/ control SP
hitrakex	tarak 'slammed'	4	1.25	rikex	nikrax 'got-wrapped'	3	1.6666667
hitxamem	tixem 'delimited'	4	1.25	ximem	nitxam 'delimited'	3	1.6666667
hitkarer	kiter 'griped'	5	0.8	kerer	herik 'emptied'	3	1.3333333
lixlex	hitxalxel 'shuddered'	4	1	hitlaxlex	xilxel 'seeped'	4	1
saraf	nifras 'spread'	4	1	nisraf	našar 'fell'	3	1.3333333
motet	hemit 'killed'	3	1.333333	hitmotet	timtem 'soddened/muddled'	4	1
kimet	hemtik 'sweetened'	5	1	hitkamet	katam 'sniped'	4	1.25
patax	pite'ax 'developed'	4	0.75	niftax	nafax 'blew'	4	0.75
nisxaf	nise'ax 'formulated'	5	0.8	saxaf	hexsif 'made/became-silver'	3	1.3333333
hictanen	henec 'buded'	4	1.25	cinen	hitnocec 'glittered'	4	1.25
šavar	biser 'announced'	1	3	nišbar	našav 'blew'	3	1
hitpazer	pirez 'demilitarized'	5	1	pizer	hefriz 'exaggerated'	4	1.25
hicmiax	maxac 'smite'	4	1	camax	hexmic 'made-sour' 'missed'	3	1.3333333
hir'id	hera 'worsened'	2	1.5	ra'ad	he'edir 'glorified'	2	1.5
hifriax	hefer 'violated'	3	1	parax	rixef 'hovered'	2	1.5
hikpi	paka 'burst'	2	0.5	kafa	hifki'a 'expropriated'	3	0.3333333
tava	hiv'it 'terrified'	2	1	hitbia	hibit 'looked'	4	0.5
hinbit	heniv 'yielded'	2	1	navat	nitev 'directed'	3	0.6666667
hizrim	ramaz 'hinted'	2	1	zaram	nirmaz 'got/was hinted'	4	0.5
af	hofi'a	2	1	he'if	afa	2	1

	‘appeared’				‘baked’		
gavar	hivrig	3	0.666667	higbir	higiv	3	0.666667
	‘screwed’				‘responded’		
hiv’ir	hebi’a	2	0.5	ba’ar	her’iv	2	0.5
	‘expressed’				‘starved’		
na	ne’ena	2	1	heni’a	ana	3	0.666667
	‘got-answered’				‘answered’		
ratat	hetir	2	1	hirtit	yiret	3	0.666667
	‘allowed’				‘intercepted/shot-down’		
kiba	baka	3	0.666667	kava	nikva	3	0.666667
	‘got-cleaved’				‘pooled’		
šaxax	ninšax	3	1	šikex	xašak	4	0.75
	‘got-bitten’				‘desired’		
hidlik	nilkad	4	1	nidlak	hiklid	4	1
	‘got-trapped’				‘rusted’		
nixšal	nixeš	3	1	hixšil	hexiš	4	0.75
	‘guessed’				‘speed-up’		
ne’eram	hitna’er	4	1	he’erim	hi’ir	4	1
	‘shaked-off’				‘waked’		
nifsak	fikses	4	1	hifsik	hikif	4	1
	‘faxed’				‘orbited’		
hirtiv	hitiv	4	1	nirtav	viter	4	1
	‘made-well’				‘gave-up’		
he’elim	ho’il	4	1	ne’elam	hil’im	4	1
	‘availed’				‘made-vanish’		
hixxid	nidxa	3	1	nixxad	hidi’ax/hedi’ax	3	1
	‘rejected’				‘rinsed’/‘dismissed’		
nexlaš	hišlix	3	1	hixliš	hexil	4	0.75
	‘tossed’				‘implemented’		
	Average	3.265	1.04			3.35	0.99

Appendix B: verbs used in experiment 2

Experimental condition

	Transitive	Intransitive		
complex-simplex	hix'is	'angered'	ragaz	'got-angry'
	hitbi'a	'drowned'	šaka	'drowned'
	hištik	'silenced'	nadam	'got-silent'
	he'if	'flew'	na	'moved'
	hiv'it	'scared'/'frightened'	yara	'feared'
	hicit	'burned' (arson)	ba'ar	'burned'
	herkid	'made-dance'	zaz	'moved'
	hexliš	'weakened'	rafa	'got-limp'
	hidgiš	'emphasized'	balat	'got-prominent'
	hirgiz	'annoyed'	ka'as	'got-angry'
complex-complex	heni'a	'moved'	zaz	'moved'
	hidhim	'amazed'	hitrashem	'got-impressed'
	hirgiz	'annoyed'	hit'acben	'got-irritated'
	higšim	'realized'/'fulfilled'	hitmameš	'realized'
	he'ir	'waked'	hikic	'wakened'
	hirgil	'habituated'	histagel	'habituated'
	hitiš	'exhausted'/'tired'	hit'ayef	'got-tired'
	hitmiha	'surprisingly astounded'	hitpale	'wondered'
	hiv'ir	'burned' (arson)	hitlahet	'heated'
	hifxit	'lessened'	hitma'et	'diminished'
simplex-simplex	hishpric	'sprayed'	nitaz	'got-sprayed'
	cimcem	'reduced'	paxat	'decreased'
	šamat	'dropped'	nafal	'fell'

Control condition

Prime	Target
hixnis	patar
hivlig	hitromem
piter	hitlabeš
hiflig	bara
hexlif	histaben
pina	nislax
patax	hitxalef
hivtiax	axal
pica	amad
kilel	higniv

gila	nirtav
hinif	hevi
bilbel	yašav
hisbir	hitga'age'a
pileg	halax
hikdiš	hista'er
liben	histapek
xalaf	hexdir
hishtaxrer	hitmid
ganav	hicmid
rac	hoši'a
hitlahev	pizer
hitpana	rikex
hitgareš	hisgir
hitkarev	himci
mica	hishki'ax
hitmaked	ina
hitrageš	ciyec
parax	hicmi
xava	naval
gar	himit
paca	hexmi
nam	hivrig
yaraš	hirdim

Appendix C: verbs used in experiment 3

Experimental condition

	Transitive	unaccusative	Translation
simplex-complex	rikex	hitrakex	softened
	ximem	hitxamem	heated
	kerer	hitkarer	cooled
	lixlex	hitlaxlex	soiled
	saraf	nisraf	burned
	motet	hitmotet	collapsed
	kimet	hitkamet	got-wrinkled
	patax	niftax	opened
	saxaf	nisxaf	swept
	cinen	hictanen	chilled
	šavar	nišbar	broke
	pizer	hitpazer	scattered
	complex-simplex	hicmiax	camax
hir'id		ra'ad	trembled
hifriax		parax	blossomed/blew
hikpi		kafa	froze
hitbia		tava	drowned
hinbit		navat	sprouted
hizrim		zaram	poured/flowed
he'if		af	flew
higbir		gavar	rose
hiv'ir		ba'ar	burned(arson)
heni'a		na	moved
hirtit		ratat	vibrated
simplex-simplex		kiba	kava
	šikex	šaxax	alleviated
	hidlik	nidlak	turned-on
complex-complex	hixšil	nixšal	tripped
	he'erim	ne'eram	stacked
	hifsik	nifsak	stop
	hirtiv	nirtav	got-wet
	he'elim	ne'elam	vanished
	hixxid	nixxad	got-extinct
	hixliš	nexlaš	weakened

