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The Transitive–Unaccusative Alternation: A Cross-Modal Priming Study

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Abstract The relationship between different linguistic manifestations of an eventuality-denoting concept, referred to in the literature as diatheses or voices, is well-studied in theoretical linguistics. Among researchers studying this phenomenon, it is widely agreed that there is a systematic relationship between the various diatheses of a concept. However, when a specific alternation is addressed, the nature of this relationship, namely, its directionality, is at debate. This research employs the much-debated transitive–unaccusative alternation as a case-study and reports the results of two cross-modal priming experiments designed to explore how Hebrew speakers perceive it. The results reveal an asymmetry between the facilitating effects of transitives and unaccusatives, thus suggesting that the relationship between these diatheses is directional. As a whole, this study demonstrates that theoretical debates regarding derivational relationships can be addressed by means of psycholinguistic research.

Keywords Directionality · Unaccusative · Transitive–unaccusative · Cross-modal priming · Hebrew

Introduction

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

- (1) Transitive: Mary *closed* the door.
- (2) Unaccusative: The door *closed*.

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- (3) Verbal passive: The door *was closed* by Mary.
- (4) Adjectival passive: The boy looked at the *closed* door.

In the linguistic 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 connection between different diatheses of the same eventuality-denoting concept (Chierchia 2004; Harley 1995; Koontz-Garboden 2009; Levin and Rappaport 1995; Marantz 1997; Pesetsky 1995; Ramchand 2008; Reinhart and Siloni 2005; among others).

Nevertheless, when a specific alternation between two diatheses is addressed, an important aspect of this connection is at constant theoretical debate: is the relationship directional, i.e. is one alternate derived from the other, or is it the case that both alternates originate from a mutual source? If the former is correct, which is the basic alternate and which the derived one?

Different models anchored within diverse theoretical frameworks provide various conceptual, theoretical and distributional arguments to favor one directionality route over the other. The objective of this paper is to show that psycholinguistic research can shed light on these debates. The key assumption of this study is that since the various views on derivational relationships were not formed to be purely theoretical entities but to constitute a model representation of psychologically real processes, the representational architecture postulated by a model which properly captures a relationship should be reflected in speakers' perception of the corresponding related forms. Accordingly, this research was designed to detect the perceptual implications of derivational directionality on the lexical retrieval of two alternating forms by comparing the facilitating effect each of them has on the retrieval of the other. The empirical array for this purpose was the well-examined transitive–unaccusative alternation, reviewed immediately below, and the targeted population was adult native Hebrew speakers.

In what follows, I present two cross-modal lexical priming experiments designed to examine how the relationship between unaccusative and transitive verbs affects lexical decision times. Experiment 1 used a cross-modal priming design to compare the facilitating effect an earlier retrieval of a transitive has on the retrieval of the corresponding unaccusative to the facilitating effect an earlier retrieval of an unaccusative has on the retrieval of the corresponding transitive. The guiding assumption of this investigation was that, all other factors being equal, a directional relationship between two diatheses is predicted to yield different facilitating effects for each of the alternating forms, while a non-directional relationship should not yield different performance. The results of experiment 1 reveal that transitives are better facilitators for the retrieval of unaccusatives than unaccusatives are for the retrieval of transitives. Experiment 2 was conducted to exclude an explanation which attributes the results of experiment 1 to a semantic entailment relationship rather than a derivational relationship. Experiment 2 therefore included pairs of verbs which only exhibit a semantic entailment relationship. As the pattern observed in experiment 1 was not replicated in experiment 2, the implications of the asymmetric pattern observed with derivationally related pairs of transitives and unaccusatives on theoretical models are subsequently discussed. Mainly, it is argued that the results suggest that the derivational relationship between transitives and unaccusatives is a directional relationship rather than a non-directional one.

Unaccusative Verbs and Their Transitive Counterparts

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 (e.g., ‘the vase’ in the sentence ‘the vase broke’) initially merges as the verb’s object and arrives at the subject’s position by syntactic movement ([Alexiadou et al. 2004](#); [Borer 1994](#); [Burzio 1986](#); [Chomsky 1981](#); [Chierchia 1989](#); [Levin and Rappaport 1995](#); [Perlmutter 1978](#); [Pesetsky 1995](#); [Reinhart and Siloni 2005](#); among others).

This analysis is supported by the fact that the subject of unaccusative verbs is crosslinguistically recognized as an internal argument (i.e. object) by various internality-detecting diagnostics, while that of unergatives is diagnosed as externally mapped (i.e. subject) (see [Belletti and Rizzi 1981](#); [Borer and Grodzinsky 1986](#); [Burzio 1986](#); [Pesetsky 1982](#); [Reinhart and Siloni 2005](#); among others, for diagnostics and judgments from English, Hebrew, Italian and Russian).

Further reinforcement the unaccusative/unergative split come from psycholinguistic and neurolinguistic studies: [Burkhardt et al. \(2003\)](#) and [Friedmann et al. \(2008\)](#) 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 et al. \(2010\)](#) 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.

The current research adopts this view, 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.

A prominent crosslinguistic fact about unaccusative verbs is that they tend to have a transitive alternate, a phenomenon I will refer to as the transitive–unaccusative alternation¹:

English

- | | | |
|-----|-------------------------------------|----------------|
| (5) | a. The window broke. | (Unaccusative) |
| | b. The girl/stone broke the window. | (Transitive) |
| (6) | a. The ball rolled. | (Unaccusative) |
| | b. The girl/wind rolled the ball. | (Transitive) |

¹ As the transitive–unaccusative alternation, like other derivational alternations, exhibits sporadic derivational gaps, there are some 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 and empirical investigation see [Fadlon \(2011\)](#).

Hebrew:

- (7) a. *ha-kadur hitgalgel* (Unaccusative)
 the-ball rolled
 ‘The ball rolled.’
- b. *roza/ ha-ru'ax gilgela 'et ha-kadur* (Transitive)
 Roza/ the-wind rolled-TRANS ACC the-ball
 ‘Roza/the wind rolled the ball.’
- (8) a. *ha-'agartal nafal* (Unaccusative)
 The-vase fell
 ‘The vase fell.’
- 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 diatheses. The views regarding the nature of this relationship vary and can be categorized into three classes: (1) *non-directional root-based* analyses (2) *directional unaccusative-to-transitive* analyses (3) *directional transitive-to-unaccusative* analyses.

The first class of theories (Alexiadou et al. 2006; Arad 2005; Doron 2003; Harley 1995; Marantz 1997, 2007) considers both alternates to originate from a third, abstract, linguistic entity. According to these views, the source of the relationship between unaccusatives and their transitive alternates is not that one of them is 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. These views will therefore be referred to here as *non-directional root-based* theories. Schematized in Fig. 1, 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:

The second class of theories (Pesetsky 1995; Ramchand 2008; Rappaport-Hovav and Levin 2011) view the transitive alternate as the product of adding a cause element to an intransitive verb. Hence, they provide the former with a structural representation embedded in that of the latter. This class of theories will be referred to here as *directional unaccusative-to-transitive* theories. To demonstrate, in Ramchand’s (2008) system, for example, a verb is always a composite of the categorial elements *t: init* (“initiation”), *proc* (“process”) and *res* (“the result state”). The process responsible of the transitive–unaccusative alternation is ‘causativization’, which involves the addition of a *init* feature in the syntax to lexical entries that do not already possess one. The resulting structure is schematized in Fig. 2, a [*init, proc, res*] *initP* which embeds the original intransitive [*proc, res*] *procP*.

Fig. 1 Arad (2005): two distinct structural representations

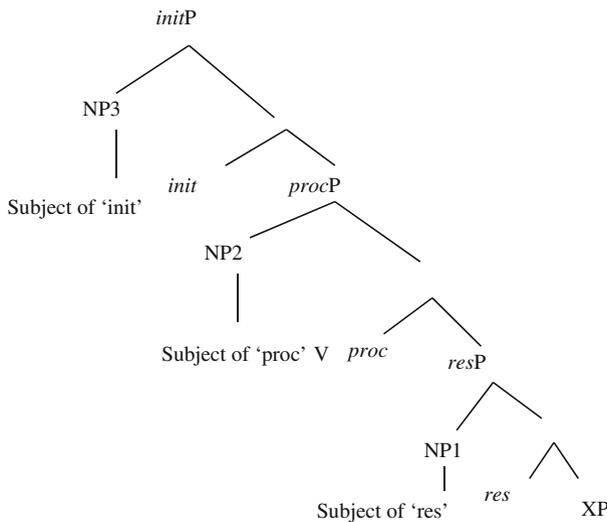
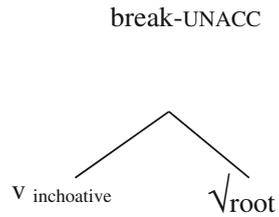
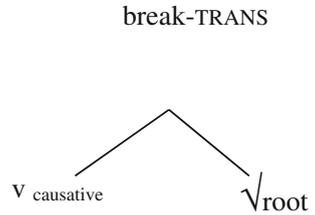


Fig. 2 Ramchand (2008): transitive structure embeds unaccusative structure

Finally, *directional transitive-to-unaccusative* theories view the unaccusative alternate as derived from its transitive counterpart by manipulation on the external argument (i.e., the Cause argument in the subject position). Chierchia (1989, 2004) and Koontz-Garboden (2009) view the relation between unaccusatives and their transitive alternates as the result of an operation on the transitive alternate’s lexical semantics, which identifies the Cause and the Theme roles of the transitive alternate, forming a single, argument. Levin and Rappaport (1995) consider the set of unaccusatives to be derived by an operation which applies to the transitive lexical entry’s Cause in the mapping from ‘lexical semantics representation’ and prevents its placement in argument structure. The analysis proposed by Reinhart and Siloni

(2004, 2005) and Horvath and Siloni (2011) suggests that transitive verbs with a Cause external role serve as input for the lexical operation of de-causativization which eliminates the transitive entry's external theta role and its accusative case feature and creates its unaccusative counterpart.

Directionality and Facilitation Effects: Predictions and Methodology

As mentioned above, the guiding assumption of this study is that the representation of derivational alternations in linguistic knowledge should affect the way speakers perceive the relationship between their members. Accordingly, it predicts that the nature of the relationship between transitives and unaccusatives would influence speakers' performance on tasks which involve the processing of both alternates. The experimental methodology chosen to reveal this anticipated effect is cross-modal lexical priming.

Many priming experiments conducted over the past few decades established this methodology as sensitive to linguistic relationships between the prime word and the target word. This means that a prime which is orthographically, semantically, morphologically or syntactically related to the target would facilitate speakers' RTs and accuracy rates in tasks which demand the processing of the target word (Bock 1986; Ferrand and Grainger 1992; McQueen and Cutler 1998; Meyer and Schvaneveldt 1971; Neely 1991; Tulving and Schacter 1990; among many others).

The particular type of priming technique used in the current study is labelled 'cross-modal' to indicate that the prime and the target are presented to the participant via two distinct modalities. This methodology was employed since the relationship this research wished to detect was a modality-independent structural connection between the abstract morphological representations of the two forms, rather than acoustic-phonetic or visual modality-specific relations. Presenting the prime and the target via different modalities is efficient in detecting these relationships, since cross-modality increases the chances of tapping into a modality-independent abstract representation by avoiding possible sources of form-based effect (Allen and Badecker 2002; Frost et al. 2000b; Marslen-Wilson et al. 1994; among others).

Given this, transitive verbs and their corresponding unaccusatives, which are both semantically and morphologically related, are predicted to facilitate the lexical retrieval of one another in a cross-modal priming experiment. The directionality of this relationship, or lack thereof, I suggest, should also be expressed in the observed facilitation effects. As derivational relationships between diatheses are a part of speakers' arsenal of linguistic mechanisms, 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. If the relationship between unaccusatives and their transitive counterparts is non-directional as argued by non-directional root-based theories, then, all other factors being equal, transitive–unaccusative and unaccusative–transitive prime–target pairs should not yield different facilitation patterns in a lexical decision task. On the other hand, different facilitation patterns for transitive–unaccusative and unaccusative–transitive pairs should be taken as indicating that the relationship between the two forms is asymmetrical, hence consistent with directional models.

Accordingly, in experiment 1, described immediately below, speakers were presented with an auditory prime and then required to complete a lexical decision task regarding a visual target; in some of the experimental trials the prime was the unaccusative verb and the target

its transitive counterpart (henceforth UT pairs), while in others the order was reversed, i.e. the transitive was the prime and its unaccusative counterpart was the target (henceforth: TU pairs).

Experiment 1

Methods

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.

Stimuli

The experiment included three conditions: an experimental condition, a phonological control condition and a non-word filler 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 (for some details regarding the morpho-phonology of the Hebrew verbal system see the section titled “Counter-balancing of morpho-phonology and frequency of occurrence” presented immediately below). Unaccusatives were identified based on two Hebrew unaccusativity diagnostics: modification by a possessive dative and simple inversion (Borer and Grodzinsky 1986; Meltzer and Siloni 2013; Reinhart and Siloni 2005; Shlonsky 1997), as demonstrated in (9) and (10):

(9) 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)

(10) 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

Counter-Balancing of Morpho-phonology and Frequency of Occurrence As the subject matter of this empirical examination is the relationship between abstract structural representations, as opposed to relationships between morpho-phonological forms, it was important to counterbalance morpho-phonology between the two levels of the experimental condition.

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 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, it is necessary and actually possible to defuse the factor of morpho-phonology and exclude it from biasing performance. Accordingly, 12 of the 34 experimental pairs 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).

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 <http://word-freq.mscc.huji.ac.il/index>, Wilcoxon signed rank test $W(24) = -74, p = 0.3$.

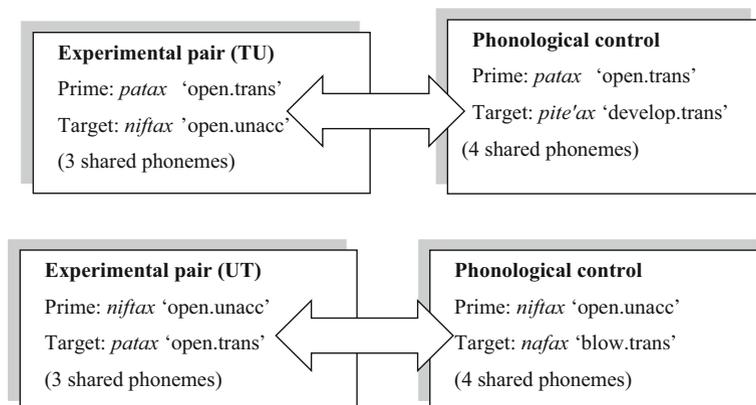


Fig. 3 Two experimental pairs and their corresponding phonological control pairs

Pretest for Basic RTs In order to unequivocally rule out the target verbs' morpho-phonology, frequency of occurrence, argument structure (number of arguments) or any other idiosyncratic feature as potential confounds, a pre-test which measured basic RTs to the unaccusatives and the transitive verbs was performed on a separate group of 30 adults (16 females, 14 males, age range 23–40, mean age: 29.53). Participants were randomly divided into two groups of 15 members, each presented with a different list of items. Each participant encountered 136 words: 17 unaccusative verbs; 17 transitive verbs; 34 filler verbs and 68 non-words structured to resemble Hebrew verbs. The composition of each list maintained the following rule: the eventualities appearing in list 1 in the transitive diathesis appeared in list 2 in the unaccusatives diathesis and vice versa. The pretest was constructed and run using E-prime 2.0 and an HP mini 10.1 inch screen net-book. The words and non-words were visually presented to speakers one after the other in a random order. 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 appeared on the screen and press 1 if it exists and 0 if it does not.

A *t* test for correlated samples comparing average RTs for the transitive and unaccusative verbs calculated by item did not find performance to be different, unaccusative mean = 756.60 ms, SD = 92.41 ms versus transitive mean = 763.95 ms, SD = 78.9 ms, $t(33) = 0.36$, $p = 0.72$. A comparison of averages calculated by participant revealed the same pattern of performance, *t* test for correlated samples $t(29) = 0.61$, $p = 0.545$.

Average lexical decision times were therefore also controlled in experiment 1, as transitives and unaccusatives did not differ with regard to this factor.

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 unaccusative and transitive manifestations of the same eventuality, 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 of the control pairs were chosen to duplicate only the phonological relation between the experimental prime and experimental target. Accordingly, control targets shared with the prime a similar number of phonemes as the experimental target did, but denoted an unrelated eventuality. Figure 3 demonstrates how phonological control items were chosen to match the TU and UT versions of the experimental stimulus pair denoting the eventuality of 'opening'. Notice that even though *patax* 'open.trans' and *piteax* 'develop.trans' also 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’.

The Non-word Filler Condition The non-word filler condition consisted of 68 randomly chosen Hebrew verbs paired with 68 non-words composed in the form of Hebrew verbs. For the full list of stimulus items see “Appendix 1”.

Design

The structure of the experimental design was inspired by the work of Frost et al. (1997, 2000a, b). A Latin square was utilized to create two lists, each consisting of 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.

The 17 experimental pairs which appeared in TU order in the first list appeared in UT order in the second list, and vice-versa. Phonological control stimulus items were featured in the list that did not include 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. Participants were randomly assigned to two groups, such that 18 participants completed each list.

Procedure

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

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 was a word and 0 if it was 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 commenced. The 136 quasi-randomly ordered experimental, control and filler prime–target pairs appeared immediately afterwards.

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

Results

A *t* test for correlated samples comparing RTs in the case of transitive–unaccusative prime–target combinations with average RTs in the case of unaccusative–transitive prime–target combinations calculated by item revealed a significantly faster performance when the prime was a transitive and the target was an unaccusative, TU mean = 685.19 ms, SD = 66.44 ms versus UT mean = 721.78 ms, SD = 106.89 ms; $t(33) = 2.44, p = 0.02$. A comparison of averages calculated by participant revealed the same pattern of performance *t* test for correlated samples $t(35) = 2.64, p = 0.012$ (Fig. 4).

In addition, RTs for the experimental stimulus items were significantly faster than RTs for the phonological control pairs, experimental mean = 702.69 ms, SD = 91.9 ms versus control

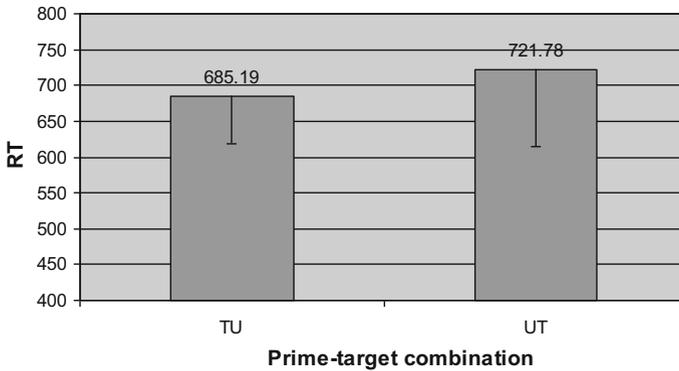


Fig. 4 Experiment 1: mean RT per prime–target combination (*error bars* represent standard deviation calculated by item)

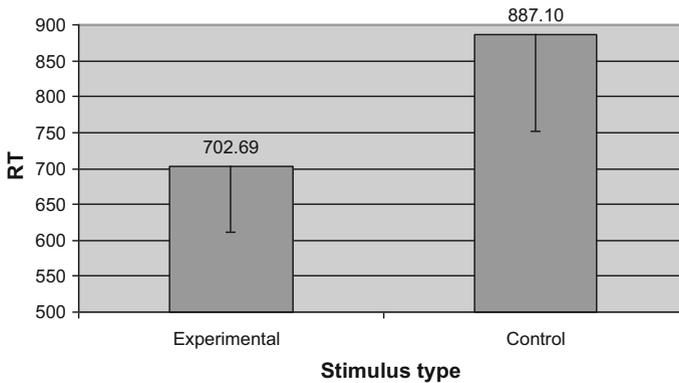


Fig. 5 Experiment 1: mean RT by stimulus type (*error bars* represent standard deviation calculated by item)

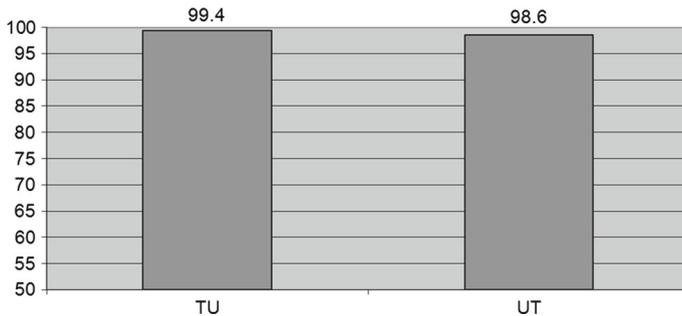


Fig. 6 Experiment 1: mean percentage of accuracy per prime–target combination

mean = 887.10 ms, SD = 135.2 ms, *t* test for correlated samples by item: $t(67) = 9.9$, $p < 0.001$, by participant: $t(35) = 12.64$, $p < 0.001$ (Fig. 5).

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% versus UT mean = 1.4%, SD = 2.7%; *t* test for correlated samples by participant: $t(35) = 1.8$, $p = 0.17$, by item: $t(33) = 1.4$, $p = 0.165$ (Fig. 6).

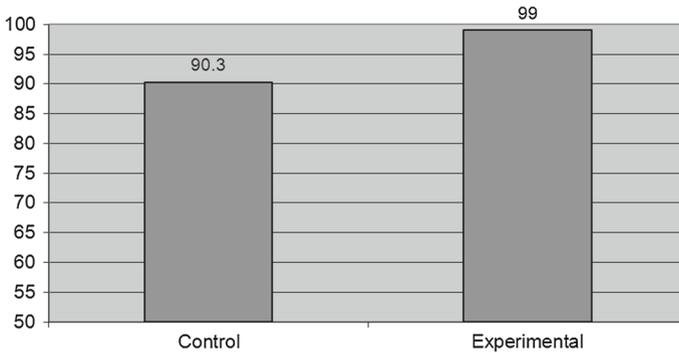


Fig. 7 Experiment 1: mean percentage of accuracy by stimulus type

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 by participant: TU versus control: $t(35) = 8.02$, $p < 0.001$, UT versus control: $t(35) = 7.85$, $p < 0.001$, by item: TU versus control: $t(33) = 3.36$, $p = 0.0019$, UT versus control: $t(33) = 3.5$, $p = 0.0013$ (Fig. 7).

Discussion

The RT patterns observed in experiment 1 reveal an asymmetry between the facilitation effects of unaccusatives and transitives: transitive primes are better at facilitating the lexical retrieval of their corresponding unaccusatives than unaccusative are at facilitating the lexical retrieval of their corresponding transitives. In addition, the significant difference found between RTs to transitive–unaccusative pairs and RTs to their matched phonological control pairs, indicates that the relationship between transitive and unaccusatives is not a purely phonological one.

As asserted above, this type of performance pattern is consistent with models which view the relationship between the two diatheses as directional. However, before we can conclude that this is indeed the nature of the transitive–unaccusative alternation, an important aspect of this relationship 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 and Siloni 2005; among others). For example, (11)a, which asserts that the wind rolled the ball, entails (11)b, which asserts that the ball rolled:

- (11) 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 propositions which contain 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 this sort of scenario, then, it is the truth conditional semantics associated with the use of the verbs that influenced speakers' performance, rather than the abstract representational or structural relationship this study aimed to tap into.

In order to examine the potential relevance of truth-conditional entailment for this particular task, a follow-up experiment examined pairs of verbs that exhibit the entailment relationship described above but are not derivationally related. 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.

Experiment 2

Methods

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.

Stimuli

Participants were presented with three types of stimulus items: an experimental condition, a control condition and a non-word filler 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. Morpho-phonologically 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 a discussion of the various aspects of this phenomenon, see Aronoff 1976; Embick and Marantz 2008; Parsons 1990).

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

Finally, in this case as well, morpho-phonological complexity and frequency of occurrence were balanced between entailing and entailed verbs, $W(24) = 87$, $p = 0.215$.

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

The Non-word Filler Condition The non-word filler condition consisted of the same non-word stimulus items used in experiment 1.

For the full list of stimulus items see “Appendix 2”.

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 Latin square was utilized to create two lists: the 17 experimental pairs featured in the first list in entailing–entailed order were featured in the second list in entailed–entailing order, and vice-versa. Since there was no specific correspondence between control and experimental items, both lists included the same control pairs.

Procedure

The procedure was identical to that of experiment 1.

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 by item did not find participants’ performance to be different, entailing–entailed mean = 723.77 ms, SD = 169.67 ms versus entailed–entailing mean = 723.99 ms, SD = 170.66 ms, $t(33) = 0.008$, $p = 0.99$. A comparison of averages calculated by participant revealed the same pattern of performance, *t* test for correlated samples $t(29) = 0.013$, $p = 0.98$ (Fig. 8).

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 versus control mean = 707.06 ms, SD = 128.43 ms, *t* test for correlated samples by participant: $t(29) = 1.32$, $p = 0.2$. *t* test for independent samples by item: $t(66) = 1$, $p = 0.32$.

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 by participant: $t(29) = 0.8$, $p = 0.42$, by item: $t(33) = 0.43$, $p = 0.0.67$. 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 by participant: entailing–entailed versus control: $t(29) = 1.52$, $p = 0.14$, entailed–entailing versus control: $t(29) = 0.68$, $p = 0.5$, *t* test for independent samples by item: entailing–

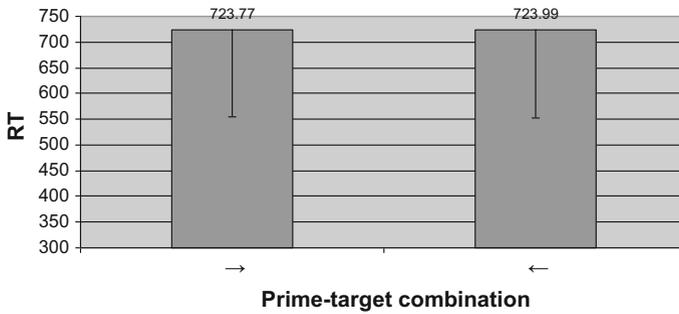


Fig. 8 Experiment 2: mean RT by prime–target combination (*error bars* represent standard deviation calculated by item)

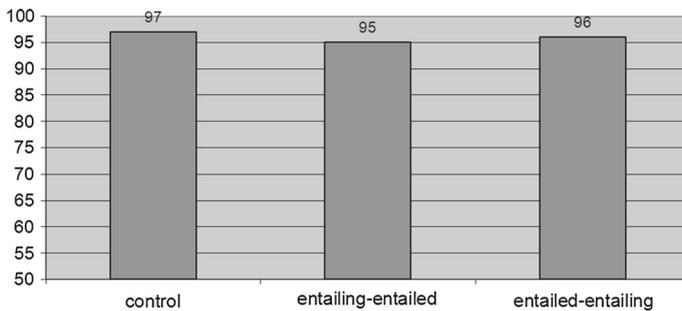


Fig. 9 Experiment 2: percentage of accuracy by stimulus type

entailed versus control: $t(66) = 0.643$, $p = 0.522$, entailed-entailing versus control: $t(66) = 1.05$, $p = 0.29$ (Fig. 9).

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.

General Discussion: Facilitation Asymmetry and Directionality

The performance patterns observed in experiments 1 and 2 are 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 and the source of this effect is not phonological closeness or semantic entailment. As mentioned above, the current study takes this asymmetry to suggest that the derivational relationship between these two diatheses is directional rather than non-directional.

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 ways:

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

The study presented above was designed with the aim of gaining insight into how the relationship between the two diatheses is reflected in speakers' performance on a task which demands the processing of both. It asked the following question: are the facilitation effects transitives and unaccusatives have on the retrieval of their counterparts similar or different? The results of experiments 1–2 provide a clear answer to this question: the facilitating effect that transitives have on the retrieval of unaccusatives is greater than the facilitating effect unaccusatives have on the retrieval of transitives.

As asserted above, this asymmetry is taken here to indicate that there is a directional relationship between the two diatheses, i.e. that one of them is basic and the other one is derived as suggested by directional analyses of this alternation.

Given that, another question arises: is there a way to determine whether the direction of this derivation is unaccusative-to-transitive or transitive-to-unaccusative?

The Direction of the Derivation: Hypotheses and Future Research

A priori, there are two opposite ways to interpret the superior facilitation effects of transitives in the context of the transitive–unaccusative alternation: it could be the on-line manifestation of transitives being the basic alternates from which unaccusatives are derived or, in contrast, the on-line manifestation of transitives being derived from unaccusatives.

In what follows, two opposite hypotheses which assume that derivational relationships are reflected in speakers' perception, the *ICE (Input Contextual Effect) Hypothesis* and the *Output Hypothesis*, are considered. Each of these hypotheses postulates a different facilitation effect: the ICE hypothesis predicts that basic alternates would be better facilitators than derived alternates while the Output Hypothesis predicts that outputs would be better facilitators. As will be discussed below, even though more research is needed to determine between the two hypotheses, it seems that there are some reasons to prefer the ICE Hypothesis over the Output Hypothesis.

The first hypothesis regarding the on-line manifestation of derivational directionality attributes superior facilitation effects to basic alternates and states the following:

(12) ICE (Input Contextual Effect):

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, or mentally represented as derived from 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.

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.

Accordingly, under the assumption of ICE, the performance patterns observed in experiments 1–2, suggest that unaccusative verbs are derived from their transitive counterparts.

The second hypothesis regarding on-line manifestation of derivational directionality that will be considered here attributes superior facilitation effects to derived alternates and states the following:

(13) 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, then, 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; more accessible than the derived alternate would be after a previous retrieval of the basic one. 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. However, it appears that there are some reasons to discard this hypothesis in the context of unaccusative-to-transitive analyses.

First, it seems that an Output-Hypothesis based interpretation of the current study's findings as consistent with unaccusative-to-transitive directionality would have to involve the assumption of a processing mechanism that is not independently justified. As described above, 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 10 illustrates this structural relationship:

As a result of the fact that unaccusative-to-transitive models analyze this derivational relationship as occurring in syntax, any analysis of the observed asymmetry in facilitation patterns in view of this type of model, whether ICE hypothesis or Output Hypothesis driven, would assume that this asymmetry is the result of structural (syntactic) priming (Bock 1986; Branigan et al. 2000; Loebell and Bock 2003; among others). Specifically, an Output Hypothesis driven analysis of this asymmetry would suggest that transitives were better at syntactically priming unaccusatives than vice versa since the lexical retrieval of the prime already required the computation of the embedded unaccusative tree fragment. As a result, once the transitive

Fig. 10 Unaccusative-to-transitive approaches: unaccusative VP is embedded under a transitive vP

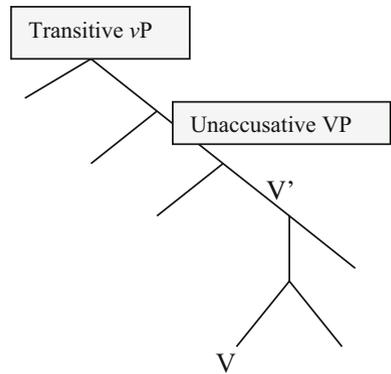


Fig. 11 The Output Hypothesis: extraction of an already computed VP

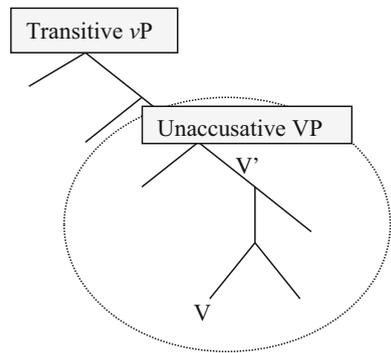
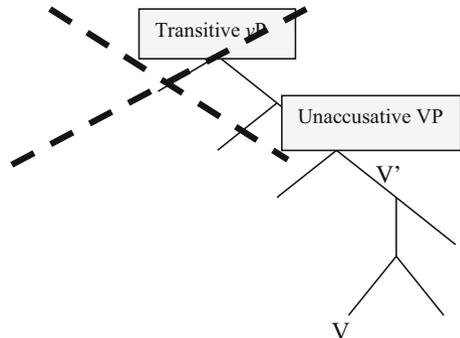


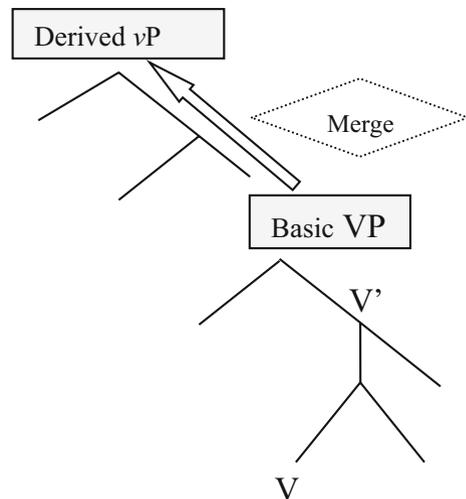
Fig. 12 The Output Hypothesis: removal of excess structure



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 Fig. 11, only required the extraction of an already computed structural fragment:

Note that 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, in addition to the well-justified assumption of structural priming, the assumption of a processing mechanism which, as demonstrated in Fig. 12, is capable of removing the top of the structure to reveal the ready-made representation of the unaccusative form.

Fig. 13 The ICE Hypothesis: a completion of the derivation via 'merge'



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 unaccusative-to-transitive models, this means that, as demonstrated in Fig. 13, a previous computation of the syntactic structure associated with the basic alternate would have a greater structural priming effect on the retrieval of the derived one than vice versa. This is since once the basic structure has been computed, a retrieval of the derived one would not have to involve a computation of its structural representation 'from scratch', but would only require a completion of the derivation, namely the merging of additional functional head(s) on top of the already computed structure.

Therefore, 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). This is a basic structure-building operation that takes computed structures and combines them with other elements into new ones, which is also assumed in psycholinguistic literature (see Ferreira 2000 and references cited therein). Whereas, in contrast, the branch-removing mechanism the Output Hypothesis would assume in view of unaccusative-to-transitive approaches, seems not to be independently motivated.

In addition, viewing the branch-removing process demonstrated in Fig. 12 as facilitating speakers' performance better than adding elements to an existing structure (i.e. 'merge') does, would be incompatible with the processing difficulties speakers are recurrently observed to experience when required to perform structural reanalysis (Altmann et al. 1992; Ferreira and Clifton 1986; Ferreira and Henderson 1991; Frazier 1987; Frazier and Rayner 1982; Pritchett 1988, 1992; among others).

It seems then, that the ICE hypothesis is more compatible, in principle, with the unaccusative-to-transitive view than the Output Hypothesis. Hence the latter appears to be less suitable for determining the validity of proposed unaccusative-to-transitive approaches than the former. Nevertheless, in order to conclusively decide between these two hypotheses, further research needs to be conducted.

One possibility is to examine speakers' performance with regard to verbal alternations for which directionality is not at debate. Suitable stimuli for such an examination would be the derivational relationships between transitive verbs and their corresponding reflexives and

verbal passives demonstrated in (14) a–c:

- (14) 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 2004; Reinhart and 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 (*hitlabša*) than vice versa. If derived alternates are better facilitators, on the other hand, the opposite performance pattern is predicted to emerge.

Summary and Conclusion

The results of experiments 1 and 2 presented above revealed an asymmetry between the facilitating effects of unaccusative verbs and their transitive counterparts. Transitive verbs were better at facilitating the lexical retrieval of the corresponding unaccusatives than vice versa. As discussed, this asymmetry suggests that the relationship between the two diatheses is directional, hence inconsistent with non-directional root-based analyses of the transitive–unaccusative alternation. Given that, two possible and opposite interpretations of the results with regard to the specific direction of the derivation were compared. A future study, targeting alternations for which the direction of the derivation is at consensus, was further suggested as a possible means of deciding between these two interpretations.

In addition, the significant difference found in this study 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 an abstract representational relationship between these diatheses, thus demonstrating psychological reality for the assumption of a derivational relationship between them.

Apart from providing a glimpse into speakers' perception of the transitive–unaccusative alternation, the 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 for Hebrew speakers, the facilitation effect of transitive verbs is better than that of unaccusatives. This performance pattern is an indication that the methodology described above 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.

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Appendix 1: Verbs Used in Experiment 1

Experimental condition

Transitive	Unaccusative	No. of shared phonemes (NSP)	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	grew
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)
heni'a	na	2	moved
hirtit	ratat	2	vibrated
Simplex–simplex			
kiba	kava	2	turned-off
Šikex	Šaxax	3	alleviated
hidlik	nidlak	4	turned-on
Complex–complex			
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	NSP	Experimental NSP—control NSP ratio	Prime	Target	NSP	Experimental NSP—control NSP ratio
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	1.3333333	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 'appeared'	2	1	he'if	afa 'baked'	2	1
gavar	hivrig 'screwed'	3	0.6666667	higbir	higiv 'responded'	3	0.6666667
hiv'ir	hebi'a 'expressed'	2	0.5	ba'ar	her'iv 'starved'	2	0.5
na	ne'ena 'got-answered'	2	1	heni'a	ana 'answered'	3	0.6666667
ratat	hetir 'allowed'	2	1	hirtit	yiret 'intercepted/shot-down'	3	0.6666667
kiba	baka 'got-cleaved'	3	0.6666667	kava	nikva 'pooled'	3	0.6666667

Prime	Target	NSP	Experimental NSP—control NSP ratio	Prime	Target	NSP	Experimental NSP—control NSP ratio
Šaxax	ninŠax 'got-bitten'	3	1	Šikex	xaŠak 'desired'	4	0.75
hidlik	nilkad 'got-trapped'	4	1	nidlak	hiklid 'rusted'	4	1
nixŠal	nixeŠ 'guessed'	3	1	hixŠil	hexiŠ 'speed-up'	4	0.75
ne'eram	hitna'er 'shaked-off'	4	1	he'erim	hi'ir 'waked'	4	1
nifsak	fiksas 'faxed'	4	1	hifsik	hikif 'orbited'	4	1
hirtiv	hitiv 'made-well'	4	1	nirtav	viter 'gave-up'	4	1
he'elim	ho'il 'availed'	4	1	ne'elam	hil'im 'made-vanish'	4	1
hixxid	nidxa 'rejected'	3	1	nixxad	hidi'ax/hedi'ax 'rinsed'/'dismissed'	3	1
nexlaŠ	hiŠlix 'tossed'	3	1	hixliš	hexil 'implemented'	4	0.75
	Average	3.265	1.04			3.35	0.99

Appendix 2: Verbs Used in Experiment 2

Experimental condition

Transitive	Intransitive	
Complex–simplex		
hix'is	ragaz	'got-angry'
hitbi'a	Šaka	'drowned'
hiŠtik	nadam	'got-silent'
he'if	na	'moved'
hiv'it	yara	'feared'
hicit	ba'ar	'burned'
herkid	zaz	'moved'
hexliš	rafa	'got-limp'
hidgiŠ	balat	'got-prominent'
hirciz	ka'as	'got-angry'
heni'a	zaz	'moved'
Complex–complex		
hidhim	hitrashem	'got-impressed'
hirciz	hit'acben	'got-irritated'
higŠim	hitnameŠ	'realized'
he'ir	hikic	'wakened'
hircil	histagel	'habituated'
hitiŠ	hit'ayef	'got-tired'
hitmiha	hitpale	'wondered'
hiv'ir	hitlahet	'heated'
hifxit	hitma'et	'diminished'
hishpric	nitaz	'got-sprayed'
Simplex–simplex		
cimcem	paxat	'decreased'
Šamat	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

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