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DIFFERENTIAL PROCESSING IN KOREAN NEGATION

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An embodied view of language processing proposes that to understand negation, hearers construct a simulation of the counterfactual situation. This paper examines how the syntax of negation constrains its understanding a through visual simulation paradigm. The particular question under investigation is whether up- or down-associated visual imagery of negated verbs is activated when the verbs are preverbally or postverbally negated in Korean. The two main findings are: (1) negation induces a facilitatory effect during visual simulation; and (2) this effect is observed only when the negator follows the verb. We interpret these findings as evidence that a preverbally negated verb in Korean is processed as an affix-like negation, which doesn't necessitate access to the affirmative verbal counterpart. They show that the syntax of negation further constrains negation simulation, and also suggest that negation may not necessarily be accessed exclusively via affirmation, contrary to previous assertions.

1. INTRODUCTION. Language comprehension theories have debated what sort of representation is involved in language understanding in general. Traditional amodal theories of language comprehension claim that sentences are encoded in an abstract symbolic propositional format that incorporates semantic features, and that language understanding therefore involves the construction of propositional symbolic representations. In this theory, sentences like *The donkey ascended* are represented as symbolic propositions, which are made up of an argument and a one-place predicate. This classical theory is disembodied in the sense that the sensorimotor system, bodily functioning and the brain play no role in language processing (Lakoff and Johnson 1999:102).

Contrary to the traditional view, recently developed embodied views of language understanding have proposed that language is associated with concrete perceptual or motor experiences and that these experiences are recreated through imagery during language understanding (Barsalou 1999, Glenberg and Robertson 2000, Bergen and Chang 2005). In this embodied view, sentences like *The donkey ascended* are encoded as modal representations, which contain detailed information about perceptual or motor input as it would be perceived or executed in interactions with the world. This model hypothesizes that understanding language involves the creation of mental simulations, i.e., constructing (or simulating) a detailed perceptual-motor representation of the event being described.

How negation is understood has been a challenge to both models. What is it that we understand when we read a sentence like *John didn't leave* out of context. How do we get to the intended factual concept? A well-received view in the literature has been that understanding negation entails affirmation, and that negation is psychologically accessed via the counterfactual affirmative counterpart. That is, processing a negated sentence initially yields a representation of the counterfactual situation – the affirmative statement being negated – and then yields activation of the factual scenario – what is actually claimed to be true. This idea was motivated by the hypothesis from philosophy and linguistics that a negative statement is relatively marked or complex with respect to its affirmative counterpart ontologically and epistemo-

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logically (see Horn 1989, chapter 1). A comparable idea is found in Langacker's (1991) characterization of negation as a complex structure having a potential counterfactual structure and an active negated counterpart (Hasson and Gluksberg 2004:4). Similarly, Fauconnier's (1994:96) mental space theory posits that "negatives set up corresponding counterfactual spaces in which the positive version of the sentence is satisfied" (Hasson and Glucksberg 2004:4).

Experimental evidence from psycholinguistic research has demonstrated that negation poses a processing burden, and negative statements are harder to verify than their affirmative counterparts (Just and Carpenter 1975, and Mayo et al. 2004, among others). In addition, converging evidence has demonstrated that the affirmative meaning is initially activated and later decreased in understanding negation (MacDonald and Just 1989, Just and Carpenter 1976, Giora, Balaban, Fein, and Alkabets 2004, and Hasson and Glucksberg 2006, among others).

The two opposing models of language comprehension converge on this assumption that the counterfactual (affirmative) situation is initially accessed in understanding negation. The two models differ, however, with respect to the form representing the counterfactual situation involved in negation comprehension. According to the formal-logical model, readers construct a linguistic propositional representation. In this propositional representation, a negative operator NOT is explicitly encoded as a one-place, truth-functional connective, which takes scope over the whole affirmative clause. For instance, the sentence *John didn't leave* is represented as the falsity of the thought that John left, as in *not [John left]*. Therefore, readers initially activate the propositional counterfactual representation *[John left]* and then perform a negative mental operation on it, shifting its truth value.

On the other hand, in the simulation model, readers construct a perceptual representation of the counterfactual situation encoded in a detailed modal or experiential format. In this perceptual representation, the negator NOT is no longer explicitly represented, since it is implausible that we simulate the falsity of a certain concept. The negator is "implicitly" represented in the two simulation processes that are undertaken when comprehending a negative sentence—a simulation of the described counterfactual situation and then a simulation of the factual situation (Kaup et al. 2005). Recently, simulation-based studies of negation understanding showed that perceivers initially construct the counterfactual simulation and then factual simulation (Kaup et al. 2005). In addition, Tseng, Kim, and Bergen (to appear) found a facilitation effect during comprehension of negated English intransitive sentences involving up- or down-motion verbs. This is interpreted to mean that the directionality embedded in motion-related verbs (e.g., up or down movement) is initially simulated when comprehending these negated verbs.

Clearly, both the simulation and amodal models have provided many experimental studies examining whether the affirmative counterpart is activated in comprehending negation. However, both models provide few experimental studies to show how the syntax of negation affects the processing or simulation of negation. Interestingly, natural languages allow similar contents to be linguistically encoded in a distinctive structure of negation. For instance, English allows similar contents to be negated in either verbal or nominal negation (e.g., *John had no books* versus *John didn't have any books*). Korean permits the same verbal contents to be negated in two distinctive forms, where the same negator precedes or follows the negated verb (e.g., *Neg-bought* versus *buy-suffix Neg-did*). It is thus expected that distinct linear order (Neg-Verb versus Verb-Neg) and their structural differences will affect how perceivers access the affirmative verbal contents. Obviously, the question then arises as to how the two forms of negation would affect perceivers' access to the counterfactual representation. This paper examines how the syntactic form of negation constrains the mental simulation of negation using the two forms of Korean negation. Before presenting this research, a brief overview of the relevant literature on the processing of negation is provided.

2. PREVIOUS STUDIES OF NEGATION UNDERSTANDING. In the psycholinguistic literature on the processing of negation, two contrasting models have been proposed under the hypothesis that perceivers initially access the counterfactual representation in comprehending negation. The model described as *Negation-As-Tag* claims that the understanding of negation involves constructing only the counterfactual model, and then a negative tag is merely attached to the counterfactual representation. Supportive evidence for this

model comes from the observation that the negative tag may be lost and only the counterfactual representation is retained (i.e., you hear "Don't come at 5 p.m." and you remember "Come at 5 p.m.") (Mayo et al. 2004:434-35).

The model described as *From Counterfactual to Factual*, by contrast, suggests that the understanding of negation leads to the construction of two explicit mental representations—one corresponding to the counterfactual situation, which is said not to occur, and another corresponding to the factual situation, which actually happened. This model is further divided between whether these two representations can be processed sequentially or in parallel, and whether the initially constructed counterfactual representation is completely suppressed or retained. In an on-line processing experiment, Hasson and Glucksberg (2006) demonstrated that two representations are processed sequentially, with the initial counterfactual representation suppressed. On the other hand, the discourse-based off-line studies of Giora, Balaban, Fein, and Alkabets (2004) showed that two representations are processed in parallel with the initially constructed counterfactual representation still retained in our conception (Giora 2003, Giora and Fein 1991a, Giora and Fein 1991b).

The two psycholinguistic models of negation comprehension demonstrated the activation of the affirmative concept in negated statements in the two forms of negation—NO-type nominal negation and NOT-type verbal negation. In the studies of NO-type negation, the probe word or nonword naming task by MacDonald and Just (1989) found that in a sentence like *Almost every weekend Elizabeth baked some bread, but no cookies,* the negated concept (cookies) was initially activated but no longer accessible 1000 msec after presentation. In addition, Kaup (2001) found that the accessibility of the noun is determined both by negation and also by whether the noun is present or absent. The reaction time for the negated/absent nouns (i.e., *no cookies* in *Mary bakes some bread but no cookies for the children*) was much slower than for negated/present nouns (*not the photographs* in *She burned the old letters but not the photographs*) at a 2500 msec ISI (Inter-Stimuli Interval).

The accessibility of the affirmative concept has been more widely demonstrated in a Not-type verbal negation sentence, through various methods and tasks. The verification task using eye-tracking method by Just and Carpenter (1975) found that subjects, upon hearing *is not north*, focused on the *north* rather than the *south*, implying that subjects first accessed the affirmative assertion embedded within the negator phrase. The lexical decision task using self-paced reading by Giora et al. (2004: Experiment 1) demonstrated that participants, when presented with sentences like *The instrument is sharp* or *The instrument is not sharp*, took comparable reaction times to make a lexical decision of the affirmative related target words (*piercing*), as compared to the unrelated target words (*leaving*). A recent on-line lexical decision study by Hasson and Glucksberg (2006) further found that negation in metaphorical positive or negated statements (e.g., *The kindergarten is a zoo/not a zoo*) increased the accessibility of terms related to the affirmative meaning (*noisy*) before 500 msec ISI, while the terms related to the factual representation (*calm*) were available later at the 1000 msec ISI.

The simulation model also provided evidence for the counterfactual simulation in both NOT-type negation and NO-type negation. A picture-identification task by Kaup et al. (2005) demonstrated that negation understanding involves transient changes of two simulations over time (from counterfactual to factual). Participants were visually presented with sentences of the form *The X is (not) above/below the Y*, followed by pictures of two objects, one above the other. The participants' task was to decide quickly whether both of the depicted objects had been mentioned in the sentence. The result found a match effect relative to the onset-delay of the picture presentation: picture identification was facilitated when the picture matched the negated counterfactual simulation in the short delay (0ms), whereas in the long delay condition (1500ms), a match effect was obtained with regard to the factual situation.

Another picture-identification task by Kaup et al. (to appear), based on the design in Zwaan et al. 2002, tested negated existential sentences such as *There was no eagle in the sky/in the nest* and *The eagle was not in the sky/in the nest*. Pictures of an eagle with outstretched or folded wings followed the sentences. The participants' task was to read the sentences and then decide whether the pictured object that followed had been mentioned in the preceding sentence. The results showed that response times were faster when the picture matched the shape of the object that was implied in the counterfactual situation

that was being negated, suggesting that perceivers constructed a simulation of the counterfactual event when understanding those sentences.

A brief note should be made on the nature of the task at this point. Recently, researchers are more and more concerned about the nature of the task involved in examining the understanding of negation. The activation of the counterfactual situation and the effects of negation on comprehension, as surveyed by MacDonald and Just (1989:633), tended to be investigated in tasks involving the component of verifying truth values. Using tasks involving truth-value verification is open to criticism, due to the nature of their task-imposed processing demands. Tasks involving verification require subjects to compare relevant propositions to determine their truth values and therefore to construct the internal representations to which negation can be applied. The tasks involving verification therefore tend to examine higher-level comprehension processes that require relatively deep semantic processing rather than normal language processing. To overcome this task-imposed processing aspect, MacDonald and Just (1989) proposed to use a probe-recognition or naming task.

Like psycholinguistic researchers, researchers working within the theory of simulation are also cautious about using tasks involving verification. This is because they could trigger conscious invocation of mental imagery, and any negation effects obtained from such tasks would argue against the fundamental simulation hypothesis that mental simulation is "routinely" and "automatically" involved in sentence processing (Kaup et al. 2005). Out of this concern, Kaup et al. (2005) examined simulation in negation by adopting a *picture-identification task*, where the subjects' task was simply to identify whether the presented pictures were mentioned in the preceding sentence or not. A concern still remains as to whether such a picture-identification task can successfully reduce perceivers' semantic processing, because subjects might be directed to think consciously about the semantic content of the presented sentences and subsequently verify the picture against the sentence when they identify it.

A recent simulation-based study by Tseng, Kim, and Bergen (to appear) adopted a less overtly semantic task, a *visual object categorization task*, in order to explore negation simulation in English sentences containing intransitive motion verbs that have been negated. This task was originally used in Richardson et al. 2003 and adopted in Bergen et al. (to appear). In the latter study, for example, participants were first presented with aural sentences composed of nouns and verbs with either upward or downward directional meaning (e.g., *The sky darkened* (up-noun); *The ground shook* (down-noun); *The lizard ascended* (up-verb); *The cat descended* (down-verb)). Then, the sentences were followed by a visual object (circle or square) in either the upper or lower quadrant of the visual screen. This location might or might not match the direction implied by the preceding sentence. The participants' task was to decide as quickly as possible whether the object was a circle or a square. Therefore, in performing this visual object categorization task, subjects were not readily induced to think consciously about the contents of the sentence. With this design, any interactive simulation effect between semantic directionality and visual object location would not come from the task-imposed interpretation of sentence meaning. What Bergen et al. (to appear) found was that visual imagery is triggered by up- and down-related nouns and verbs in intransitive (positive) sentences (like *The roof* (up-noun) *creaked*, *The cellar* (down-noun) *flooded, The glass fell* (down-verb) and *The dolphin soared* (up-verb)), interfering with the following up and down visual perception (at 200 ms ISI).

Tseng et al. (to appear) adopted Bergen et al.'s (to appear) method to examine whether mental simulation is engaged in comprehending negated intransitive sentences. Tseng et al. tested whether the same up- or down-related nouns and verbs used in Bergen's study would trigger visual imagery, when embedded in negated sentences (like *The cellar* (down-noun) *didn't flood*, *The roof* (up-noun) *didn't creak*, *The glass didn't fall* (down-verb), *The dolphin didn't soar* (up-verb)). Tseng et al. hypothesized that comprehending those up- or down-related negative sentences would still engage up or down visual interaction effects, especially in the early counterfactual simulation stage, where the affirmative content is accessed. In the later factual simulation stage, however, it is hypothesized that no visible simulation effect would occur, since no explicit information about the factual content is given in their sentence stimuli. With combined results, they further aimed to capture a simulation transition from the counterfactual to the factual by testing the same task at three time courses (0ms, 200ms, and 500 ms ISI).

The results showed that for negated subject-noun sentences (*The cellar didn't flood*), a significant (facilitation) interaction effect was found, in which visual object identification was faster when the object location matched the location indicated by a subject noun at all three ISIs. For negated verb sentences (*The glass didn't fall*), the facilitation effect only approached significance at all three ISIs.

The overall results indicate that perceivers accessed the up- or down-related affirmative counterfactual contents in comprehending negated intransitive motion-related sentences, facilitating the following visual object identification in the same directionality. This facilitation effect observed in negated up- or down-related sentences was opposite to the interference effect observed in the up- or down-related positive intransitive sentences in Bergen et al. (to appear). As for the source of such a facilitation effect in negated sentences, Tseng et al. claimed that subjects who understood negated sentences still attended to directionality in their mental simulations of the counterfactual contents, but they did not simulate a concrete image.[1] In other words, this compatibility effect is interpreted as the effect of perceivers' attentional focus upon the affirmative counterparts.

In sum, psycholinguistic or simulation-based studies of the understanding of negation have demonstrated that processing a negated sentence initially yields a representation of the counterfactual situation and then yields activation of the factual scenario. The two models, however, critically differ in the nature of the representation: the psycholinguistic approach claims that the representation is in an abstract amodal propositional format, while the simulation-based approach claims that it is in a detailed modal format.

3. THE PRESENT EXPERIMENT. Previous studies investigated negation comprehension within various structures, such as negated copular (i.e., John *is not* tidy), negated noun (i.e., John baked *no cookies),* negated existential sentences (i.e., There *is no* eagle in the sky; The eagle *is not* in the sky), and negated intransitive motion-verb sentences (i.e., The dolphin *didn't soar*). One less studied issue is whether the syntactic form of negation would affect the understanding of negation, and if it did, then how the syntactic form of negation would constrain the path of understanding of negation. We have limited evidence on what types of syntactic negation yield what different sorts of processing. This matter is critical, since natural languages allow different negators to be embedded in different syntactic structures of negation. Moreover, a synonymous negated concept can be encoded in different syntactic forms. For instance, English can negate a synonymous proposition [buy a book] in a verbal NOT-negation, such as *John didn't buy any books* and also in a nominal NO-negation, such as *John bought no book*. Therefore, there arises the question of whether the two different negation forms would induce different sorts of processing. Would the nominal concept "book" be more likely to be activated in an implicitly negated noun (*any books*) rather than in an explicitly negated noun (*no book*)? This issue hasn't been investigated yet.

Korean negation forms pose an interesting test case for the current issue. In Korean, a synonymous verbal proposition is negated in two different constructions: preverbal negation, which places the negator before a verb, and postverbal negation, which places the same negator after a verb. The present study examines how the two syntactic forms of negation in Korean may affect the accessibility of the counterfactual content in comprehending negation. Within the simulation paradigm, we replicate the visual object categorization task from Tseng et al.'s English study (to appear). Our test sentences are either preverbally or postverbally negated intransitive sentences which include upward or downward directionality denoting verbs. The particular question under investigation is whether the up- or down-related visual imagery embedded in the verb can be activated in both patterns of negation, causing an interaction (facilitation) effect with the following up or down visual object perception. Two time intervals between sentence presentation and visual object presentation (0ms and 200ms) are used to capture the potentially different time course

[1] Bergen et al. argued that the inhibitory effect they observed resulted from (1) sentence processing and visual processing making use of overlapping neural resources, and (2) the simulation evoked by the sentences not being integratable with the visual stimulus. A possible explanation for this facilitation effect (contrasted with the inhibition found by Bergen) is that counterfactual scenes that are simulated in response to negated sentences are less detailed; this allows visual stimuli to be more easily integrated with those simulated scenes (for the mechanism which produces facilitation or interference in visual imagery experiment, see Kaschak et al. 2004).

with which listeners construct the initial counterfactual simulation in the two negation forms. Before the design is presented, a description of Korean negation is provided.

4. FACTS ABOUT KOREAN NEGATION. Korean is syntactically head-final and morphologically an agglutinative language. Korean has two ways of negating a verb. The negator *an* can precede or follow the verb that it negates, producing two forms, [Neg+V] and [V-suffix+Neg+Aux], respectively called "preverbal negation" and "postverbal negation." For an affirmative sentence (1a), both preverbal and postverbal negation forms are possible, as shown in (1b) and (1c), respectively. In the preverbal (or short) negation (1b), the negator *an* is placed before the main verb, which is inflected for tense and mood. In (1c), which is the postverbal (or long) negation, the same negator *an* follows the main verb. The main verb is in the invariant participle form with a complementizer *ci*, then followed by the negator *an* plus the auxiliary verb *ha-ta* 'do' (*an* Neg + *ha* 'do' is usually contracted into *anh*). This contracted negative auxiliary is then inflected for tense and mood. This makes the two forms differ in their length and structure.

(1) (a) Affirmative:
John-un ollaka-ss-ta
John-Topic ascend-Past-Decl
'John ascended'

(b) Preverbal (short-form) *an* negation:
John-un **an** ollaka-ss-ta
John-Topic Neg ascend-Past-Decl
'John didn't ascend'

(c) Postverbal (long-form) *an* negation:

John-un ollaka-**ci** **anh**-ass-ta
John-Topic ascend-Comp Neg-Past-Decl
'John didn't ascend'

In semantics, it has been at issue whether the two forms of negation differ in their meaning and in their pragmatic import. The early transformational-generative linguists argued that the two forms of negation are synonymous (see the summary in J. K. Kim 1996:24–27). But recent discourse-based studies recognize that the two forms of negation are not completely synonymous in their pragmatic implications, and the two negations in fact bear some pragmatic distinctions in their usage (McClanahan 1998, Kidong Lee 1993, J. K. Kim 1996).[2] Obviously, most native speakers of Korean sense that there are semantic and pragmatic differences between the two negation forms (J. K. Kim 1996:28). But no consensus exists on the nature of those pragmatic distinctions. One claim says that the preverbal negator *an* form is pragmatically associated with the speaker's strong volitional insistence not to do the denoted action, whereas such a volitional implication is not involved in the postverbal *an* negation (McClanahan 1998). Another claim says that the postverbal negation bears more pragmatic ambiguity, since it has an extra morpheme *-ci* associated with "presuppositional" implication (Kidong Lee 1993).

The two negation forms differ with respect to their formality as well. Choo and Kwak (in press) report that the preverbal form is more direct and therefore more colloquial and informal, while the postverbal form is less direct and is more frequently used in formal writing. One last difference between the two negation forms is their distributional property. It is known that the preverbal negator is restricted in its distribution: it tends not to occur with a verb of relatively many syllables, and never with a denominal verb from the lexicon of Chinese loanwords. The postverbal negation, by contrast, exhibits no such distributional constraints, since it can occur with any verbs.

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[2] A debated issue among Korean linguists has been over whether the two negations differ from each other in the scope of negation and a universal quantifier: only postverbal negation exhibits scope ambiguity, or both types behave alike with respect to scope ambiguities (Kim Jong-Bok 1995:32, note 5).

5. METHOD. In examining the effects of two negation forms on the accessibility of the counterfactual simulation in Korean, this study extends Tseng et al.'s (to appear) study of English negated intransitive up- or down-motion verb sentences, replicating their visual object categorization task. The critical stimuli were controlled for the directionality of the verb. Twenty-four critical motion up or down verbs (12 up and 12 down) were selected. Subject nouns were manipulated so as not to entail any up or down meaning. The subject nouns were also topic-marked instead of nominative-marked, in order to ensure that only the verbal concept was likely to fall within the scope of the negator. Those 24 critical up/down verbs morphologically consisted of compound verbs, half of which were four-syllable and the other half of which were five-syllable verbs, in both up and down condition[3].

The set of 12 up and 12 down verbs were then embedded within two different patterns of negation. This produced four types of critical sentences: 12 preverbally negated up-sentences (2a), 12 postverbally negated up-sentences (2b), 12 preverbally negated down-sentences (2c), and 12 postverbally negated down-sentences (2d).

(2) **(a) UP preverbal *an* negation:**
Tangnakwi-nun **an** olla-ka-ss-ta
donkey-Topic Neg ascend-go-Past-Decl
'The donkey didn't ascend'

(b) UP postverbal *an* negation:
Tangnakwi-nun olla-ka-**ci** **anh**-ass-ta
donkey-Topic ascend-go-Suffix Neg-Past-Decl
'The donkey didn't ascend'

(c) DOWN preverbal *an* negation:
Ywulikhep-un **an** tteleci-ess-ta
Glass-Topic Neg fall- Past-Decl
'The glass didn't fall'

(d) DOWN postverbal *an* negation:
Ywuikhep-un tteleci-**ci** **anh**-ass-ta
Glass-Topic fall-Suffix Neg-Past-Decl
'The glass didn't fall'

We manipulated the syllable length of the subject noun to control for syllable length, resulting in all critical preverbal negative stimuli being of the same nine-syllable length and all critical postverbal negative stimuli being of the same twelve-syllable length.

In addition to 24 critical negated items, 76 filler stimuli were constructed. The filler sentences were also intransitive and mostly denoted spontaneous intransitive motion (i.e., *The ball rolled along*), but contained neither subjects nor verbs with an up or down implication. Among 76 fillers, 24 were preverbal negation versions, 24 were postverbal negation versions, and the remaining 28 were positive versions. All fillers were of the same length as target stimuli: positive fillers were eight syllables in length, preverbal negation fillers were nine syllables in length and postverbal negation fillers were twelve syllables in length. The overall ratio of positive to negative was 28:72.

This ratio with a larger number of negatives was necessary in order to counterbalance the number of up, down, right, or left visual object locations for negated sentences. To ensure that subjects attended to the meaning of the sentences, 15 filler sentences were followed by yes/no comprehension questions. Comprehension questions were constructed to encourage participants to pay attention to the meaning of the entire sentence and to whether it was positive or negative in order to give a correct answer (i.e., *The*

[3] Korean has only a small number of root verbs denoting up or down motion (i.e., *sot-ta* 'soar', *ttu-ta* 'rise', *o-lu-ta* 'ascend', *nay-li-ta* 'come down'), but it has a larger number of compound verbs that denote up or down motion.

stick is NOT warped. Was the stick straight? (Yes); The flag fluttered NOT. Was the wind quiet? (Yes); The leopard jumped. Did the leopard run away? (No)).

Since we tested the same 12 up and 12 down verbs in the preverbal or postverbal negation forms, 24 critical verbs were divided into two sets: each set contains half (6) up in the preverbal version, the other half (6) up in the postverbal version, half (6) down in the preverbal version, and the other half (6) down in the postverbal version. Two sets of critical stimuli were constructed into two lists with the same fillers. In each list, sentences were pseudo-randomized and ordered such that critical sentences would not occur in sequence. Each list was then repeated in a different pseudo-randomized order, producing two halves with an interval. This was in order to test the critical stimuli twice, once in the up-object and once in the down-object condition.

This is thus a within-subject design, where each subject saw each critical sentence twice (once in the up-object and once in the down-object condition). The two halves in each list were then switched to form an additional two lists varied between subjects, to reduce any effect of presentation order. These four lists were then tested at an ISI of 0 ms and an ISI of 200 ms, creating a total of eight lists. Each subject was randomly assigned to one of these eight lists. Halfway through the experiment, subjects were given the option of taking a five minute break. The experiment took between twenty to thirty minutes to complete. The subjects' task was to hear the sentence, see the shape, which would be up or down, decide if it was a circle or square, and press a button labeled "circle" or "square."

In sum, an experimental trial consisted of (1) a fixation cross (1000ms), (2) a negated or positive intransitive sentence (heard through headphones), (3) a variable ISI of either 0 ms or 200 ms, and (4) a circle or a square appearing in the top, bottom, left, or right quadrant of the screen (for 200ms), and (5) the subject's button-press response ("z" for circle, "x" for square). Subjects for the experiments were undergraduate or graduate students from several universities in Korea.

6 RESULTS

6.1 VERB NEGATION IN INTRANSITIVE SENTENCES: 0MS RESULT. 37 subjects participated—18 females and 19 males. One subject was eliminated due to having average means higher than 2.5 standard deviations from the mean across subjects. Two filler sentences (*The fish NOT fainted* and *The water current became smooth NOT*) were eliminated due to having average means higher than 2.5 standard deviations from the mean across items. One critical postverbally negated down sentence *The flea bounce-rise NOT* had an average mean (669.03 ms) higher than 2.5 standard deviations from the mean across items (633.39 ms), but it was not eliminated.

For preverbal negation (Neg1) at 0ms, a 2x2 repeated measures ANOVA by sentence condition and object condition found a significant main effect of verb condition (up or down), for subjects at $F_1(1,35)=9.354$, $p<0.01$ and for items at $F_2(1,22)=4.692$, $p<0.05$. Thus, down verbs (491ms) were responded to more slowly than up verbs (460 ms). In addition, there was a significant main effect of object condition (up or down), for subjects at $F_1(1,35)=15.757$, $p<0.01$. Thus, objects were responded to more slowly in the down visual quadrant (499 ms) than in the up visual quadrant (452 ms). However, there was no interaction effect between verb condition and object condition. The reaction times, along with standard deviations, are listed in Table1 and Figure 1 below.

Sentence Condition	ISI	Down Visual Quadrant (s.d.)	Up Visual Quadrant (s.d.)
Neg1 Down-Verb	0ms	509 (138)	469 (174)
Neg1 Up-Verb	0ms	486 (163)	432 (145)

TABLE 1. REACTION TIMES IN MILLISECONDS TO PREVERBALLY NEGATED SENTENCES (NEG1) AT 0MS WITH NO SIGNIFICANT INTERACTION EFFECTS

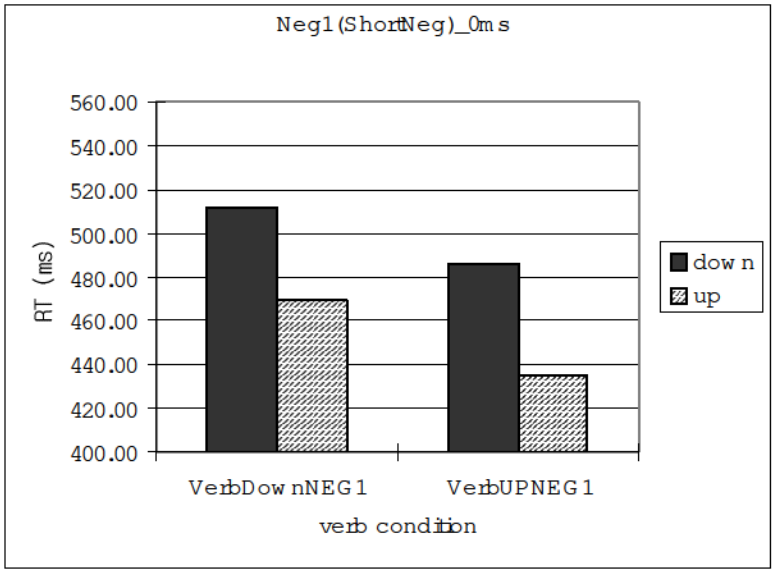

FIGURE 1. RT TO PREVERBAL NEGATION (NEG 1) AT 0MS

For postverbal negation (Neg2) at 0ms, a 2x2 repeated measures ANOVA by sentence condition and object condition found a significant main effect of object condition for subjects: $F_1(1,35)=6.242$, $p<0.05$. Thus, objects were responded to more slowly in the down visual quadrant (501.5 ms) than in the up visual quadrant (472.5 ms). In addition, there was a significant interaction effect of verb condition and object condition by subjects $F_1(1,35)=9.293$, $p<0.01$ (Table 2; Figure 2). This was the same facilitation effect that was found in the English negation study by Tseng et al. (to appear). Thus, postverbally negated up verb sentences caused much quicker reaction times to the up objects and much slower reaction times to the down objects. Postverbally negated down verb sentences caused quicker reaction times to the lower quadrant of the screen and slower reaction time to the upper quadrant of the screen. The reaction times, along with standard deviations, are listed in Table 2 and Figure 2 below.

Sentence Condition	ISI	Down Visual Quadrant (s.d.)	Up Visual Quadrant (s.d.)
Neg2 Down-Verb	0ms	471 (152)	478 (139)
Neg2 Up-Verb	0ms	532 (172)	467 (139)

TABLE 2. REACTION TIMES IN MILLISECONDS TO POSTVERBAL NEGATION SENTENCES (NEG2) AT 0MS WITH SIGNIFICANT INTERACTION EFFECTS

The result at 0ms showed that the postverbal negation (Neg2) caused a facilitatory interaction effect, but the preverbal negation (Neg1) didn't cause this effect. In order to see whether such a difference between Neg1 and Neg2 was significant, a 2x2x2 repeated measures ANOVA (Neg condition, sentence condition, and object condition) was conducted. It showed a significant three-way interaction for subjects, $F_1(1,35)=4.185$, $p<0.05$. Thus, the preverbal negation (Neg1) was significantly different from the postverbal negation (Neg2) at 0ms. There was also a marginally significant main effect of Neg condition ($F_1(1,35)=3.876$, $p=.057$). Thus, responses were faster for Neg1 (preverbal) (475.41 ms) than for Neg2 (postverbal) (487.05) at 0ms.

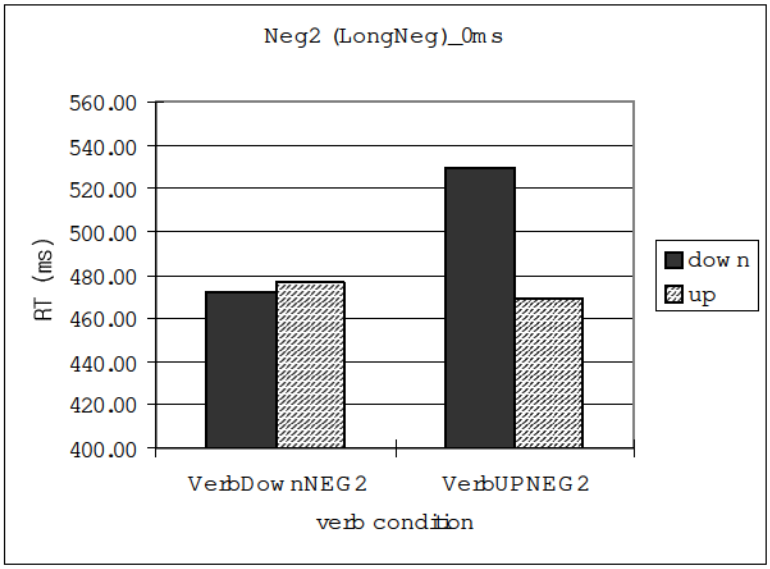

FIGURE 2. RT TO POSTVERBAL NEGATION (NEG 2) AT 0MS

6.2 VERB NEGATION IN INTRANSITIVE SENTENCES: 200MS RESULT. 35 subjects participated—19 females and 16 males. One subject was eliminated due to having average means higher than 2.5 standard deviations from the mean across subjects. Two filler sentences (*The glass door spun* and *The snail NOT crawled*) were eliminated due to average means higher than 2.5 standard deviations from the mean across items. One critical postverbally negated down verb sentence (*The bricks collapsed NOT)* had average means (595.28 ms) higher than 2.5 standard deviations from the mean across items (589.37 ms). However, it was not eliminated.

For preverbal negation (Neg1) at 200ms, a 2x2 repeated measures ANOVA by sentence condition and object condition found a significant main effect of verb condition, for subjects at $F_1(1,33)=5.958$, $p<0.05$. Thus, down verbs were responded to more slowly than up verbs. In addition, there was a significant main effect of object condition—for subjects: $F_1(1,33)=23.050$, $p<0.01$, and for items: $F_2(1,22)=7.883$, $p<0.05$. Thus, objects were responded to more slowly in the down visual quadrant than in the up visual quadrant. However, there was no interaction effect between the verb condition and the object condition (for subjects, $F_1(1,33)=1.891$, $p=.178$ and for items, $F_2(1,22)=.923$, $p=.347$). The reaction times in milliseconds, along with standard deviations, are listed in Table 3.

Sentence Condition	ISI	Down Visual Quadrant (s.d.)	Up Visual Quadrant (s.d.)
Neg1 Down Verb	200ms	483 (187)	432 (158)
Neg1 Up Verb	200ms	447 (153)	423 (158)

TABLE 3. REACTION TIMES IN MILLISECONDS TO THE PREVERBAL NEGATION SENTENCES (NEG1) AT 200MS WITH NO SIGNIFICANT INTERACTION EFFECT

For postverbal negation (Neg2) at 200ms, a 2x2 repeated measures ANOVA by sentence condition and object condition found a significant main effect of object condition, for subjects at $F_1(1,33)=5.991$, $p<0.05$, and for items at $F_2(1,22)=4.453$, $p=.046$. Thus, objects were responded to more slowly in the down visual quadrant than in the up visual quadrant. However, there was no interaction effect between verb condition and object condition for subjects, $F_1(1,33)=.706$, $p=.407$, and for items, $F_2(1,22)=.905$, $p=.352$. The reaction times in milliseconds, along with standard deviations, are listed in Table 4.

Sentence Condition	ISI	Down Visual Quadrant (s.d.)	Up Visual Quadrant (s.d.)
Neg2 Down-Verb	200ms	471 (175)	458 (186)
Neg2 Up-Verb	200ms	467 (191)	434 (157)

TABLE 4. REACTION TIMES IN MILLISECONDS TO THE POSTVERBAL NEGATION SENTENCES (NEG2) AT 200MS WITH NO SIGNIFICANT INTERACTION EFFECTS

7. DISCUSSION. We examined how the two different forms of negation in Korean influence the visual simulation of the counterfactual situation. The results showed that for the postverbal negation, there was a facilitatory interaction effect between sentence location and object location at the 0ms ISI but not at the 200ms ISI. For preverbal negation, however, there was no such interaction effect at either of the 0ms or 200ms ISIs. The combined results indicate that the up/down visual imagery associated with the verb was simulated when the verb was paired with the postverbal form, right after the sentence was heard (at 0ms). On the other hand, the same up/down visual imagery was not simulated when the verb was paired with the preverbal negation syntactic structure at either of the two time courses (0ms and 200ms). In sum, our results showed the presence of simulation effects in postverbal negation, and the absence of such simulation effects in preverbal negation.

The presence of a simulation effect in postverbal negation indicates that the counterfactual situation was accessed and simulated during comprehension. That is, the upward or downward directionality of a verb, when embedded in a postverbally negated statement, was accessed, causing a *facilitatory* interaction effect between up or down visual simulation and the following actual visual perception of an object in the up or down visual field. This result replicated the finding of the English study by Tseng et al. (to appear) that negation in general induces a facilitatory simulation effect.

The results in this study also showed that preverbal and postverbal negation result in differing processes of negation understanding, thus broadly supporting our hypothesis that the syntax of negation further constrains the understanding of negative intransitive sentences. Our results, however, provided no concrete evidence of how and why the two negation forms differ in terms of the accessibility or simulation of the counterfactual situation. Our results also provided no account of what particular aspect of the syntax of negation (linear order or structural complexity or something else) was responsible for the absence or presence of a visual simulation of the counterfactual concept in the two negation forms. These issues will be left for a future study. I interpret the current finding as implying that the two negation forms trigger different processing, in that preverbal negation exhibited no measurable simulation effects, whereas postverbal negation did exhibit simulation of the verbal content, right after the sentences were heard.

Below I conjecture on possible causes of the observed absence of simulation effects in preverbal negation. First, no simulation evidence in preverbal negation can be due simply to a method- or task-related limitation. This means that we can't completely rule out the possibility that preverbal negation is indeed able to engage the activation of the counterfactual representation. A future study can re-examine the availability of the counterfactual processing in preverbal negation by using different sorts of tasks.

Second, under the assumption that preverbal negation should be no different from postverbal negation in allowing the accessibility of verbal content, the observed asymmetry may simply reflect the frequency asymmetry existing between the two negation forms. Preverbal negation, after all, is restricted in its distribution, occurring more frequently in spoken context and tending to avoid verbs with relatively longer syllable length, unless they are compound verbs with linking suffixes (*-e* or *-a*) (Song 1988:85). In fact, this syllable constraint associated with preverbal negation can be violated, given proper pragmatic context in actual language use, resulting in different degrees of acceptability for the preverbal negation of those long syllable verbs (Jin-Kyoung Kim 1995:45). Our critical up/down verbs were all four-syllable and five-syllable compound verbs with a linking suffix which legitimately allows the preverbal syntax (see Kisim Nam 1991). Thus we suspect that our preverbal negation especially with five-syllable verbs, although theoretically legitimate, may have caused processing difficulty due to their lower frequency. If this

is the case, our preverbal negation sentences might cause processing difficulty, inhibiting building a counterfactual representation and resulting in no measurable simulation effect. A future study therefore may control verb frequency in comparing the processing of the two negation forms.

Still, some of our results suggest that the absence of the counterfactual simulation in preverbal negation may not be merely the effect of its processing difficulty. First, we conducted a separate analysis of the four-syllable verbs which pose no restriction in their association with preverbal negation, but didn't find any simulation effects. In addition, the response time for preverbal negation was significantly faster than that for postverbal negation at the 0ms condition (response times were measured from sentential offset), indirectly suggesting that preverbal negation was not visibly hard in their processing.

As for the true explanation of the absence of counterfactual simulation in preverbal negation, I propose that the morphological structure of a negator is a probable source of the observed processing asymmetry between preverbal and postverbal negation. According to the standard view in generative syntax, the two Korean negation forms are both analyzed as sentential negation.[4] In opposition to this traditional view, it was recently proposed that preverbal negation is a lexical (or affix-like) negation, whereas postverbal negation is a syntactic negation (Jin-Kyoung Kim 1996:54). The lexical negation parallels English *He is dishonest* and the syntactic negation parallels English *He is not honest*.

Two pieces of evidence support the lexical (affixal) nature of the preverbal negator (see Jin-Kyoung Kim 1996:55). First, syntactic negation is fully productive in the sense that it applies to all verbs, whereas lexical negation is not productive and does not apply to all verbs or adjectives (e.g., *dishonest, incompetent, untruthful, *dis/*un-good, *dis-simple*). Postverbal negation in Korean resembles syntactic negation with regard to productivity, since it can negate all predicates. In contrast, preverbal negation resembles lexical negation, since it cannot negate all predicates, such as Sino-Korean nominal verbs (i.e., **an-kongpwu-hata* 'Neg-studying-do'). In addition, the lexical nature of the preverbal negator is also supported by the fact that the NEG morpheme *an* is prefixed to what it negates, with no adverbs or objects intervening between the two.

Based on this proposal, we presume that the "affixal" or "lexical" nature of the preverbal negator is somehow responsible for the decreased accessibility (or unavailability) of the counterfactual representation. Now, the question is why affixal negation such as *He is dishonest* does not involve the activation of the counterfactual representation, whereas syntactic negation such as *He is not honest* does. This leads to the question of how affixal and syntactic negations differ in their semantics. According to Horn (1989:33, and chapter 5, *Pragmatics of contra(dicto)ry negation*), "affixal negation (*un-, iN-, -less*) does not yield true negation. *A is un-B* is affirmative in nature. Affixal negation produces a contrary affirmation rather than a true contradictory negation". Horn goes on to claim that contrary negation is what allows a middle: we can say *John is neither happy nor unhappy*. Contradictory negation by contrast is what excludes a middle: saying *John is not happy* is rejecting or denying *John is happy*. In this view, *unhappy* is not equivalent to *not happy*. *John is unhappy* is affirming unhappiness, whereas *John is not happy* is denying happiness.

If affixal negation, as Horn described it, is characterized as contrary negation, i.e., affirming a contrary concept rather than denying affirmation, then processing affixal negation may not presuppose the earlier performance of mental affirmation (i.e., the counterfactual situation processing). On the other hand, if sentential or syntactic negation is characterized as contradictory negation, it presupposes earlier mental performance of affirmation. If this is the case, preverbal negation, as affixal negation, would facilitate direct access to the factual situation, whereas postverbal negation, as sentential negation, would necessitate the initial access of the counterfactual situation. This is what the current study found.

A future study needs to re-examine our hypothesis: that processing asymmetry between preverbal and postverbal negation is due to the affixal versus syntactic nature of negation structure. Although Horn's distinction between affixal and sentential negation relates to the category of adjective (e.g., *unhappy* versus *not happy*), I applied this affixal/sentential distinction to the category of verbs in Korean. It is not cer-

[4] One outstanding piece of evidence for the sentential negation view is that the preverbal and postverbal negators both license an NPI (negative polarity item) in the subject position.

tain whether affixal negation (with contrary negation) is naturally conceivable in the verbal category as well. In order to test the affix-like nature of the preverbal negator *an,* we may examine the case where the preverbal negator *an* comes with adjectives instead of verbs.

8. CONCLUSION AND FURTHER RESEARCH**.** This study examined whether different syntactic types of negation would affect simulating a negated concept. Specifically, it showed that two different syntactic realizations of negation in Korean, although synonymous in their propositional contents, can constrain "access to the counterfactual situation." It also suggested that the morpho-syntax of negation can affect the simulation in negation. This finding has several implications.

First of all, our results suggest that the understanding of negation may not always involve a shift between two mental states and may instead involve the process of construction of the factual mental state. We interpret this as suggesting the possibility that understanding negation may not always necessitate initial access to the counterfactual representation. A similar idea was proposed by the experimental study by Mayo, Ruth, Schul, and Burnstein (2004). Their study showed that how a negated concept is mentally accessed in a natural language can be constrained by cognitive factors such as mental schema. They found that understanding negation with *unipolar descriptions* having no opposite alternative schemas (e.g., *creative, adventurous, moral,* etc.) engaged explicit access to the counterfactual affirmative contents. On the other hand, negation with *bipolar descriptions* having an opposite alternative schema (e.g., *industrious/lazy, tidy/messy, optimistic/pessimistic*) was quickly processed as a negated factual concept. This finding suggests that the understanding of negation could involve the direct construction of the factual situation especially when an opposite mental schema exists.

The current finding, along with Mayo et al.'s, further suggests that negation and its understanding in natural languages, from the pragmatic perspective, is a complex matter. Horn's (1989:xiii) remark is relevant to this: "despite the simplicity of the one-place of connective or propositional logic and of the laws of inference in which it participates, the form and function of negative statements in ordinary language are far from simple and transparent." In fact, perception of negation facts and events in "actual language use" may involve further variability beyond a mechanical process such as from the counterfactual to the factual, as traditionally hypothesized and as widely demonstrated in the experimental settings.

Second, our finding provides evidence in support of a simulation-based model of language processing, more broadly supporting the embodied view of language understanding. The critical issue in language comprehension theories, as noted in the introduction, revolves around the nature of the representation that is being constructed during language comprehension. Traditional amodal theories of language comprehension claim it to be in a propositional format, whereas the embodied view claims it to be in an experiential, modal format. The parsimonious amodal approach to the mental representation can not explain the current finding that perceivers, when hearing a sentence with up or down directionality, found it easier to identify a visual object in the same location.

Our findings also suggest that the morpho-syntactic details of natural language have some relevance in explaining the details of performing mental imagery for the purpose of language understanding. These results therefore draw attention to the interface between simulation and syntax, i.e., the importance of the linguistic details in the construction of a mental simulation. In addition, the current findings provide cross-linguistic evidence for the claim that mental imagery is involved in understanding negation. The current finding also confirmed the results of Tseng et al.'s (to appear) English study, where visual simulation in comprehending a negative sentence can cause a facilitatory interaction effect between sentence location and object location. More broadly, our findings support the embodied view of language understanding: that it critically engages mental imagery or mental simulation.

If the current finding of the processing asymmetry between the two negation forms in Korean is on the right track, future studies need to re-examine the availability and the time-course of the counterfactual processing in preverbal and postverbal negation forms. Also, future studies need to examine specifically how and why they differ. In doing that, one may have to recognize that the syntax of negation is not solely responsible for the observed processing asymmetry between preverbal and postverbal negation forms, acknowledging such asymmetry may in fact result from multiple factors.

We noted that the two forms of negation in Korean differ in multiple ways: (1) the linear order of the negator and the verb (Neg-Verb versus Verb-Neg); (2) syntactic complexity (monoclausal versus biclausal); (3) the morphological nature of the negator *AN* (prefix-like versus auxiliary-compound similar to English *don't*); (4) the pragmatic factors associated with each negation form; (5) frequency and formality (the preverbal form is more frequent in the spoken context, whereas the postverbal form is more frequent in the written context); (6) distributional considerations (the preverbal form is restricted in its distribution, whereas the postverbal form is not restricted).

Future studies may pinpoint what factor or factors are crucially responsible for the lesser likelihood of activating the counterfactual representation in preverbal negation and its relatively strong accessibility in postverbal negation. Although Korean linguists have tried to pinpoint the distinctions between the two forms of negation in terms of their underlying representations, distribution, and semantic and pragmatic differences (see the summary in Jin-Kyung Kim 1996:24–27, Jong-Bok Kim 1995), no consensus has been reached yet. The current type of study may provide some new ideas about the controversially debated issue of how the two Korean negation forms differ in their syntax, semantics, and mental representation.

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