Negation and Compositionality

Hwan-Mook Lee
Chonnam National University

0. Negative sentences of natural language have presuppositions and assertions as well as truth conditions. All that Montague (PTQ) can tell us about the sentence (1) is its truth condition.

(1) John does not like Mary.

That is to say, the sentence above is true if and only if the ordered pair of two individuals denoted by 'John' and 'Mary' is not a member of the set of ordered pairs of individuals denoted by 'like'. In addition to its truth condition, however, we can infer from this negative sentence at least one of the following:

(2) a. Someone likes Mary and it is not John, or
b. John likes someone and it is not Mary, or
c. John and Mary have some relation, and it is not liking.

In this paper we will attempt to show that truth conditions, presuppositions and assertions of negative sentences can be more systematically explained under the assumption that (i) the negative expression 'not' is a basic functional expression, the category of which is determined by the category of its argument, and (ii) the argument of 'not' has focus, which plays a key role in determining the presuppositions and assertions of negative sentences.

Our analysis of 'not' as a basic expression implies not only that Montague's syncategorematic approach (PTQ) to 'not' and some other lexical items conceals linguistic cases where homomorphism does not hold between syntax and semantics, but also that there is an important theoretical difference between artificial language and natural language.

1. One of the basic aims of Montague Semantics is to 'characterize the notions of a true sentence'(UG, footnote 2), and Montague seeks to assign truth values to sentences 'by assigning extralinguistic entities to all expressions involved in the generation of sentences(...) in such a way that (a) the assignment to a compound will be a function of the entities assigned to its components...'(EFL, p.217). Partee calls this principle Compositionality and defines it as given below:

> The meaning of an expression is a function of the meaning of its parts and of the way they are syntactically combined. (1983, p. 1)

Compositionality is obviously a principle of semantics. However, 'is a function of' shows that semantics is closely related to syntax. The relation between syntax and semantics is shown in Montague as follows:

> (...) the meaning assignment for L determined by $\mathcal{B}$ is the unique homomorphism g from $\langle A, F_\gamma \rangle_{\gamma \in \Gamma}$ into $\langle B, G_\gamma \rangle_{\gamma \in \Gamma}$

such that $f \leq g$. (UG, p. 227)

Here $\mathcal{B}$ is an interpretation for L (that is, an intensional model for L). $\langle A, F_\gamma \rangle_{\gamma \in \Gamma}$ and $\langle B, G_\gamma \rangle_{\gamma \in \Gamma}$ are the syntax and the semantics for L respectively. A is the smallest set including all the basic expressions and all the expressions generated by all the structural operations F_γ. B is the set of meanings prescribed by the interpretation $\mathcal{B}$. G_γ is the semantic operation corresponding to the structural operations F_γ. f assigns meanings to the basic expressions of the language $\mathcal{L}$. Montague defines the function homomorphism as follows:

> If $\langle A, F_\gamma \rangle_{\gamma \in \Gamma}$ and $\langle B, G_\gamma \rangle_{\gamma \in \Delta}$ are algebras, then h is a homomorphism from $\langle A, F_\gamma \rangle_{\gamma \in \Gamma}$ into $\langle B, G_\gamma \rangle_{\gamma \in \Delta}$ if and only if (1) $\langle A, F_\gamma \rangle_{\gamma \in \Gamma}$ and $\langle B, G_\gamma \rangle_{\gamma \in \Delta}$ are similar (in the sense that $\Gamma = \Delta$ and, for each $\gamma \in \Gamma$, F_γ and G_γ are operations of the same number of places; (2) h is a function with domain A and range included in B;.... (UG, p. 225)

Compositionality is obviously a principle of semantics and whether any semantic theory observes it or not can be examined by way of homomorphism. Semantics is said to be homomorphic to syntax if the structure of syntax is reflected in that of semantics in the sense that the structure of the first is identical to the structure of the second. Here the structure of an expression is understood to reflect the syntactic relations of the constituents of the expression. The syntactic relation a word has with the other expression in a complex expression is shown by way of the category of the word in PTQ.

If we accept that 'the idea of homomorphism is that of a structure-preserving transformation of syntax and semantics' as discussed in Halvorsen and Ladusaw (1979, p. 195) and that the categories of expressions reflect their syntactic relation, we can safely infer from these facts that the relation between the categories of syntax and those of semantics corresponds in a one-to-one fashion. This conclusion follows from Montague's mapping function f whose domain is the categories of English and whose range is the types of intensional logic(PTQ, p. 260). However, Montague(PTQ) shows us a case of the discrepancy between the category of 'not' in syntax and its type in semantics. He introduces 'not' into '$\neg$' by translation rule T 17.

> S 17. If $\alpha \in P_T$ and $\delta \in P_{IV}$, then $F_{11}(\alpha, \delta), \ldots \in P_t$, where $F_{11}(\alpha, \delta) = \alpha\delta'$ and δ' is the result of replacing the first verb in S by its <u>negative</u> third person singular present;....
>
> T 17. If $\alpha \in P_T$ and $\delta \in P_{IV}$, and α, δ translate into α', δ' respectively, then $F_{11}(\alpha, \delta)$ translates into $\neg\alpha'(\hat{}\delta'), \ldots$.
>
> (the underlines are ours.)

Although we understand the type of 'not' to be $\langle\langle s,t\rangle,t\rangle$ 'in the usual way'(PTQ, p. 257), its corresponding category of 'not' is 'only implicitly defined, by the totality of the rules of the grammar' (Partee 1976, footnote 13) and it is anything but t/t. It is not clear with the exception of some trivial morphological problems why Montague does not assign 'not' to an expression of category t/t as in EFL(p. 190). We could dispose of such a categorial discrepancy simply by assigning the category t/t to 'not' and conclude that PTQ has no problem with regard to compositionality or homomorphism in so far as it is concerned with negation. Such a solution, however, would prove to be an ad hoc one when we analyze some English negative sentences which contain 'not', as below.

Both of the following English sentences bear a similarity in that they are negative sentences containing 'not'.

(3) a. Every man does not walk.
    b. Not every man walks.

PTQ can not only generate (3)a but also explain its ambiguity by using S 17, S 4, and S 14. However, it can not generate (3)b in spite of its similarity to (3)a. We can not avoid this kind of descriptive inadequacy just by analyzing 'not' as an expression of category t/t because it is difficult to find a consistent way of description when 'not' comes before the sentence and before the verb.

There are many other English negative sentences which can not be generated by PTQ, even though they contain 'not'.

(4) a. John beats his wife not because he loves her.
    b. Not many of the arrows hit the target.
    c. Not very often does Tom go to town.
    d. She's a not unprincipled woman.
    e. He gave a not completely erroneous answer.
    f. Not until you agree to come along will Bill be willing to face the boss.
    g. John tried not to sleep.

These examples reveal that the English word 'not' possesses a different syntactic behavior from that of the logical expression '$\neg$' in the sense that '$\neg$' appears only in front of a formula while 'not' does not have such a fixed position. More importantly, such a difference is not only related to the way of the arrangement of expressions but also to their functions in the sentences it appears, as will be seen below.

2. We are now in a position to analyze, examine, and elaborate the negative expression 'not' as an English word, not simply as exact corresponding counterpart of the logical negative expression, '$\neg$'.

Montague defines the set of categories of English as 'the smallest set X such that (1) e and t are in X and (2) whenever A and B are in X, A/B and A//B are also in X'(PTQ, p. 249). This categorial definition is based on Ajdukiewicz (1935, English edition 1967). Ajdukiewicz was concerned with the problem of syntactic connection and tries to specify 'the conditions under which a word pattern, constituted of meaningful words, forms an expression which itself has a unified meaning' (1967, p. 207). Furthermore, he classifies e and t as basic categories and all others as function categories. Though he does not give us the precise definitions of these categories, functor categories are understood as categories whose expressions take another expression as their argument from his definition that " a 'function' is the same as a 'functional sign', or 'an unsaturated symbol' with brackets following it". In Ajdukiewicz's terms, the categories defined by the second clause of Montague's categorial definitions are functor categories, whose forms are either A/B or A//B. 'not' is neither a name nor a sentence, rather it is a functor expression whose category form is either A/B or A//B. Therefore, the category of the expression which 'not' takes as its argument determines both the category of 'not' and that of the whole resulted expressions. It is not difficult to find out the expressions 'not' negates in the sentence (1) if we extend it in the following way:

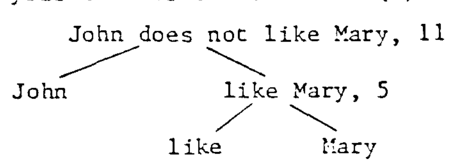
(5) a. John does not like Mary but Jack likes Mary.
    b. John does not like Mary but John likes Jane.
    c. John does not like Mary but John hates Mary.

(5) shows that 'not' can negates 'John', 'Mary' and 'like'. The resulted expressions (i.e. 'not John', 'not like', 'not Mary') have the same syntactic functions as those of the original expressions (i.e. 'John', 'like', 'Mary'). Therefore,the category of 'not' in the sentence (1) is either T/T, or IV/IV according to the category of the expression 'not' negates. Furthermore, the following examples in (6) show that 'not' negates almost every word in the sentence and even the tense which is not expressed in a word form and that the category of 'not' should be determined explicitly according to which expression 'not' negates in the sentence.

(6) a. Not every boy walks but some boys walk.
    b. Not every boy walks but every girl walks.
    c. Reagan is not a French president but he is an American president.
    d. The book is not on the table but it is under the table.
    e. John does not like Mary but he used to like her.

The analysis tree of the sentence (1) is (7) according to PTQ.

(7)



On the other hand, we can assign at least three different analysis trees to the sentence (1) according to the arguments of 'not'. We need some new functional rules related to 'not'.

(8) S 101 If $\delta \in P_{T/T}, \beta \in P_T$, then $F_{101}(\delta, \beta) \in P_T$, where $F_{101}(\delta, \beta) = \delta\beta$.

S 102 If $\delta \in P_{IV/IV}, \beta \in P_{IV}$, then $F_{101}(\delta, \beta) \in P_{IV}$.

(9) a. John does not like Mary (R)

not John like Mary, 4

not John, 101 like Mary, 5

not John like Mary

b. John does not like Mary (R)

John not like Mary, 4

John not like Mary, 5

not like, 101 Mary

not like

c. John does not like Mary (R)

John like not Mary, 4

John like not Mary, 5

like not Mary, 101

not Mary

The analysis trees in (9) demonstrate the categories of 'not' more explicitly than that of (7). The notion 'category' is significant in any theoretical system because of its function to make the description much simpler. 'not', as a word of high frequency in English, should be classified to various categories according to its argument category for the sake of simpler description. Furthermore, 'not' is a functor expression whose argument must be identified so that we can understand the meaning of the sentence where 'not' occurs. That is the second role of the category which reveals the relation among elements of a sentence.

Though our analysis of 'not' in (9) agrees with much of our linguistic intuition (as shown in (5) and (6)), some differences arise, which Montague's approach (PTQ) as shown in (7) does not address. The expressions 'not John', 'not Mary', 'not like' in (9) are disambiguated well-formed expressions generated by syntactic rules, so they are not actual English expressions. They do not violate Partee's well-formed constraint, that is, "each syntactic rule operates on well-formed expressions of specified categories to produce a well-formed expression of a specified category" (1979, p. 276). Here, Partee uses the term "well-fromed expression" in the sense of Montague's meaningful expression in UG(1970) and PTQ(1973, pp. 256-7), and clarifies the notion "the well-formedness constraint" by pointing out that 'the constraint(...) is imposed by Montague on the disambiguated language L', and he imposed no comparable constraint on the final or "surface" language L, (...)." This implies that there can be some formal differences between actual English expressions and disambiguated expressions. Montague (UG, p. 226) attributes these differences to the disambiguating relation R with domain of disambiguated expressions and range of ambiguous actual expressions. Partee(1979, p. 277) specifies R as including deleting labelled brackets, erasing the subscripts of variables, and some morphological operations such as changing 'PAST see' to 'saw' and 'she [+ACC]' to 'her'. Through the comparison of the analysis trees (7) and (9) we can say that (7) lacks one step of deriving the final disambiguated expression. For example, (7) is the analysis tree of the English sentence 'John does not like Mary', which is an actual sentence not corresponding to its disambiguated expression. As a result, the ambiguating relation R can be misunderstood as a part of a syntactic operation (such as F_{11} in PTQ). The disambiguated expression of 'John does not like Mary' or 'John like not Mary' and these should be put under the actual English sentence as in (9), and the ambiguating relation R relates these two different kinds of expressions. When we compare the English sentence and its corresponding ambiguated expressions, we can understand the function of the ambiguating relation R more clearly. One of the effects the binary relation R performs in (9) is to rearrange 'not' of the last stage of the disambiguated expression as in the actual English sentence. The complete identification and formalization of the relation R, however, seems to be another problem yet to be solved and lies beyond the scope of our present paper.

Montague (PTQ, p. 262) translates 'not' into the logical expression '$\neg$' without showing its type just as he does not identify its category directly. Such a translation is possible only because of its syncategorematical introduction. On the other hand, as our approach introduces 'not' as a basic expression and assigns it various categories according to those of its arguments, we have to show its corresponding types and logical expressions. We will follow the logical tradition in translating 'not' into the logical expression '$\neg$', and in interpreting it as showing that the formula immediately following '$\neg$' is not true, that is, the extension of the argument of the formula is not a member of the extension of the predicate of the formula. We will make use of the lamda-device in representing various types of 'not'. Two different categories of 'not' are found in (9) and they are translated into logical expressions as in (10) according to Montague's translation rules of categories (PTQ, p. 260).

(10) a. If not $\in B_{T/T}$, then $\mathfrak{g}$ (not) $= \lambda\mathcal{P}\lambda P \neg \mathcal{P}\{P\}$.
b. If not $\in B_{IV/IV}$, then $\mathfrak{g}$ (not) $= \lambda P \lambda x \neg P\{x\}$.

Now we can compare two methods (Montague's and ours) by translating the sentence (1) based on (7) and (9).

(7') John does not like Mary $\Rightarrow$ $\neg$ like'$_*$(j,m)

John $\Rightarrow \lambda P \lambda P\{^\wedge j\}$ like Mary $\Rightarrow$ λx like'(x,$^\wedge m^*$)

like $\Rightarrow \lambda\mathcal{P}\lambda x$like'(x,$\mathcal{P}$) Mary $\Rightarrow \lambda PP\{^\wedge m\}$

(9') a. John does not like Mary (R)

not John like Mary $\Rightarrow$ $\neg$ like'$_*$(j,m)

not John, 101 $\Rightarrow \lambda P \neg P\{^\wedge j\}$ like Mary $\Rightarrow \lambda x$like'(x,$^\wedge m^*$)

not $\Rightarrow \lambda\mathcal{P}\lambda P \neg \mathcal{P}\{P\}$ John $\Rightarrow \lambda PP\{^\wedge j\}$ like $\Rightarrow \lambda\mathcal{P}\lambda x$like'(x,$\mathcal{P}$) Mary $\Rightarrow \lambda PP\{^\wedge m\}$

b. John does not like Mary (R)

John not like Mary, 4 $\Rightarrow$ $\neg$ like'$_*$(j,m)

John $\Rightarrow \lambda PP\{^\wedge j\}$ not like Mary $\Rightarrow \lambda x \neg {}^\wedge\lambda\mathcal{P}\lambda x$like'(x,$\mathcal{P}$)$\{^\wedge m^*\}\{x\}$

not like $\Rightarrow \lambda\mathcal{P}\lambda x \neg {}^\wedge\lambda\mathcal{P}\lambda x$like'(x,$\mathcal{P}$)$\{\mathcal{P}\}\{x\}$ Mary $\Rightarrow \lambda PP\{^\wedge m\}$

not $\Rightarrow \lambda S \lambda\mathcal{P}\lambda x S\{\mathcal{P}\}\{x\}$ like $\Rightarrow \lambda\mathcal{P}\lambda x$like'(x,$\mathcal{P}$)

c. John does not like Mary (R)

John like not Mary $\Rightarrow$ $\neg$ like'$_*$(j,m)

John $\Rightarrow \lambda PP\{^\wedge j\}$ like not Mary $\Rightarrow \lambda x \neg$ like'(x, $^\wedge m^*$)

like $= \lambda\mathcal{P}\lambda x$ like'(x,$\mathcal{P}$) not Mary $\Rightarrow \lambda P \neg {}^\wedge\lambda PP\{^\wedge m\}\{P\}$

not $\Rightarrow \lambda\mathcal{P}\lambda P \neg \mathcal{P}\{P\}$ Mary $\Rightarrow \lambda PP\{^\wedge m\}$

Here $\Rightarrow$ indicates 'translates into' and all the variables are used as in PTQ with the exception of S whose type is $\langle\langle s,\langle\langle s,\langle\langle s,e\rangle,t\rangle\rangle,\langle\langle s,e\rangle,t\rangle\rangle\rangle$. As (7') and (9') reveal, both approaches give the same logical expression '$\neg$ like'$_*$(j,m)' to the sentence (1). In other words, both approaches give it the same truth condition. Therefore, they satisfy the aim of Montague Semantics: the construction of the truth conditions of declarative sentences.

3. Montague (UG, p. 223) begins his semantic theory under the assumption that "there is no important theoretical difference between natural language and the artificial language of logicians", and this is true when we restrict "the basic aim of semantics to characterizing the notions of a true sentence (...) and of entailment" (UG, footnote 2). However, sentences of natural languages, unlike those of artificial languages, convey presuppositions and assertions in addition to truth values and entailments. Presuppositions and assertions play very important roles in natural languages to the extent that we can not say safely that we understand the meaning of a given sentence completely without the presuppositions and assertions conveyed by the sentence.

When we are talking about presuppositions and assertions of a sentence, our discussion goes beyond the boundary of truth-conditional semantics. Presuppositions and assertions lie in the domain of pragmatics in the sense that we can not say anything about them without referring to the context in which a sentence is uttered. Within the context are included speakers, hearers and some other elements. Stalnaker (1978, p. 321) defines presuppositions as "what is taken by the speaker to the COMMON GROUND of the participants in the conversation, what is treated as their COMMON KNOWLEDGE or MUTUAL KNOWLEDGE". Sentence (1) can have at least three different presuppositions according to which expression 'not' negates in it. In spoken English, the negated expression receives a stress and the stressed expression becomes the focus in the sentence. We can determine the presuppositions of sentence (1) by replacing the focus by a variable in the following way (cf. Chomsky (1971), A. von Stechow (1981)) :

(11) a. $\exists x$ [X likes Mary]
b. $\exists x_{TV}$ [John Xed Mary]
c. $\exists x$ [John likes X]

The three propositions in (11) represent some of the possible presuppositions of the sentence (1). When the sentence (1) is uttered, we can grasp which one of the above presuppositions is conveyed by way of the stress. Because of their relation to stress, Chomsky(1971, pp. 199-207) assigns presuppositions to a sentence at the level of its surface structure. Sentences have assertions in addition to presuppositions. The subjects of the assertions refer to the variables of the presuppositions and these variables have the foci of the sentence. Therefore, we can detect these assertions only by way of the stress just as in the case of presuppositions. For illustration, the sentence (1) has at least three different pairs composed of presuppositions and assertions like (12).

(12) a. Someone likes Mary and it is not John.
b. John likes someone and it is not Mary.
c. John and Mary have some relation and it is not liking.

In (12), the first three clauses are equal to the three propositions in (10) except the replacement of 'someone' and 'some relation' for the variables. The second three clauses constitute the assertions conveyed by the sentence (1). As said at the outset, we can infer (12) from the sentence (1) only under the assumption that the sentence (1) is true.

Even though the sentence (1) has only the one truth-condition, as revealed in (7') and (9'), it can convey three different pairs of presuppositions and assertions according to the different focus assignment (cf. A. Stechow, 1981). As the argument of 'not' receives stress and becomes the focus of the negative sentence, our approach to 'not' as a basic expression can provide a ground for dealing with presuppositions and assertions as well as truth-conditions of negative sentences in the framework of Montague Grammar just by assigning various categories to 'not' according to its argument. In English and some other languages the negative expression has a fixed position before a verb and its argument is indicated by the stress, while in Russian, the negative expression 'ne' comes before its argument. Dahl(1979, p. 23) "makes a distinction between focus-dependent placement and verb-dependent Neg placement" according to the interaction between focus and the negative expression. He shows three different Russian sentences corresponding to English sentence (13).

(13) I do not read newspapers on Sundays.
(14) a. Ne ja čitaju gazety po voskresen' jam.
b. Ja ne čitaju gazety po voskresen' jam.
c. Ja čitaju gazety ne po voskresen' jam.

The English negative sentence is less ambiguous as for focus when it is uttered than when it is written. The corresponding negative sentences (14) do not possess such an ambiguity problem. This Russian example strongly supports our analysis of 'not' as a basic expression as shown in (9).

Up to now, we have analyzed English negative sentences under the assumption that the different focus assignment does not affect the truth conditions of a sentence and it changes only its presuppositions and assertions (cf. A. Stechew (1981), p. 95). Moravcsik (1983, p. 235), on the other hand, insists that "'Mary did not walk into the house' has different truth conditions depending on whether we stress 'Mary' or 'the house'". Partee (personal communication, 1983) also makes a similar assertion that the sentence 'If John hadn't married Susan, he wouldn't have inherited his grandfather's fortune.' has different truth conditions depending on whether we stress 'Susan' or 'married'.

Another problem to be solved is whether the notion of truth condition in Moravcsik and Partee is the same as that of Montague. Yet it seems to be obvious that in natural language stress performs a significant role with regard to the meaning of sentences including truth conditions, presuppositions and assertions. We can suggest the possibility that Montague Grammar can easily deal with even presuppositions and assertions by assigning 'not' to various categories according to its arguments.

ACKNOWLEDGEMENT

This paper was written with the support of an official leave from Chonnam National University, a Fulbright Foreign Curriculum Consultant Grant G-5-186, and the support service of the State University of New York at Stony Brook, all of which I acknowledge with gratitude. I would like to thank Suk-Jin Chang and Kiyong Lee for their very helpful comments on an earlier version of this paper. I would also like to thank Robin Cooper and Barbara Partee for helpful discussions and suggestions. Special thanks to Mark Aronoff for valuable suggestions and comments during the writing. Finally, thanks to Mizuho Hasegawa for her secretarial help and insightful discussions. None of them is, however, responsible for all the judgements in this paper and all errors and shortcomings are my own.

REFERENCES

Ajdukiewicz, K., 1967, 'Syntactic Connexion', in S, McCall (ed.), Polish Logic 1920-1939, with an introduction by T. Kotarbinski and translated by B. Gruchman, H. Hiz, Z. Jordan, E. C. Luschei, S. MacCall, W. Teichmann, H. Weber, and P. Woodruff, the Clarendon Press, Oxford.

Chomsky, N., 1971, 'Deep Structure, Surface Structure, and Semantic Interpretation', in: Steinberg and Jakobovits, 1971, Semantics: An interdisciplinary reader in philosophy, linguistics and psychology, Cambridge University Press, New York.

Dahl, Ö., 1977, 'Negation in Universal Grammar' --- in Gothenburg Papers in Theoretical Linguistics, 33.

Halvorsen, P. K. & Ladusaw W., 1979, 'Montague's Universal Grammar' : An introduction for the linguist', Linguistics and Philosophy, 3, 185-223.

Montague, R., 1974, Formal Philosophy : Selected Papers of Richard Montague, edited and with an introduction by Richmond Thomason, Yale University Press, New Haven.

Moravcsik, J. M., 1983, 'Natural Languages and Formal Languages: A Tenable Dualism', in R. S. Cohen and M. W. Wartofsky (eds.) Language, Logic, and Method, pp. 225-239, D. Reidel Publishing Company, Dordrecht.

Partee, B. H., 1976, 'Some Transformational Extensions of Montague Grammar' in B. H. Partee (ed.), Montague Grammar, Academic Press, New York.

Partee, B. H., 1979, 'Montague Grammar and the Well-formedness Constraint', in F. Henry and H. Schnell (eds.) Syntax and Semantics, vol., 10, Academic Press, New York, 275-313.

Partee, B. H., 1983, 'Compositionality' to appear in F. Landman and F. Veltman (eds.), Proceedings of the Fourth Amsterdam Colloquium, Foris, Dordrecht.

Stalnaker, R. C., 1978, 'Assertion', in P. Cole (ed.), Syntax and Semantics 9 : Pragmatics, Academic Press, New York, 315-332.

Stechow, A., 1981, 'Topic, Focus and Local Relevance,' in W. Klein and W. Levelt (eds.), Crossing the Boundaries in Linguistics, D. Reidel, Dordrecht, 95-130.