

Head Movement and the PF Interface*

Myung-Kwan Park
(Dongguk University)

Park, Myung-Kwan. (2002). Head movement and the PF interface. *Language Research* 38(3), 763-777.

This paper examines subject-auxiliary inversion (SAI) in comparative and exclamative clauses and preposition-its complement inversion (PCI) in sluiced (or IP-elided) clauses of English. It will first be shown that SAI and PCI in these clauses interact with deletion and sentence stress assignment, that are considered to be PF operations. Based on this interaction at PF, I will argue that SAI and PCI in these clauses are most naturally understood as taking place at PF, that is, in the mapping from Spell-Out to PF. SAI and PCI in these clauses then constitute an argument that at least one kind of head-movement occurs after Spell-Out, with effects on word order.

Key words: subject-auxiliary inversion (SAI), preposition-its complement inversion (PCI), comparatives, exclamatives, sluicing, sentence stress, focus, PF interface

1. Introduction

Establishing the level of representation or the point in a derivation at which movement takes place has never been a trivial matter, and as such remains a topic of substantial ongoing interest. For overt movement, this question is complicated by the availability in principle of two components in which movement could take place with indistinguishable effects on word order: in the derivation leading to Spell-Out, or in the mapping from Spell-Out to PF. To a great extent, the reasoning brought to bear on this question has been concentrated on A- and A'-movement and their properties; head-movement, in contrast, has remained a distant third. In this paper, I will show that a little-studied peculiarity of

*I am grateful to Zeliko Boscovič, Sun-Woong Kim, Klaus Abels, Howard Lasnik, Fumi Niinuma, and three anonymous reviewers of this journal for comments and suggestions. I also would like to acknowledge the financial support of Dongguk University Research Grant in the program year of 2002.

subject-aux inversion (SAI) in comparative and exclamative clauses and preposition-its complement inversion (PCI) in sluiced (or IP-elided) clauses of English can cast new light on this question, providing evidence that there is indeed head-movement which takes place late in the derivation at PF, after Spell-Out.

2. SAI in Comparative Clauses

As far as I know, it was Emonds (1970) who first examined SAI in comparative clauses. Emonds noted that SAI in comparatives is optional, so that under his framework, he treated it as a secondary inversion rule which is not a root transformation. The relevant data are provided below:

- (1) a. She spoke more convincingly than did Harry
b. She spoke more convincingly than Harry did
- (2) a. Abby knows more languages than does her father
b. Abby knows more languages than her father does
- (3) a. Abby can play more instruments than can her father
b. Abby can play more instruments than her father can

Furthermore, recently Merchant (2001) noted that there is another severe constraint on SAI in comparative clauses. He pointed out that the main verb within VP must be elided under SAI in comparatives as shown below:

- (4) a. Abby can play more instruments than can her father (*play)
b. Abby can play more instruments than her father can play
- (5) a. Abby has been awarded more accolades than has her father
(*been awarded)
b. Abby has been awarded more accolades than her father has
been awarded.

In addition, pseudogapping is prohibited when SAI is applied in comparative clauses:

- (6) a. *Abby plays the flute better than does her father the trumpet
 b. Abby plays the flute better than her father does the trumpet
- (7) a. *Abby can play more sonatas than can her father concertos
 b. Abby can play more sonatas than her father can concertos

The generalization that Merchant made is the following:

- (8) Comparative SAI and VP-ellipsis generalization
 I-to-C movement in comparative clauses can occur only if
 VP-ellipsis deletes the VP complement to I^0

Merchant tried to capture this generalization by relying on the presence of an intermediate trace of the A'-moved comparative operator, which is subject to the ECP at PF. His formulation of the ECP at PF is as follows:

- (9) The Empty Category Principle at PF
 At PF, a trace of A'-movement must either be
 i. PF-head-governed, or
 ii. PF-antecedent-governed.
- (10) a *PF-head-governs* β iff
 i. α is a head, and α c-commands β , and
 α respects Relativized Minimality wrt β , and
 ii. α is PF-active.
- (11) A link α_i in a chain $\langle \alpha_1, \dots, \alpha_n \rangle$ is *PF-active* iff α_i is the link at which lexical insertion occurs.
- (12) a *PF-antecedent-governs* β iff
 i. α and β are co-indexed, and α c-commands β , and
 α respects Relativized Minimality wrt β , and
 ii. α is PF-visible.
- (13) An expression α is *PF-visible* iff α has phonetic exponence.

According to Merchant, having phonetic exponence means that the relevant element is pronounced. Assuming that the null operator moves

to Spec of CP in overt syntax, (4a), which is repeated as (14), will have the following structure in (15):

(14) *Abby can play more instruments than can her father play (same as (4a))

(15) . . . than [_{CP} *OP*₁ can [_{IP} her father *t*_{can} [_{VP} *t*₁ [_{VP} *t*_{SU} play *t*_i]]]]

In the structure of (15) the lower trace *t*_i satisfies the ECP at PF because the main verb *play* is PF-active. However, the intermediate trace *t*₁ violates the ECP at PF because the lower copy of *can* (*t*_{can}), which is not PF visible, does not PF-head-govern *t*₁. Furthermore, *OP* in Spec CP does not PF-antecedent-govern *t*₁ because it cannot satisfy the PF-visible requirement due to its lack of phonetic content. Hence, the intermediate trace *t*₁ violates the ECP at PF, which correctly rules out the example in (14) under Merchant's analysis.

The immediate question that arises is how we can account for the acceptable sentences, for example (3a), which is repeated as (16). Let us consider the structure of this example in (17), where underlined items indicate that they are deleted:

(16) Abby can play more instruments than can her father (same as (3a))

(17) . . . than [_{CP} *OP*₁ can [_{IP} her father *t*_{can} [_{VP} *t*₁ [_{VP} *t*_{SU} play *t*_i]]]]

Following the logic of Lasnik (1995, 1999) and Merchant (1999), Merchant (2001) argued that ellipsis can save violations due to the ECP at PF. In particular, Merchant claimed that when the offending trace (*t*₁) in (17) is deleted by VP-ellipsis, then it is not subject to the ECP any longer at PF.

3. Problems

Merchant's (2001) proposal for the repair strategy of VP-ellipsis in comparative clauses is quite interesting. However, it is not entirely convincing for the following two reasons. First, it is conceptually problematic because under the Minimalism framework, notions such as the ECP and government should be eliminated.

Second, Emonds (1970:9) noted that pronouns cannot be placed in a sentence-final position when SAI occurs, as illustrated below:

- (18) a. *I hope you found the play more interesting than did we
 b. I hope you found the play more interesting than we did
- (19) a. *John likes Beethoven more than do I
 b. John likes Beethoven more than I do

Notice, however, that if the apparently inverted pronoun is assigned stress, then the sentence becomes grammatical as follows:

- (20) a. *Abby can play more sonatas than can he
 b. Abby can play more sonatas than can HE

Under Merchant's analysis both sentences should be acceptable, contrary to fact.

(21) . . . than [_{CP} *OP*₁ can [_{IP} he *t*_{can} [_{VP} *t*'₁ [_{VP} *t*_{he} play *t*]]]] (20a)

(22) . . . than [_{CP} *OP*₁ can [_{IP} HE *t*_{can} [_{VP} *t*'₁ [_{VP} *t*_{HE} play *t*]]]] (20b)

It is thus appropriate to seek an alternative analysis of SAI in comparative clauses.

4. The Proposed Analysis

The proposal that I will develop here crucially relies on the analysis of Reinhart (1997) and Reinhart and Neelman (1998). They examined scrambling in Dutch, arguing that scrambling is a PF phenomenon and it interacts with sentence stress assignment, as in (23)-(24):

- (23) a. Ik heb nog niet DE KRANT nog niet gelezen, maar ik heb
 I have not yet the newspaper not yet read, but I have
 al wel HET BOEK gelezen.
 already indeed the book read
- b. *Ik heb DE KRANT nog niet gelezen, maar ik heb HET BOEK al
 wel gelezen

- (24) a. Ik heb het boek gisteren GELZEN en niet VERSCHEURD.
 I have yesterday the book read and not torn up
 b. *Ik heb gisteren het boek GELZEN en niet VERSCHEURD.

In general, sentence stress in Dutch falls on the object, which counts as the most deeply embedded element in the sentence (cf. Cinque (1993)). In a context where the object is to be assigned sentence stress, it is not permitted to scramble (for instance, across the adverb) as shown by the contrast between (23a) and (23b). In a context where the verb is to be stressed or serve as the focus of the sentence, on the other hand, scrambling of the object is obligatory since it allows the verb rather than the object to count as the most deeply embedded element, as in (24a). It is to be noted that scrambling takes preference over the stress-shifting or marked stress assignment operation as indicated by the ungrammaticality of (23b) and (24b). This means that scrambling makes it possible to use unmarked/neutral stress, avoiding marked stress.

Notice that scrambling in Dutch and SAI in comparatives of English share some properties. First, it is apparently optional. Second, they affect sentence stress assignment. More specifically, after SAI occurs pronouns in comparative clauses of English cannot be put in a sentence-final position unless they are stressed, thereby being focused. Hence I suggest that similarly to scrambling (NP-movement) in Dutch, English has an option of moving a head element to change the focus structure of the sentence. In particular, head-movement in comparative clauses makes it possible for the subject NP to serve a focus. Under the proposed analysis, the relevant structure will be as follows:

- (25) Abby can play more instruments than can her father

- (26) . . . than [_{CP} *OP*₁ can [_{IP} her father *t*_{can} [_{VP} *t*₁ [_{VP} *t*_{SU} play *t*₁]]]]
 ↑ head-movement at PF

I will assume, following Merchant (2001) that the null operator moves to Spec of CP in overt syntax. However, departing from Merchant, I argue that the modal *can* moves to C at PF. Note that in English, the most deeply embedded element which is in the sentence-final position receives neutral sentence stress (cf. Cinque, 1993). Hence after I-to-C movement the subject *her father* counts as the most deeply embedded element which is

assigned neutral sentence stress. This means that I-to-C movement in comparative clauses is triggered when that makes it possible for the subject to receive neutral sentence stress, avoiding marked one. If this is the case, the contrast between (20a) and (20b) is expected; only the stressed strong pronoun can occur in the clause-final position. Furthermore, when the auxiliary verb receives neutral stress, I-to-C movement is not permitted as in (27b) since it does not bring about a change in stress assignment:

- (27) a. John plays more instruments than his FATHER DID
 b. *John plays more instruments than DID his FATHER

Next, let us consider the unacceptable sentence (28), which has the structure (29):

- (28) *Abby can play more instruments than can her father play (same as (4a))

- (29) . . . than [_{CP} OP_i can [_{IP} her father t_{can} [_{VP} t_i [_{VP} t_{SU} play t_i]]]]
 ↑
 head-movement at PF

The reason why the sentence (28) is unacceptable is that SAI does not change the focus structure of the sentence. Notice that in this sentence, neutral sentence stress does not fall on the subject *her father* whether SAI occurs or not. This is because even after SAI applies, the subject does not count as the most deeply embedded element in the sentence-final position. Hence SAI need not and cannot apply as in (30):

- (30) Abby can play more instruments than her father can play

If so, the derivation of (28) violates the principle of economy at PF. Notice that, following the line of analysis by Fox (1995), Reinhart (1997) argues that scrambling in Dutch applies only when it is needed to derive a different word order with a concomitant different focus structure; otherwise it cannot be applied. If Reinhart's argument on economy at PF is on the right track, we do not have to worry about the intermediate trace within VP which Merchant (2001) is concerned with.

To conclude, the PF movement analysis of SAI in comparatives can

dispense with the ECP at PF, which is a desirable move under the Minimalism framework. Notice, furthermore, that in order for the subject to be assigned neutral sentence stress, it must be the case that the whole VP must be elided, as shown in (25). If, as standardly assumed, VP-ellipsis and sentence stress assignment are PF operations and if head-movement is also a PF operation, then there can be an interaction among them. The phenomenon of SAI in comparative clauses in English clearly points to this interaction.

5. Exclamatives in English

Let us consider the following data from exclamatives in English:

- (31) a. What a nice person John is!
 b. What a nice car John bought!

There are some properties that comparatives and exclamatives share. Oda (2002) observed that they are both subject to negative islands, as shown in (32a-b):

- (32) a. *What a nice person John *isn't*
 b. *John is nicer than Mary *isn't*

Diane Lillo-Martin (personal communication) pointed out that the inverted version of (31a) is also acceptable as in (33):

- (33) What a nice person is John!

Furthermore, Howard Lasnik (personal communication) pointed out that the inverted version of (31b) is unacceptable. However, if the main verb *buy* is included in the VP-elided constituent, then the sentence is improved substantially as in (34b):

- (34) a. *What a nice car did John buy!
 b. [What a nice truck Bill bought!] ?And what a nice car did John buy, too!

In addition, if the subject and the verb are inverted, then the former must be stressed when it is a pronoun:

- (35) a. *What a nice person is he!
 b. What a nice person is HE!
 c. What a nice person he is!

Since SAI in comparative clauses and exclamatives share some properties, it is quite natural to unify both. If this is on the right track, then instances of exclamatives constitute counterevidence for Merchant (2001). Merchant's ECP at PF crucially relies on the existence of the null operator, so that the following sentence is unacceptable because the phonetically null operator cannot satisfy the requirement of *PF-visible*, failing to PF-antecedent-govern the intermediate trace:

- (36) a. *Abby can play more instruments than can her father play
 (same as (4a))
 b. . . . than [_{CP} *OP*₁ can [_{IP} her father *t*_{can} [_{VP} *t*'₁ [_{VP} *t*_{SU} play *t*₁]]]]

However, Merchant's (2001) analysis cannot be extended to exclamatives. The reason is that in exclamatives, the *wh*-phrase overtly moves to Spec of CP and it is clearly PF-visible, so that it would PF-antecedent-govern the intermediate trace *t*' within VP. Hence, his account would predict that the example (37a) should be acceptable, contrary to fact.

- (37) a. *What a nice car did John buy!
 b. [_{CP} [what a nice car]₁] did [_{IP} John *t*_{did} [_{VP} *t*'₁ [_{VP} *t*_{John} buy *t*₁]]]

The proposed analysis can naturally extend to exclamatives in English. Let us assume, following Oda (2002) that the *wh*-phrase moves to Spec of CP in overt syntax as shown in (38):

- (38) a. [_{CP} [what a nice car]₁] [_{IP} John is *t*₁]
 b. [_{CP} [what a nice car]₁] [_{IP} John bought *t*₁]]

I claim that the element in the *I*⁰ position moves to C at PF to yield an apparently inverted structure as shown in (39).

(39) What a nice person is HE!

(40) $[_{CP} \text{ [what a nice car]}_i \text{ is } [_{IP} \text{ HE } t_{is} \ t_i]]$
 \uparrow head-movement at PF

I-to-C movement in exclamatives is optional. But the movement makes it possible for the subject now placed in the sentence-final position to receive neutral stress. This is evidenced by the fact that only stressed strong pronouns, not weak pronouns, are allowed to occur in a sentence-final position. The unacceptable sentence (41) is also expected because of PF economy, following Reinhart (1997) and Reinhart and Neelman (1998).

(41) *What a nice car did John buy!

(42) $[_{CP} \text{ [what a nice car]}_i \text{ did } [_{IP} \text{ John } t_{did} \text{ } [_{VP} \ t'_i \text{ } [_{VP} \ t_{John} \text{ buy } t_i]]]]]$
 \uparrow head-movement at PF

Notice that in order to change word order with PF movement, we should expect some effects on stress assignment; otherwise PF movement is not required to take place. In (41), the subject *John* is not in the sentence-final position, and it cannot receive neutral stress even after SAI applies. Hence, we do not have to and cannot apply SAI to the structure. Therefore, to assign neutral stress to the subject, VP-ellipsis is required to apply to the structure, as shown below:

(43) ?What a nice car did John!

(44) $[_{CP} \text{ [what a nice car]}_i \text{ did } [_{IP} \text{ John } t_{did} \text{ } [_{VP} \ t'_i \text{ } [_{VP} \ t_{John} \text{ buy } t_i]]]]]$
 \uparrow head-movement at PF

5. A Further Empirical Extension: PCI under Sluicing

Prosodically-conditioned head-movement can also be found in the Sluicing (or IP deletion) construction of the following type, which was investigated in detail by Rosen (1976).

- (45) a. The neighbors have been complaining. Guess what about
- b. The bell is tolling, but you shouldn't ask who for
- c. Shirley went to Gristleburg, but nobody knows {who with, what for}
- d. Howard shares the apartment, but I have no idea who with

Apparently, the examples in (45) involve preposition stranding. As a first approximation, it can be supposed that, for instance, (45a) is derived from the following structure, as suggested by Ross (1969):

- (46) The neighbors have been complaining. Guess what the neighbors have been complaining about

However, this cannot be right, because if (45a) is derived from the structure (46) by the deletion operation, it raises a problem with constituenthood. The underlined string in (46) that undergoes deletion does not count as a constituent, neither IP nor VP.

One possible way of fixing the problem may be to suppose that the stranded preposition is extraposed to IP before deletion applies, as suggested by Kim (1997). The relevant structure is represented in (47):

- (47) The neighbors have been complaining. Guess what_i [_{IP} the neighbors the neighbors have been complaining]] [about t_i]
└─┬─┘ extraposition

Despite its success for the sake of constituenthood in deletion, however, the postulated structure in (47) poses a problem with movement out of the extraposed item. It has been generally acknowledged since Ross (1967) and Wexler and Culicover (1980) that extraposition bleeds extraction.

Departing from the previous analyses, I propose that the examples in (45) are alternative variants of the following sentences:

- (48) a. The neighbors have been complaining. Guess about what
- b. The bell is tolling, but you shouldn't ask for whom
- c. Shirley went to Gristleburg, but nobody knows {with whom, for whom}
- d. Howard shares the apartment, but I have no idea with whom

This means that the examples in (45), like those in (48), involve pied piping of PP to Spec of CP. For instance, (45a) will have the same structure with (48a) in a certain point of derivation, as in (49):

- (49) The neighbors have been complaining. Guess [_{CP} [about what]_i [_{IP} the neighbors have been complaining t_i]]

Now a question is how the surface form of (45a) is derived from (49). Obviously, the operation needed to achieve this is preposition-its complement inversion (PCI) in Spec of CP.

What is the nature of PCI? First, PCI behaves in the same way as SAI in comparative and exclamative clauses, in that it makes an apparently 'inverted' preposition receive neutral sentence stress as in (50a). This is contrasted with (50b), where its complement wh-element in-situ in the sentence-final position is assigned the corresponding sentence stress, as noted by Kim (1997):


- (50) a. The neighbors have been complaining. Guess what ABOUT
 b. The neighbors have been complaining. Guess about WHAT

Second, PCI is sensitive to the morphophonological property of both prepositions and their complements. Loosely speaking, prepositions and their complements which are 'simplex' morphophonologically allow PCI, but 'complex' ones do not, as shown (51) and (52), where highlighted and italicized items represent 'offending' complex prepositions or complements:

- (51) a. *She is driving, but God knows *what town* to
 b. *He'll be at the Red Room, but I don't know *what time* till
 c. *She fixed it, but she wouldn't let us in on *what tool* with
 d. *He's been living in Arizona, but I don't know *how much time* for
- (52) a. *Gordon stroke a deal, but he wouldn't let us in on who *between*
 b. *Lisa has finished a homework, but I don't know when *before*
 c. *Peter found a book, but I have no idea what *on top of*

Given the two set of properties regarding PCI, it seems more plausible

to suppose that PCI results from the complement of a preposition undergoing incorporation (that is, head-movement) and adjoining to the preposition rather than XP movement of it to Spec of PP. The proposed analysis is schematized with the example (45a), as in (53):

- (53) The neighbors have been complaining. Guess [_{CP} [_{PP} what_{t1} about t₁]₂
 [_{IP} the neighbors have been complaining t₂]]
- 
- ↑
head-movement
at PF

Note that in the XP movement analysis as proposed by van Riemsdijk (1978), why PCI is not allowed when the complement of a preposition is 'complex' as in (51) remains a puzzle. In the proposed head-movement analysis, however, this follows from the fact that the 'complex' XP complement of a preposition simply cannot undergo incorporation. Furthermore, it can be said that the ungrammaticality of (52) is due to head-movement being sensitive to the complexity of the target head that a head moves and adjoins to.

To conclude, if the proposed analysis of PCI is on the right track, PCI is another instance of head-movement at PF. Sluicing or IP deletion makes it possible for a pied piped PP in Spec of CP to occur in a clause final position. In this structural environment, either the preposition or its complement receives neutral sentence stress, depending on whether PCI as head-movement applies or not.

6. Conclusion

The nature and timing of movement operations have been central themes in linguistic theory and continue to be so; as such, any source of illumination bearing on them is welcome. In this paper, I have argued that one such source comes from a rather modest and largely overlooked set of data hidden away in the nooks and crannies of the grammar of English. Based on the interaction of SAI and PCI with deletion and sentence stress assignment that are considered to be PF operations, I concluded that head-movement involved in SAI and PCI is most naturally understood as taking place at PF, that is, in the mapping from Spell-Out to PF (cf. Chomsky (2000) and Chomsky (2001a, b)). To the extent that this conclusion is correct, SAI and PCI do provide an argument that at

least one kind of head-movement occurs after Spell-Out, with effects on word order.

References

- Chomsky, N. (1971). Deep structure, surface structure and semantic interpretation. In D. Steinberg and L. Jakobovitz, eds., *Semantics: An Interdisciplinary Reader in Philosophy, Linguistics and Psychology*. Cambridge: Cambridge University Press.
- Chomsky, N. (2000). Minimalist inquiries: The framework. In R. Martin, D. Michaels, and J. Uriageraka, eds., *Step by Step: Essays on Minimalist Syntax in Honor of Howard Lasnik* (pp. 89-155). Cambridge, Mass.: MIT Press.
- Chomsky, N. (2001a). Derivation by phase. In M. Kenstowicz, ed., *Hale: A Life in Language* (pp. 1-52). Cambridge, Mass.: MIT Press.
- Chomsky, N. (2001b). Beyond explanatory adequacy. Ms., MIT, MA.: Cambridge.
- Cinque, G. (1993). A null theory of phrases and compound stress. *Linguistic Inquiry* 24(2), 239-298.
- Emonds, J. (1970). *Root and Structure Preserving Transformations*. Unpublished doctoral dissertation. MIT. Cambridge, MA.
- Fox, D. (1995). Economy and scope. *Natural Language Semantics* 3, 283-341.
- Kim, J.-S. (1997). *Syntactic Focus Movement and Ellipsis: A Minimalist Approach*. Unpublished doctoral dissertation. University of Connecticut, Storrs, CT.
- Lasnik, H. (1995). A note on pseudogapping. *MIT Working Papers in Linguistics* 27, 143-163.
- Lasnik, H. (1999). On feature strength: Three minimalist approaches to overt movement. *Linguistic Inquiry* 30, 197-217.
- Merchant, J. (1999). *The Syntax of Silence*. Unpublished doctoral dissertation. University of California, Santa Cruz, CA.
- Merchant, J. (2001). Subject-auxiliary inversion in comparatives and PF output constraints. In K. Schwabe and S. Winkler, eds., *The Interface: Deriving and Interpreting (Omitted) Structures*. John Benjamins: Amsterdam.
- Reinhart, T. (1997). Interface economy: Focus and markedness. In W. Chris,

- G. H. Martin and B. Manfred, eds., *The Role of Economy Principles in Linguistic Theory* (pp. 46-69). Berlin, Germany: Akademie.
- Reinhart, T. and A. Neelman. (1998). Scrambling and the PF interface. In B. Miriam and G. Wilhelm, eds., *The Projection of Arguments: Lexical and Compositional Factors* (pp. 309-353). Stanford, CA: CSLI.
- van Riemsdijk, H. (1978). *A Case Study in Syntactic Markedness: The Binding Nature of Preposition Phrases*. Foris: Dordrecht.
- Rosen, C. (1976). Guess what about? In A. Ford, J. Reighard and R. Singh, eds., *Papers from the 6th Meeting of the North Eastern Linguistic Society* (pp. 205-211). Montreal: Montreal Working Papers in Linguistics.
- Ross, R. (1967). *Constraints on Variables in Syntax*. Unpublished doctoral dissertation. MIT. Cambridge, MA.
- Ross, R. (1969). Guess who? In Binnick, A. Davison, G. Green and J. Morgan, eds., *Papers from the 5th Regional Meeting of the Chicago Linguistic Society* (pp. 252-286). Chicago: Chicago Linguistic Society.
- Oda, T. (2002). Exclamatives and negative islands. Unpublished master's dissertation. University of Connecticut, CT.
- Wexler, K. and P. Culicover. (1980). *Formal Principles of Language Acquisition*. Cambridge, MA: MIT Press.

Park, Myung-Kwan
Department of English
Dongguk University
Pil-dong, Chung-gu
Seoul, 100-715, Korea
E-mail: parkmk@dgu.edu

Received: Jun. 10, 2002

Revised version received: July. 23, 2002

Accepted: Aug. 24, 2002