A Corpus Based Analysis of Korean and English Science Popularization Texts in Terms of Reader-Involvement*

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In the present research, Korean and English science popularization texts in newspapers are compared from the perspective of the writer's management of the strategies for the reader's involvement in the text. The concept of involvement in discourse was originally regarded as relevant to spoken discourse. However, the notion is extended to the writer's linguistic attempts to evoke the reader's involvement in text. I argue that by employing resources such as the 1st person plural and the 2nd person pronouns, questions, and modal expressions of obligation in particular ways, the writer may evoke the reader's involvement in the text. Through the analysis, I explore how these linguistic resources are employed differently in the Korean and the English texts.

Keywords: cross-cultural text analysis, Reader-Involvement Evoking acts, the 1st person plural and the 2nd person pronouns, questions, modal expressions of obligation

1. Introduction

Features of Korean texts have not been researched in the Western academic world until relatively recently because of language barriers. However, interest in texts from non-Western cultures has increased as a result of pedagogical research on academic texts written by L2 learners. Since the organization of English L2 writings is distinctively different from that of native speakers (Kaplan 1966), growing attention has been paid to texts from non-Western cultures (Hinds 1983, 1987; Cheng 1985); rhetorical patterns of L1 texts have been thought to affect those of L2 English texts (Kaplan 1987, 1988; Taylor and

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Chen 1991; Grabe and Kaplan 1996; Dudley-Evans 1997; Hinkel 1997). For this reason, the research on Korean text has mainly focused on the organization of Korean academic texts or L2 Korean students' academic writings in comparison with that of native English texts (Eggington 1987; Y-H Choi 1988; J-S Ok 1991; J-H Cho 1999; S Lee 2000).

However, the writing conventions of Korean academic text have converged with English writing styles because of the increasing influence from, and of the necessity to communicate with, the English using academic world. For this reason it is difficult to find culturally unaffected ways of text organization in the academic genre. Even considering broader studies of texts in other genres, little attention has been paid to textual aspects other than organization.

Therefore, in the present research, a cross-cultural comparison of text will be done with a different type of data and from a different perspective. Firstly, science popularization texts in newspapers from the Korean and British cultures were chosen. Science popularization texts (scientific popularization, popular science or popular science writings) are usually understood as 'science writing for the general people' (Calsamiglia 2003: 139) and the word 'popularize' can be defined as 'to publish, spread, make something available to the general public' (Ciapuscio 2003: 209). Nowadays, this genre appears frequently in magazines or newspapers for ordinary readers. Unlike academic texts which have a relatively limited number of professional readers, newspapers are read by a large portion of the general public. Since newspapers cannot ignore the market pressure from the readers, the authors and the publishers need to be responsive to the readers' preferences regarding the various aspects of the texts in a given culture. For this reason, even though newspapers started from the Western world, this genre is more likely to reflect culturally characteristic features of Korean text than the academic genre. Furthermore, since the most topics of science popular genre are about science in general, the texts tend to deal with common scientific issues (e.g., genetically modified food, global warming, etc.). For this reason, it makes the cross-cultural comparison easier than other genres in news media such as political columns.

Secondly, instead of the viewpoint of 'textual meaning' (Halliday 1994) that emphasizes text organization, the comparison was made from the perspective of 'interpersonal meaning' of the text. Particular attention was paid to the linguistic devices writers can use to 'involve' the reader, such as reader oriented 1st person plural and 2nd person pronouns, questions, and modal expressions of obligation. Through comparing the two corpora, the final aim of the present study is to describe the cross-cultural differences in the ways of evoking reader-involvement in text and to identify the factors reflected in the differences.
2. The Study

2.1. The Notion of Involvement in Discourse Studies and Reader-Involvement Evoking Acts

The notion of involvement has been viewed from the perspective of spoken discourse. For the analysis of conversational discourse, Tannen (1989: 9-12) defines involvement as 'an internal, even emotional connection individuals feel which binds them to other people as well as places, things, activities, ideas, memories, and words'. She argues that a variety of linguistic means, such as repetition, dialogue, and imagery, are used by speakers to create involvement in the discourse.

In Chafe's research (1982: 35-53) on the comparison of spoken and written language, involvement is one notion that explains the features of spoken language and contrasts with the detachment which characterizes written language. Chafe argues that the contrast of involvement vs. detachment arises from the difference that speakers are normally engaged in face-to-face interaction with their audience, whereas writers are not. He also argues that speakers' involvement with their audience is realized through frequent reference to themselves using first person pronoun and to their own mental processes using cognitive verbs (e.g., think, have no idea, and feel) (see also Chafe and Danielewicz (1987), Biber (1988)).

Even though it is sometimes difficult to draw a clear border between the spoken and written modes, the notion of involvement has been regarded as a characterizing feature of spoken language and particularly viewed as a property of addressors (the solid arrow in Figure 1).

![Figure 1](image)

**Figure 1.** Addressor's involvement (solid arrow) and Reader-Involvement Evoking acts (dotted arrow)

However, the idea of involvement can be extended to include the attempt of the writer (the addressor in written discourse) to evoke the involvement of the

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1 In addition, Chafe (1982: 46-48) also adds that involvement is shown through linguistic devices for monitoring information flow (e.g., Well, I mean, and you know), for expressing enthusiastic involvement (e.g., just and really), for vagueness (e.g., and so on, sort of, and something like), and for hedging; and that the use of direct quotes also expresses involvement.
reader (the addressee in written discourse) in written discourse (the dotted arrow in Figure 1). In the present research, any textual attempt made by the writer to evoke the reader's involvement in the text will be called 'Reader-Involvement Evoking acts' (henceforth, RIE acts).

In order to explain the writer's attempt to involve the readers in the text, similar arguments that support the idea of RIE acts have been advanced in the area of written discourse analysis. Marley (2002) argues that copy-editors tend to use questions and modality to engage the readers in the advertisement. According to Schely-Newman (2004), newspaper columnists tend to use various linguistic devices such as creative use of pronouns, reported speech, use of coda and lexical inventions to make the readers be engaged in discourse. Hyland (2005: 176) also discusses linguistic strategies that he categorizes as 'engagement' – for example, reader pronouns, directives (including modals of obligation addressed to the reader), questions, shared knowledge, personal asides – as ways in which the writers of academic research articles 'relate to their readers with respect to the positions advanced in the text'. Therefore, in the next section, we will examine which lexico-grammatical devices can be used for RIE acts.

2.2. Linguistic Evidence of RIE Acts in Text

From the perspective of the extended concept of involvement, it can be recognized that various linguistic devices are employed in particular ways by writers for RIE acts. However, in order to ensure greater reliability, I ignore any linguistic features which can be used for RIE acts but do not occur frequently enough to give productive results, in the present research, the focus is put on the following three areas: reader-oriented 1st and 2nd person pronouns, questions, and the modal expressions of obligation.²

Firstly, it is found that the inclusive 1st person plural form and the 2nd person pronoun (see e.g., Pennycook 1994; Hyland 2001) are used for this purpose. Example (1) show's how the Korean first person plural form *wuli* can be used for an RIE act:

(1) *wuli-*ka wumcikitusi, *wuli* mom sok-uy DNA-to wumciki-n-ta.
we-NOM move.as our body in-GEN DNA-also move-PRS-DECL
'As we move, DNA in our body also moves.' (K-Text 1³)

² In the previous research on reader-involvement (Marley 2002; Schely-Newman 2004; Hyland 2001, 2002a, 2002b, 2005), the main focus of analysis was also put on reader-oriented personal pronouns, questions, and the modal expressions of obligation.

³ 'K-Text 1' stands for 'Korean Text No.1' which is in the Korean corpus used for the research. Similarly, 'E-Text 1' stands for 'English Text No.1'.
However, if *wuli* is changed into a common noun *inkan* ('human being'), the feeling the new sentence gives may be different in terms of RIE acts.

(2) *inkan -i wumcikitusi, inkan mom sok-uy DNA-to human beings -NOM move.as human body in-GEN DNA-also wumciki-n-ta. move-PRS-DECL

‘As human beings move, DNA in the human body also moves.’

(my alternation of (1))

When (1) and (2) are compared, it can be argued that the former sounds more involving and relevant to us than the latter even though the propositional contents of the two sentences are the same. In addition, the latter sounds more distanced from and neutral to us than the former. A possible reason for the feeling of involvement in the text is the employment of the personal pronoun in (1). As the referent of the 1st person pronoun plural form is ‘people in general’4 (‘generic use’, Quirk et al. 1985: 353) or includes the addressee as well here (‘inclusive use’, Quirk et al. 1985: 339-340), the personal pronoun in (1) can be seen as referring to the reader. In other words, by making explicit reference of the reader through the personal pronoun, the writer is construing a textual persona5 with whom the readers can identify themselves. The same explanation is applicable to the use of the 2nd person pronoun in (3):

(3) khemphyuthe-nun tangsin -uy maum -ul alci Computer -TOP you -GEN intention -ACC recognize moshan-ta. not.do-PRS-DECL

‘Computers do not recognize your intention.’ (K-Text 81)

(4) khemphyuthe-nun inkan -uy maum -ul alci Computer -TOP human beings -GEN intention -ACC recognise moshan-ta. not.do-PRS-DECL 'Computers do not recognize human being’s intention.'

(my alternation of (3))

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4 Apart from *WE*, 2nd person pronoun *YOU* and other personal pronouns can also be used generically (see Quirk et al. (1985: 353)).

5 Thompson and Thetela (1995: 110-111) specifically name such potential reader's persona in text 'reader-in-the-text'.
By referring to the reader using the 2nd person pronoun tangsin, the writer is constructing a textual persona with whom the reader could identify himself/herself, i.e., the writer is performing RIE acts.

Secondly, questions, which are typically realized as interrogatives in written texts, can also be employed for RIE acts (see e.g., Kirszner and Mandell (1987), Frank (1989), Swales and Feak (1994), Webber (1994), Hyland (2002)) because the inherent function of questions is basically to request addressees to give some kind of response (or information) (Schegloff and Sacks 1973: 295; Quirk et al. 1985: 804; Halliday 1994: 69; Tsui 1994: 65).

By asking a question, the writer can offer a chance for the reader to think about the answer, to provoke the reader's curiosity about what comes next after the question or to make the reader 'accept the direction the text is taking' (Thompson 2001: 61). In addition, the writer can construct questions which the future readers may possibly have asked for themselves in their minds while they are reading. All these attempts the writer makes can be understood as a strategy for RIE acts. This point can be clearly recognized in (5):

(5) He was sure he was looking at a helix, that he and Crick were on the right track. Why was he so certain? Because Wilkins had told him as much since 1951 and, coincidently, Crick had just developed a brilliant mathematical theory of how a helix would look under X-ray diffraction. (E-Text 5)

Through the question, the writer introduces the underlined sentences as the answer to the future readers' possible question. Thompson (2001: 62) argues that, through using this type of question, the writer is involving the readers in the development of the argument more effectively. If the question is replaced with the wordings He was so certain, such effect questions can give disappears as in (6):

(6) He was sure he was looking at a helix, that he and Crick were on the right track. He was so certain because Wilkins had told him as much since 1951 and, coincidently, Crick had just developed a brilliant mathematical theory of how a helix would look under X-ray diffraction. (my alternation of (5))

Thirdly, apart from the use of personal pronouns and questions for RIE acts, the modal meaning of obligation (deontic modality), which is realized by expressions such as must or have to in English and -eya/aya hata or -eya/aya

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6 Apart from tangsin, there are various forms of Korean 2nd person pronouns: ne, cane, yelepwen, imca, and kutay.

7 As well as deontic modality, the expressions of epistemic modality can be a linguistic device for RIE acts as in 'You may think...'. I discussed this topic in my major studies (see C-K Kim (2006)).

8 Since each English modal verb for deontic modality has its own inherent semantic peculiarity, it
toyta in Korean, can also be used for the same purpose. The basis for the assumption is that the modal meaning of obligation in text shows the writer's awareness of the presence of the reader as an interactant. At the same time, the imposition of obligation can place a kind of psychological pressure on the reader which may potentially affect the reader's thoughts and behavior. For example:

(7) We know that our planet's resources will not last forever and that we should be trying to reduce the amount of rubbish we throw out.

(E-Text 60)

Through the modal expression should, the writer is imposing an obligation upon the reader which may possibly affect the reader's thoughts and, as a result, can possibly evoke the reader's involvement. If the underlined sentence is replaced with another sentence that does not have any modal expression as in (8), the effect of the RIE act will be decreased.

(8) We know that our planet's resources will not last forever and that it is important to try to reduce the amount of rubbish we throw out.

(my alternation of (7))

In the present research, the three linguistic devices mentioned above will be focused on for the comparison of Korean and English texts. In the next section, the information about the data will be given.

2.3. The Data

The data were collected from the science popularization texts from two Korean and two British newspapers. The texts were written by the science reporters of the newspapers ('journalist-writers') or scientists ('scientist-writers') themselves working in the given areas. Table 1 shows the total numbers of texts and of sentences in the two corpora.

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can be assumed that there are possible differences in the effect of RIE acts: although the modal verbs must and have (got) to express the same basic meaning of 'obligation', the modal verb must 'typically suggests that the speaker is exercising his/her authority', whereas have (got) to tends to lack such implication of exercising personal authority (Quirk et al. 1985: 225). In addition, although must, should and ought to normally suggest the speaker's authority, should and ought to do not imply that 'the speaker has confidence that the recommendation will be carried out' (ibid., p. 227). For these reasons, it can be argued that must can be a choice that sounds more involving to the reader than the other deontic modal expressions. This kind of possible variations in the effect of RIE acts is worth discussing. However, we cannot focus only on the modal expressions here; the main purpose of this paper is to present an overall picture of cross-cultural comparison of texts in terms of RIE acts. Therefore, the variations in the effect of RIE acts will be discussed later in the future study.
In order to control possible variables, I set out to compare the same amount of data from the two groups of texts. As shown in Table 1, more Korean texts were collected in order to equalize the total number of sentences because the Korean science popularization texts I collected were usually shorter than the English ones in length.

In most corpus analysis, the amount of data is measured by the number of words using corpus analysis softwares such as Wordsmith Tools. The softwares usually identify one string of letters as one word because they are mostly designed based on English. However, Korean words do not correspond to strings because the Korean language is an agglutinative language: one string of Korean letters, which the softwares count as one word mechanically, may be more than one Korean word. This point makes it impossible to use the number of words as a unit for measuring the data. For this reason, the number of sentences is chosen for a unit for measuring the data.9

2.4. Methodology

The comparison of the two groups of texts was done broadly in two ways. Firstly, the frequencies of the three linguistic devices used for RIE acts mentioned in Section 2.2 were compared. Specific examples of the three linguistic devices identified in the analysis are given in Table 2.

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9 The total numbers of strings of letters in the English and the Korean corpus are 168,500 and 155,850 respectively. Considering the agglutinativeness of the Korean language, it can be guessed that the total numbers of words in each corpus may not be so different.
Table 2. The linguistic devices cross-culturally compared in the present research

<table>
<thead>
<tr>
<th>Linguistic Devices</th>
<th>Examples in Korean</th>
<th>Examples in English</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Personal pronouns</td>
<td>1\textsuperscript{st} wuli</td>
<td>WE</td>
</tr>
<tr>
<td></td>
<td>2\textsuperscript{nd} tangsin, yelepwan</td>
<td>YOU\textsuperscript{10}</td>
</tr>
</tbody>
</table>

(ii) Questions which are realized through any independent interrogative clause, tag or sentence fragment ending with a question mark. (In the Korean texts, any independent clause that ends with interrogative suffixes but without a question mark is also regarded as a question.)

<table>
<thead>
<tr>
<th>(ii)</th>
<th>Examples in Korean</th>
<th>Examples in English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questions</td>
<td>-eya/aya hata,</td>
<td>must, ought to,</td>
</tr>
<tr>
<td></td>
<td>-eya/aya toyta</td>
<td>should, have to,</td>
</tr>
<tr>
<td></td>
<td>VERB STEM-nun kesi philyohata</td>
<td>have got to\textsuperscript{11}</td>
</tr>
<tr>
<td></td>
<td>AGENT-ka/(un/un)GOAL-ul/ul VERB STEM-l philyoka</td>
<td>need to</td>
</tr>
<tr>
<td></td>
<td>issta</td>
<td>It is necessary for AGENT to INFINITIVE GOAL,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There is a need to INFINITIVE</td>
</tr>
</tbody>
</table>

Secondly, the ways in which these devices are employed were compared. For more efficient comparison, I devised the following three research questions (henceforth RQ).\textsuperscript{12} Analytical categories particularly for (ii) and (iii) in Table 2 were devised in a way which allowed the comparison to be carried out according to the possible answers to RQ 2 and 3. The followings are the three RQs:

- **RQ1.** Which pronoun (1\textsuperscript{st} person plural or 2\textsuperscript{nd} person) is preferred?
- **RQ2.** Is the question relevant to the topic of the whole text?
- **RQ3.** Is the obligation imposed on explicit or implicit agents?

Firstly, RQ1 asks the frequency of each pronoun in the two corpora. Regarding RQ2, if a question is related to the topic of the whole text, the question is categorized as ‘Global type’. Because of the close link to the topic, Global type questions usually come at the beginning or near the beginning of

\textsuperscript{10} Although the word reader in English (or tokca in Korean) is a common noun, it can be counted as a case of a RIE act if it is employed as vocatives to address the reader directly. However, there is no such case in the two corpora for the present research.

\textsuperscript{11} In addition, the English personal pronouns in italicized capital letters (e.g., WE, YOU) in this paper represent all case forms of the pronoun (subjective, objective case form, possessive determiners, possessive pronouns and reflexive pronouns).

\textsuperscript{12} The modal verb shall is used for a meaning of obligation in very restricted cases (e.g., legal or quasi-legal discourse) (Quirk et al. 1985: 230) and the modal idiom had better has a meaning of strong recommendation, similar to the deontic meaning of ought to and should (ibid., p. 142). However, they are not considered for this analysis; both of them found in the present corpus are not used for a meaning of obligation.

\textsuperscript{12} There are clearly many aspects that could be compared apart from these RQs in my major studies. However, in the present paper, I have chosen one most revealing issue for each of the three linguistic devices which can show differences between the two corpora clearly because of the limited space.
the text, or as titles or headlines. In addition, the whole text usually deals with the question by providing answers or examining conflicting views. For this reason, the same question tends to be repeated in different formulations throughout the text. For example:

(9) [the beginning of the text] Could it be that the universe is fundamentally ugly? For 90 years, most astronomers believed that the simplest, most beautiful version of Einstein's theory of gravity describes how the universe evolves. Four years ago, however, a group of astronomers astonished the world by showing that, according to new data, nature does not adopt the most beautiful version of the theory but prefers an ugly variant and last week NASA announced stunning new observations that lent strong support to the notion that the universe is not beautiful in the way Einstein supposed. Soon, other astronomers will contribute new evidence on the way the universe is built. ... Will beauty prevail?

It was Einstein himself who first pointed out that it was logically possible

... But could this widely accepted picture be built on sand and the cosmological constant be zero after all, as Einstein hoped? Several experiments are now under way to check this, once and for all.

The satellite has another three years' worth of data to collect and it will be fascinating to see what new insights are in store. In the field of supernova research, Robert Kirshner's former research student Adam Reiss is leading a team that is using a new camera on the Hubble Space Telescope to take repeated images of a typical spot in the sky every 40 days.

... Einstein's simplest version of his theory of gravity would be dead, but at least Kirshner's dog would be spared. Could it be that the version of Einstein's theory with a cosmological constant is but part of a yet-to-be-conceived more encompassing, even more beautiful theory of the universe?

My bet is that Einstein will have the last laugh and that beauty will prevail [the end of the text]. (E-Text 4)\(^{13}\)

Even though the wordings of questions in (9) are different, they are repetitions of the same content that is the topic of the whole text: whether Einstein's theory is right or not. Through the repetition, the writer signals that he is dealing with the same problem again and again throughout the text.

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\(^{13}\) The full text of this example is written in Appendix I.
On the other hand, if a question is not closely relevant to the topic of the whole text but is used simply to introduce some information, the question is classified as 'Local type'. The question in Example (10) below is Local type:

(10) yenghwa maythuliksuy kasangseykyeynun yecenhi hyensil kwa kwupyelil eylepta. ettkey ikesi kanunghalkka? kwahakcatulun kasangseykyeyul silceywa ttokkathi mantulkwiwhay, khukey ney kaciuy hayksimiksulpi phiyohtaka malhanta. chesccaynun...twu pencaynun...sey pencaynun... macimakun taythepeysu kiswulita....

noy-khemphyuthe inthepheyisu kiswuluy swuhyeysanun wusen cangayintul ita.

'It is still difficult to differentiate the virtual realities in the movie Matrix from real life. How is this possible? Scientists said that roughly four key technologies are needed in order to make the virtual realities the same as real life. Firstly... Secondly... Thirdly... Lastly, it is the database technology....

It is most of all the disabled who will receive the benefit from Brain-Computer Interface technology....' (K-Text 4)

As shown with the underline, the answer is directly given after the question and therefore only restricted parts of the text is dealing with the question. After the question and the answering session represented in underlined sentences in the example, a new issue (the 'Brain-Computer Interface technology'), which is the main topic of the whole text, is introduced.

Concerning RQ3, there are two possible categories according to whether the obligation is imposed on explicit agents which include the reader - such as wuli in Example (11), you in (12), and everybody (everyone) in (13) – or on implicit ones such as the omitted agent of passive clauses in (14) below. The former three examples are categorized as 'Explicit type' of imposing obligation, whereas the latter 'Implicit type'.

According to Brown and Levinson (1987: 66), the imposition of obligation can 'threaten the addressee's face', and this means that the writer's use of modal expressions of obligation can be regarded as a FTA to the reader. This justifies the division of the data into Explicit and Implicit type; the way in which the agent is realized in text may reflect the writer's different strategies for doing this kind of FTAs.

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14 In Example (10), the syntactic explanation is not given because it is not the main point of this example. Instead, the original Korean text of (10) is listed in Appendix 3.
(11) "From now, we should search for the answer to the third question 'Does life only exist in the Earth?'' (K-Text10)

(12) There's not a lot you need to know about the link between MMR and autism, except that there's very little evidence to suggest any link at all. You don't have to take my word for it, because I'll describe the science later,... (E-Text 51)

(13) "Whether you've got a family history of heart disease or not, everybody should be living a healthy lifestyle," Shaw says. (E-Text 13)

(14) At the end of a year, the group tested in Pennsylvania showed no difference in weight loss, regardless of the diet they had been on. The results of both tests, it seems, should be treated with caution. (E-Text 48)

In Korean, apart from the cases of agnetless passive voice clauses, there are many cases where the subject of a sentence does not appear; contextually retrievable nominal elements are easily omitted if they are not topicalized in the Korean language (H-M Sohn 1999: 265). Thus, the subject of the verb to which the modal expressions of obligation are agglutinated, i.e., the agent who should fulfill the obligation, can be easily omitted: as shown in (15), there is no subject for thvwcahayya hanta 'must invest'. This case will also be regarded as Implicit type.15

(15) tokchangcekin yenkwu-lul swuhayngha-nun changuycekin 
original research-ACC do -REL creative
kwahakca-lul paychwlhaki wihaysenun tayhak kyoyuk-uy
scientist-ACC fostering for university education-GEN
te manhun sikan-ul cenkong kyoyuk-ey
much more time-ACC specialty education-ey

15 No matter how common the omission of the subject in Korean is, the agent for modal expressions of obligation can still be expressed explicitly in text if the writer intends this. This justifies all the cases of the omitted agent are categorized as Implicit type although the omission is frequent in Korean.
3. Results and Discussions

3.1. The Use of Personal Pronouns for RIE Acts

The frequencies of the Korean and the English personal pronouns used for RIE acts are listed in Table 3 below. As shown in the table, there is a significant difference in the numbers of the pronominal use for RIE acts. In the Korean corpus, the personal pronouns are employed about 6 times less frequently than in the English corpus. One reason for this lower frequency comes from the syntactic features of the Korean language. As explained with Example (15), Korean pronominal elements can be easily omitted where, in English, the use of pronouns may be necessary. This syntactic feature may be the major reason why Korean personal pronouns are not employed as frequently as English ones are.\(^\text{16}\)

In addition, there are distributional differences in the pronominal use for RIE acts. In English, \textit{YOU} and \textit{WE} are employed with almost equal percentage, whereas in Korean, the 1\(\text{st}\) person plural \textit{wuli} alone is the predominant choice, and the 2\(\text{nd}\) person \textit{tangsin} or \textit{yelepwn} is seldom used. Among the various Korean 2\(\text{nd}\) person pronouns – such as \textit{ne}, \textit{caney}, \textit{tangsin}, \textit{yelepwn}, \textit{imca} and \textit{kutay} – classified in terms of the honorific system, \textit{tangsin}\(^\text{17}\) or \textit{yelepwn} is usually employed to refer to the reader in newspaper articles because it is the least inappropriate one in terms of honorific levels. However, it is found in the present analysis of science popularization that even these least inappropriate choices are employed with very low frequency.

\(^{16}\) Regarding the low frequency of the Korean personal pronouns, one of the reviewers points out that it is not because the pronouns are omitted as I argue here; it is because 'a phonetically null (or zero) pronoun' is used instead. Although I agree with the comments, I find it impossible to measure the frequency of the null pronoun mechanically using \textit{Wordsmith Tools}. In addition, what is more concerned here is the writer's explicit realization of pronouns for readers' involvement. Therefore, the cases of the null form are not considered for the present research and the use of the null pronoun is regarded as the omission of the pronoun.

\(^{17}\) P-Y Lee (1987: 220) argues that the 2\(\text{nd}\) person pronoun \textit{tangsin} is typically used between interlocutors who are over 30 years old and feel a high degree of psychological pressure, i.e., the pronoun is used among adult interlocutors who are not familiar with each other.
Table 3. The frequencies and the percentages of personal pronouns for RIE acts

<table>
<thead>
<tr>
<th></th>
<th>English</th>
<th>Korean</th>
<th>Significance Test(^{18})</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL NUMBERS</td>
<td>1383</td>
<td>230</td>
<td>907.19*</td>
</tr>
<tr>
<td>2(^{nd}) person</td>
<td>YOU: 681</td>
<td>tangshin: 4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(49.24%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1(^{st}) person plural</td>
<td>WE: 702</td>
<td>wuli: 225</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(50.76%)</td>
<td>(97.83%)</td>
<td></td>
</tr>
</tbody>
</table>

\(^{18}\) Significant differences are asterisked. For the significance test in the present study, I calculated Log-likelihood value. The higher the Log-likelihood value, the more significant is the difference between the two frequency scores. For this table, a Log-likelihood value of 3.84 or higher is significant at the level of p<0.05.

In order to refer to the addressee appropriately in terms of honorifics using a 2\(^{nd}\) person pronoun, the Korean addressor needs to know information on the addressee’s places in the social hierarchy. In spoken situations, since face-to-face interaction is available, it is relatively easy to identify the addressee’s social status. However, in written discourse situations like newspapers, since such direct interaction between the writer and the reader is not possible, writers of newspaper articles can have very limited knowledge of the reader’s social status. Therefore, Korean writers are more likely to use the resources of the Korean grammatical system which allow them not to address the reader directly in text.

In contrast to the Korean pronominal use for RIE acts where socio-cultural as well as grammatical factors play important roles, in the English data the psychological factors of the individual writers seem to have an effect on the pronominal choice. In Example (16), through using the generic use of we, the writers are representing the idea that they and the reader are people in the same group who equally do not have complete knowledge on lions and the ecology of them.

(16) But a deeper understanding of the biology of this great species is also crucial to their informed conservation. It is no longer safe to assume that \textit{we} know everything about lions and that \textit{we} can be confident of their survival. (E-Text 95)

However, the use of the personal pronoun \textit{YOU} can have the opposite effect. For example:
The emotional pain of heartbreak is familiar to billions of us. But how far does the hurt actually go? Was Billy Corgan right - can you die from a broken heart?

Scientists have long known that falling in love has specific physiological effects on the body. Adrenaline shoots into the bloodstream when a person thinks about or lays eyes on their loved one, the pupils dilate, the heart speeds up, blood is diverted away from non-vital organs such as the stomach and you start to sweat more. In fact, the reaction is almost identical to the classic “fight or flight” response, a person’s response during a stressful event such as a job interview. But falling out of love also has its consequences. The body slows down, the immune system suffers and stress hormones shoot around the body, causing all manner of illness and disease. And if you are already ill, you’d better watch out. (E-Text 93)

(17) is about a correlation between ‘emotional pain of heartbreak’ and health. Even though the personal pronoun you refers to people in general, the writer is not construed as included in the referents of the pronoun. Through using you, the writer seems to be signaling that he distances himself from the readers, representing most of the readers as possibly having less knowledge of medical science than he has. Through distancing, the writer is representing himself as an objective observer who is not affected by the effects of the emotional pain. At the same time he is representing the readers as potentially vulnerable to the heartbreak.

To sum up 3.1, the analysis reveals that the Korean writers tend to employ the personal pronouns for RIE acts much less frequently than the English authors because of the syntactic feature of the Korean language. In addition, the ways in which the 2nd and 1st person pronouns are used seem to be influenced by different extra-linguistic factors.

3.2. The Use of Questions for RIE Acts

The quantitative results for questions used for RIE acts are as follows:

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19 Hyland (2001: 557) argues that the personal pronoun you indicates the writers' detachment from their readers in text.
Table 4. The frequencies and the percentages of questions for RIE acts

<table>
<thead>
<tr>
<th></th>
<th>English</th>
<th>Korean</th>
<th>Significance Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL NUMBERS</td>
<td>316</td>
<td>249</td>
<td>7.54*</td>
</tr>
<tr>
<td>- Global type</td>
<td>176 (55.69%)</td>
<td>84 (33.73%)</td>
<td></td>
</tr>
<tr>
<td>- Local type</td>
<td>140 (44.30%)</td>
<td>165 (66.27%)</td>
<td></td>
</tr>
</tbody>
</table>

(*p < 0.05; critical value=3.84)

As shown in Table 4, a significantly smaller number of questions are used for RIE acts in the Korean texts. One plausible reason of this difference is that the Korean writers seem to be less interested in providing textual dialogue in the text than the English authors.

In addition, the ways in which questions are used differ between the two cultures. In the Korean texts, Local type questions are far more frequently used (66.27%), whereas Global type questions in the English texts are slightly preferred (55.69%). This distributional difference can plausibly be linked to the writer’s view on the genre of science popularization.

As shown in (9) earlier and (18) below, by employing Global type questions more, the English writers are focusing on introducing unfinished debates among various research groups over a certain scientific topic. This open-ended way of writing reflects the fact that the English writers seem to regard the genre as a place where ongoing processes of scientific development, which may have wide-ranging possible hypotheses and debates, are introduced to the reader.

(18) [title] The coolest experiment ever
[headline] *Was Einstein right about general relativity? We’ll soon find out, says Tim Radford*

Scientists are about to launch the coolest experiment ever, to measure the most intangible thing in the universe - a warp in space-time. The experiment has been 40 years in the making, and it could settle a puzzle that is almost 90 years old: *was Albert Einstein right about general relativity? Do massive objects create a gravitational “well” around them into which things fall? Does a spinning planet drag space-time around with it?*

To answer these questions researchers have made gyroscopes out of the most perfect spheres ever, and the most exquisitely accurate telescope, sealed them inside a lead balloon in a 9ft-long vacuum chamber that is emptier than outer space, and dropped the whole thing into a flask holding 400 gallons of superfluid liquid helium. The whole package is now being prepared for launch from Vandenberg air base, California, to orbit 400 miles above the Earth where the telescope will be focused on the dead centre of a distant star. So will the spinning gyro-
... So, in 1915, Einstein proposed another way of thinking: suppose space (and therefore space-time) was a kind of fabric that would be distorted by massive bodies: the heavier the body, the greater the distortion and therefore the faster other objects would roll down the slope towards it.

... However in 1960, Leonard Schiff, one of the team at Los Alamos that tested the first atomic bomb, calculated that a gyroscope spinning in a vacuum and mounted in a spacecraft orbiting the planet's poles at an altitude of 400 miles should show that space-time was being "dragged" by the Earth's mass.

... "The second and more dramatic possibility is that the entire theory would have to be abandoned and replaced by something else that is fundamentally different in conceptual structure. There are alternative theories of gravity waiting in the wings," says Davies. "But my prediction is: general relativity will pass the test with flying colours." [the end of the text] (E-Text 59)

In contrast, as shown in (10) above and (19) below, rather than bringing up uncompleted debates in science, the Korean writers tend to give more absolute and determined answers directly after Local type questions in the texts. This relatively deterministic way of writing also seems to reflect the Korean writers' view of the genre: it is for explaining scientific events already accepted as true among scientists to the reader. This is a similar way of writing to textbooks where, in most cases, fully accepted scientific principles are explained to novice readers.


‘How was it like on the Earth during the Cretaceous period? Pangaea, the prehistoric continent which existed before the Triassic period and which Asia was a part of, was one entity but started to be separated from the late Jurassic period. When the Cretaceous period came, Asia,
North America and Europe, which once comprised one big continent, started to be separated.' (K-Text 6)

Summarizing 3.2, the analysis shows that questions for RIE acts are significantly more employed in the English corpus than the Korean one. Furthermore, the writers' preference for a certain type of questions seems to reflect their contrasting viewpoint on the given genre.

3.3. The Use of Imposing Obligation for RIE Acts

The quantitative results for the imposition of obligation using modal expressions in each corpus are as follows:

<table>
<thead>
<tr>
<th></th>
<th>English</th>
<th>Korean</th>
<th>Significance Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL NUMBERS</td>
<td>107</td>
<td>74</td>
<td>5.84*</td>
</tr>
<tr>
<td>-Explicit type</td>
<td>94 (87.85%)</td>
<td>20 (27.03%)</td>
<td></td>
</tr>
<tr>
<td>-Implicit type</td>
<td>13 (12.15%)</td>
<td>54 (72.97%)</td>
<td></td>
</tr>
</tbody>
</table>

(*p < 0.05; critical value=3.84)

As shown in Table 5, the Korea writers use expressions for imposing obligation for RIE acts less frequently than the English writers. In addition, there are also distributional dissimilarities in the use of the expressions for RIE acts. In the English texts, Explicit type of imposition of obligation, such as Examples (7), (12), (13), (20), (21) and (22) where there are explicit realization of the agents who should fulfill the obligation (e.g., we, you, everybody and people), occurs far more frequently than Implicit one such as (14).

(20) He thinks that instead of looking for the "obvious" possible health effects of radiation from mobile phones - cancers, say, or death - we should be exploiting modern techniques to study the effect of the radiation on the brain's chemistry. (E-Text 66)

(21) No, you shouldn't. Yes, you should. If it weren't so serious, there might have been something funny about the row between scientists either side of the Atlantic about how much salmon we should all eat. (E-Text 110)

(22) Madden says that, ultimately, people need to start looking at removing the need for so much travel. (E-Text 60)

In contrast, in the Korean texts, Implicit type, such as Example (15) where the
subject of the clause is omitted or (23) below which is a passive clause with an omitted agent, occurs far more frequently\(^{21}\) than Explicit one.

(23) nanchipyeng chilyo- lul wihan cheyseypho pokcey obstinate.disease remedy-ACC for stem.cell cloning yenkwu -nun kyeysoktoy -eya ha -n-ta.
research-TOP be.continued -should-PRS-DECL

'Stem-cell cloning research for the remedy of obstinate diseases should be continued (by us).’ (K-Text 173)

As indicated Section 2.4, through using modal expressions of obligation in text, the writers in both cultures are doing a kind of FTA (Brown and Levinson 1987) to the readers. However, from the results in Table 5, it can be argued that different strategies are employed for doing FTAs between the two cultures.

Based on the results in Table 5 and applying Brown and Levinson’s (1987) theory to them, it can be argued that English writers prefer to use two among the various strategies for doing the FTA of imposing obligation. The first one is a kind of positive politeness strategy: including both the writer and the reader in fulfillment of the obligation (p. 127). In Examples (7), (13), (20) and (22), by representing \textit{WE} and common nouns \textit{people} or \textit{everybody} as the explicit agents who should fulfill the obligation, the English writers are signaling that the fulfillment of the obligation should be shared between the writer and the reader who are in the same group because the reader as well as the writer can be one of the \textit{WE} and the \textit{people}. As a result, the English writer can reduce the degree of the FTA caused by the obligation and at the same time, achieve politeness to enhance the effect of RIE acts.

The second strategy is that the English writers impose obligation ‘without any redressive action, baldly’ (Brown and Levinson 1987: 69): there are a considerable number of occurrences (37 out of total 107 cases of imposing obligation) of the pronoun \textit{YOU} as the explicit agent who should fulfill the obligation (see Examples (12) and (21)) and this can give an impression that the writer is simply imposing obligation solely on the readers. This result may seem to contradict the argument in the preceding paragraph. However, these cases like (12) and (21) can also enhance the effect of RIE acts because, on the one hand the imposition is a kind of suggestion that is clearly beneficial for the reader, and on the other hand the 2\textsuperscript{nd} person pronoun is functioning as the direct reference to the reader.

\(^{21}\) As one of the reviewers suggested, it is worth considering that even the Implicit types can create a strong feeling of obligation when used with the adverbs such as pantusi, kkok or kiphilhho that mean ‘certainly’. However, this point is not discussed here because the scope of the present study does not allow me a detailed discussion of it.
In contrast, it can be argued that the Korean writers prefer to 'impersonalize' (Brown and Levinson 1987: 109) the agent through omitting the subject like (15) or passivization like (23) which are negative politeness strategies. One possible reason for this preference is that employing the Implicit type can be more desirable for the imposition of obligation than the Explicit one in the Korean culture where indirectness among interlocutors is usually highly valued; through avoiding explicit realization of the agent with whom the readers can identify, the pressure from the imposition of obligation on the reader may be relieved and this can increase the effect of RIE acts in the culture.

The cross-cultural differences in terms of the Explicit and the Implicit type seem to be in line with the classification of Western and Asian texts as being 'writer-responsible' and 'reader-responsible' respectively (Hinds 1987, 1990). Since the writers of Western culture tend to make the main messages and other information in text as transparent as possible for their readers, the agent who should fulfill the obligation tends to be explicitly represented as *you*, *we* and other forms of common nouns in the English texts. In contrast, since Asian readers are expected to fill in the gap between what the writer intends and what are really expressed in text for themselves, the agent does not seem to be clearly expressed in the Korean texts.

To sum up 3.3, the analysis indicates that the English writers use the modal expressions for RIE acts more frequently than the Koreans. In addition, it is also found that the two groups of writers seem to have their own strategies for doing the FTAs of imposing obligation on their readers.

4. Conclusion

In the present cross-cultural research, I have examined how personal pronouns, questions, and expressions for modal meaning of obligations are used differently in the two languages from the perspective of reader-involvement. Through defining the notion of RIE acts, the three linguistic devices between Korean and English science popularization texts have been compared. Quantitatively, all these three devices for realizing RIE acts are less frequently used in the Korean texts than in the English ones. From this result, it can be argued that the Korean writers appear less concerned about the construction of and the interaction with the reader in the text than the English writers are.

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22 The term 'indirectness' is used in various ways in written discourse analysis. It was originally used to explain the non-linear discourse organisation of Asian – particularly, Koran, Japanese and Chinese – texts (Kaplan 1966; Hinds 1983; Egginton 1987; Cahill 2003). However, the term is also used to refer to other linguistic features which serve to relieve a potential feeling of imposition caused by direct reference to the readers (see Hinkel (1997)). In the present discussion, the term has the latter meaning.
In addition, the analysis also shows qualitative dissimilarities in the ways of using the three devices for RIE acts. Firstly, the pronominal choice in the Korean texts is affected by socio-cultural factors. With the help of syntactic features, there are actually three choices of addressing the reader in the Korean texts: the 2nd person tangsin, the 1st person plural wuli and omission. However, the majority of Korean writers tend to avoid direct and exclusive reference to the reader through choosing omission in order to evade possible tension caused by their lack of information on the reader's social status in relation to themselves for honorifics. If a personal pronoun is still needed, 1st person plural wuli, which can refer to the reader and the writer as well, is employed. In contrast, the majority of English writers employ YOU and WE equally importantly, and the pronominal choice in the English texts seems to depend on each writer's psychological attitude toward his/her knowledge-derived authority in relation to the reader. On the one hand, the pronoun YOU represents the writer as psychologically distancing him/herself from the readers on the grounds of his/her knowledge-derived authority. On the other hand, the pronoun WE shows the writer's sense of 'in-group membership' (Cutting 2001) with the readers.

Secondly, the way in which questions are used for RIE acts reflects culturally different views on the science popularization genre. The Korean writers tend to assume that the genre is for supplying already proven knowledge to the reader, whereas the English writers seem to regard it as a place where various possible opinions in science are introduced.

Lastly, the study also reveals culturally distinctive strategies for doing FTA in the use of textual imposition of obligation for RIE acts. The Korean writers predominantly employ one of 'negative politeness' strategies, whereas the English choose 'positive' as well as 'bald on record' ones (Brown and Levinson 1987). From this, it can be argued that the writers of the two cultures have different attitudes toward the textual imposition of obligation. The Korean writers choose the negative politeness strategy suggesting that they regard the imposition as very much face threatening. In contrast, the English ones employ the positive one or do the imposition without any redress presumably reflecting the assumption that it may not threaten the reader's face so greatly (see the figure in Brown and Levinson (1987: 60)).

Based on these qualitative dissimilarities in the ways of using the textual devices for RIE acts, it is found that the text is not solely affected by the elements at the linguistic level. Instead, it can be argued that the construction of the text is influenced by both extra-textual and intra-textual factors. The former are mostly socio-cultural elements, including the writer's view of the genre, the writer and reader's relation in terms of social hierarchy, or the writer's psychological attitude toward the readers in the writing context, whereas the latter are usually syntactic features of a language.
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**Appendix 1: A Sample Text from the English Corpus (E-Text4)**

**The ugly truth about the universe**
Recent astronomical findings are bad news for Einstein and his dream of a simple, beautiful explanation for the universe, says Graham Farmelo

*Could it be that the universe is fundamentally ugly?* For 90 years, most astronomers believed that the simplest, most beautiful version of Einstein's theory of gravity describes how the universe evolves.

Four years ago, however, a group of astronomers astonished the world by showing that, according to new data, nature does not adopt the most beautiful version of the theory but prefers an ugly variant and last week NASA announced stunning new observations that lent strong support to the notion that the universe is not beautiful in the way Einstein supposed. Soon, other astronomers will contribute new evidence on the way the universe is built. *Will beauty prevail?*

It was Einstein himself who first pointed out that it was logically possible to make an unsightly addition to his gorgeous 1915 theory of gravity. He even used this flexibility to tinker with his theory by introducing something he called the cosmological constant. Always uneasy about the presence of this constant in his theory, he hoped that its value would be zero. Einstein wrote in 1947 to the Belgian cleric and Big Bang pioneer Georges-Henri Lemaître: "I am unable to believe that such an ugly thing should be realised in nature."

For once, it appears that Einstein's intuition was wrong. The unwanted con-
constant really does seem to be needed if Einstein’s theory is to describe nature. The first experimental demonstration that the cosmological constant is not zero was announced four years ago by a team of astronomers led by Brian Schmidt and his former research supervisor the ebullient Robert Kirshner, of the Harvard-Smithsonian Centre for Astrophysics. In 1998, *Science* magazine in the US cited this discovery as the “Science breakthrough of the Year”.

The data, however, had large uncertainties and many fellow astronomers were sceptical. “At first, I thought this must be wrong,” Kirshner admits. “After all, Einstein thought the cosmological constant was his greatest blunder, and he was pretty smart. But now, five years later, I’d bet my bull terrier!”

Confidence in the results was boosted when a similar result was reported by another team led by Saul Perlmutter of the Lawrence Berkeley Laboratory in California. Both groups were studying supernovae, exploding stars that disgorge their matter into outer space, simultaneously giving off light that astronomers measure when it arrives on Earth after travelling for several billion years. These supernovae are the torrid cauldrons that cook up the universe’s supply of heavy chemical elements. For example, the iron in your blood and in soil was originally manufactured billions of years ago in those stellar convulsions.

Kirshner and his colleagues were hunting for supernovae whose emitted light has taken more than seven billion years to reach the Earth – that’s a long way away even for astronomers. The supernovae that the experimenters were studying each have a very similar brightness, so the astronomers were puzzled when they found that the distant supernovae were rather dimmer than they expected.

They eventually came to the remarkable conclusion that the disparity in the brightnesses was an artefact of the way the universe is evolving. It turned out that this could most simply be explained if the universe is expanding at a gradually increasing rate. We appear to be living in a universe that’s accelerating towards oblivion.

One explanation is that the acceleration is due to mysterious force fields known as “quintessence”. Another, less adventurous but more popular, theory is that the apparent cosmic acceleration is due to the cosmological constant not being zero after all. If Einstein had been buried, he would have been turning in his grave.

His rotations would have resumed last week when spectacular evidence for the accelerating universe theory and the non-zero cosmological constant was announced in the US. This evidence did not come from astronomers studying supernovae but from a satellite, located on the other side of the Moon. This satellite, MAP, has been taking data that examine the microwave radiation that pervades the universe like light from the dying embers of the fireball of its distant past.
By studying the temperature of this background radiation, the group found that the universe is, in the jargon of Einstein's theory, “flat”. This means that parallel lines will never meet, even over cosmically large distances. This flatness makes it relatively easy to account for the different types of matter in the universe.

By comparing this satellite data with other astronomical observations, it is now possible to pin down the relative amounts of the different types of matter in the universe. It turns out that about 23 per cent of the universe is made of mysterious particles of “dark matter”, stuff that doesn't shine or reflect light, but whose existence is evident from the forces it exerts on distant galaxies (a bit like the waving of a distant flag tells us that it's in a wind).

Only about four per cent of the universe is made of the common-or-garden atoms that make up you, me and all the matter on our planet. So a whopping 73 per cent of the universe should be made of a mysterious material (unhelpfully dubbed “dark energy”) that somehow provides a negative pressure that drives the expansion of the universe.

Astronomer David Spergel of Princeton University says: “Remarkably, all the evidence from different cosmological sources now fits together, giving a simple description of the universe from its origins in the Big Bang 13.7 billion years ago.” But could this widely accepted picture be built on sand and the cosmological constant be zero after all, as Einstein hoped? Several experiments are now under way to check this, once and for all.

The satellite has another three years' worth of data to collect and it will be fascinating to see what new insights are in store. In the field of supernova research, Robert Kirshner’s former research student Adam Reiss is leading a team that is using a new camera on the Hubble Space Telescope to take repeated images of a typical spot in the sky every 40 days. By subtracting one picture from another, the hope is to find more distant supernovae than can be detected from telescopes on the ground. If the current picture for cosmic acceleration is correct, these supernovae should be so distant that they will show the effects of cosmic slowing down, before the dark energy gained the upper hand.

Kirshner says: “It’s like a tug-of-war. First we expect the weight of dark matter to slow the universe, but as the universe expands, the dark energy gets the upper hand, so we expect acceleration to take over at later times. If we see that change, from slowing down to acceleration, it will clinch the case.”

If later observations don’t wreck the current consensus, the aesthetes will have to come to terms with their disappointment. This is a classic case of what the biologist T H Huxley described 130 years ago as “the great tragedy of science - the slaying of a beautiful hypothesis by an ugly fact”.

Einstein's simplest version of his theory of gravity would be dead, but at least Kirshner's dog would be spared. Could it be that the version of Einstein's theory with a cosmological constant is but part of a yet-to-be-conceived more
encompassing, even more beautiful theory of the universe? My bet is that Ein­
stein will have the last laugh and that beauty will prevail.

Appendix 2: A Sample Text from the Korean Corpus (K-Text6)

6500만년 전 한반도는 ‘쥐라기 공원’
“공룡 발자국이 또 있어?” 전라도 일대에서의 공룡 발자국 발견 소식에, 전공은 다르지만 항상 나의 연구에 관심을 갖고 있는 동료학자가 던진 말이 다. 그만큼 우리나라에서 공룡 발자국은 이제 혼하다. 처음 공룡 발자국이 우리나라에서 발견됐을 때 느꼈던 신비감은 많이 회석했다.

동료 학자가 “공룡 발자국이 이렇게 많으니, 그만큼 공룡들이 많이 살았 다는 증거 아닐까”고 묻는다. 물론 그렇다. 한반도에 공룡이 번성했다는 사 실은 거의 확실하다. 하지만 한반도의 공룡들을 이해하기 위해서는, 보다 넓게 볼 필요가 있다. 전 세계 공룡의 생태를 되짚어보면, 당시의 한반 도를 바라볼 필요가 있는 것이다.

현재 한반도에서 발견되는 공룡화석들은 모두 중생대 백악기 지층에 둔 힌 것들이다. 공룡들은 지금으로부터 2억3000만년 전인 삼철기 후기부터 6500만년 전인 백악기 후기까지 약 1억6000만년 동안 지구를 지배했다.

시대적으로 보면, 공룡은 쥐라기 때가 훨씬 살기 좋았다. 영화 ‘쥬라기 공 원’을 보면 거대한 초식공룡인 브라키오사우루스가 키 높이만큼 자란 삼나 무 숲 속에서 먹이를 끄고 있는 장면이 나오는데, 당시 공룡들의 평균 생 활량은 단적으로 보여준다. 쥐라기의 은난한 기후와 풍부한 식물은 초식공 봉 거대화의 바탕이 됐다. 하지만 막상 한반도에 공룡들이 찾아온 것은 공 념시대 후기인 백악기이다.

백악기의 지구는 어떠했을까? 아시아가 속해 있던 초대륙 ‘판계야’는 삼철 기 때부터 하나의 대륙으로 몽쳐졌다가, 쥐라기 후기부터 큰 대륙으로 갈라 지기 시작한다. 백악기의 마지막에는 아시아, 북미, 유럽은 서로 분리되기 시작한다. 당시 한반도는 일본, 중국과 하나의 대륙으로 몽쳐있었 고, 곳곳에는 커다란 호수가 산재한 환경이었다.

당시 화산 폭발과 온실의 낙하하는 지구의 대기환경에 이산화탄소 등 유해 물질을 채우고, 오존층까지 영향을 받은 것으로 추정된다. 유럽의 기후는 서울해지고 곳곳에서 우기가 찾아왔다. 대형 초식공룡들은 방대한 양의 식 물들을 먹어치워 산림을 황폐화시켰다. 못먹던 식물들은 키 작은 속씨식물 로 진화했다. 이런 환경에서는 디플로도쿠스 같은 어금니가 없는 목 긴 공 봉보다, 하드로사우루스 같은 어금니가 발달한 오리주둥이 공룡들이 훨씬 더 유리했다.

한반도는 위기에 몰린 공룡들의 ‘마지막 보루’ 역할을 했다는 것이 현재 유력한 학설이다. 그럴 수 있었던 가장 중요한 요인은 기후조건이었던 것으로 보인다. 당시의 한반도는 지금과 달라서, 미국의 오대호 같은 커다란 호수가 산재했던 것으로 생각된다. 호수 주변에는 각종 침엽수와 양치류 같은 식물들이 풍부했다. 공룡들도 용각(龍腳류, 조각(鳥腳)류 등 골고루 분포했
다. 공통 주변에는 거북, 악어, 초기 포유류 등 각종 척추동물과 연체동물·절지동물 등의 화석이 풍부하게 발견되고 있다.

때문에 한반도의 공룡화석을 연구하다 보면, 수많은 익룡들이 한반도 남부 호 sok가에서 거대한 날개를 접고 먹잇감을 찾고 있는 모습을 자연스럽게 상상하게 된다. 당시 한반도와 비슷한 환경의 땅은 동물 고비사막과 중국 북동부 정도였다. 같은 시기에 북미에서는 공룡들이 절멸의 길을 걸고 있었다.

'공룡의 피난지' 한반도를 즐기는 종족은 수없이 발견되고 있다. 해남·화 순·여수·마산·울산 등 전라도와 경상도 곳곳에서 나타나는 세계 최대 규모의 공룡 발자국 화석이 대표적이다. 공룡 알은 하동·보성·서화호·통영에서, 익룡 발자국은 해남에서 무더기로 발견됐다.

보성·해남·하동·의성 등지에서는 공룡뼈 화석이 발굴을 기다리고 있다. 공룡 화석과 함께 산출되고 있는 식물 화석 및 각종 척추·무척추 동물의 화석도 백악기 당시의 한반도를 복원하는 데 큰 힘이 될 전망이다.

한반도 공룡 연구가 앞으로 풍부한 1번 번째 숙제는 일단 공룡발자국 연구가 될 전망이다. 발자국은 공룡의 걸음걸이, 속도, 행동 습성 등을 통해 아이가 검증할 수 있는 다양한 정보를 갖고 있기 때문이다. 최근 애국지에서는 공룡발자국 연구를 통해 타라노사우루스가 시속 20km도 달리지 못했다는 내용의 논문이 실리기도 했다. 통솔은 시속 70km였다. 일부 학자들은 타라노사우루스가 족은 동물을 먹는 나약한 젖이었다는 주장도 있으나 있다.

한반도는 이러한 문제를 해결할 수 있는 무수한 공룡 발자국 자료를 갖고 있다. 최근 한반도의 공룡 연구가들에게, 발자국 연구결과 공룡이 격려나 떠는 대신 종종 걸음(trot)으로 걸었다는 가능성을 제기하고 있는 것이 대표적인 예이다.

백악기 후기의 수수께끼를 풀는 데 한국은 천재의 땅이다. 기후 및 습도, 공룡과 식물의 관계, 익식 충돌의 진위, 공룡여공명기의 진화이론 등 '숙제'는 무수하다. 이를 해결하기 위해 학자들은 컴퓨터 단층 활영을 통해 공룡알 내부 구조를 해석하는 하지만, 백악기 후기의 공룡의 각 종 동물들의 생태 분석을 진행 중이다.

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Appendix 3: The Original Korean Text of Example (10)

(10) '영화 메트릭스의 가상세계는 여전히 현실과 구별이 어렵다. 어떻게 이것이 가능한가? 과학자들은 가상세계를 실제와 동일이 만들기 위해, 크게 나가지의 핵심 기술이 필요하다고 말한다. 첫째는...

...두 번째는... 세 번째는... 마지막은...데이터베이스 기술이다.... 뇌-컴퓨터 인터페이스 기술의 수혜자라는 우선 장애인들이다....'
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