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The Implications of Content Schemata for Standardized Reading Tests

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This article reports that a testee's content schemata have detrimental effects on the validity of standardized reading comprehension tests, in case that the reading passages constitute his prior background knowledge framed by regular academic pursuits focused on a major field of study. The empirical research findings on such a reliability issue have shown that the Korean subjects' familiarity with the content domain of the reading materials may substantially enhance their test performance, operated as unfair advantages over the other participants at the same level of English proficiency who do not possess technical knowledge closely related to the contents of the test passages. Based on these results, it may be argued that the reading text should be composed of maximally neutral contents to every testee to avoid the possible overlapping between a test-taker's content schemata and the content domain of the materials. Therefore, this article claims that the tenets of schema theory with its long-standing foundation on culturally predetermined content and formal schemata need to be expanded to cover professional knowledge structures, like those acquired by higher education, as the hard-wired framework of an individual's original culture-specific background knowledge.

[schema theory/content schemata/language proficiency testing, 선험지식구조이론/내용지식구조/언어능력시험]

Ⅰ. INTRODUCTION

The primary purpose of this article is to account for the implications of schema

theory in standardized English proficiency tests by initiating a validation study of reading comprehension passages selected from the Test of English as a Foreign Language (TOEFL) administrated by the Educational Testing Service (ETS) in the United States. Schema theory and its bulk of research findings (Anderson & Pearson, 1984; Block, 1992; Carrell, 1983, 1984, 1985, 1987, 1989; Carrell & Eisterhold, 1983; Casanave, 1988; Grabe, 1991; Lee, 1986; Nelson, 1987) indicate that students learning English as a Foreign Language or a Second Language (EFL or ESL) gain higher scores in reading comprehension section when encountering their native culture-oriented test materials.

Given the major tenets of schema-theoretical approach to EFL or ESL reading skills, the culture-oriented contents and rhetorical organization embedded in any standardized reading examinations may attenuate the validity of such official language testing systems. With this in mind, it would be necessary to take a careful look at the neutrality of such reading comprehension sections with weight on the test-takers' diverse cultural origins and background knowledge. In doing so, the conceptual boundary of *schema* first needs to be revisited with a possible expansion of schema-based argumentation, and its major differences from the psycholinguistic model of reading. Much attention will be given to the ways in which the test-makers are required to design or excerpt the standardized reading test materials from the points of the existing schema-theoretical view and a test-taker's specialized fields of knowledge to be conceivable as the acquired schemata.

II. CLAIMS OF SCHEMA THEORY

It is widely known that the term *schema* originates from Bartlett's research activities on human memory mechanisms, referring to the mental representation of an individual's past experience. In other words, any prior background knowledge or previously acquired knowledge structure -- a systematic mass of factual data signifying the general concepts stored in a man's long-term memory -- is called *schemata* (Carrell & Eisterhold, 1983). From this notion, we can understand that language processing is achieved when readers find a "configuration of hypotheses which offer a coherent account for the various aspects of the text" (Rumelhart, 1984 in Casanave, 1988, p. 284). In addition, Nunan (1991, p. 67) introduces Minsky's

views on the human's perception of new information; ". . . human memory consists of sets of stereotypical situations (frames) which guide comprehension by providing a framework for making sense of new experiences."

Researchers also hold that there are two different kinds of schemata -- *content* and *formal schemata* -- which are independently or collectively recalled to facilitate the interpretation of the text. The former, a *content schema*, refers to what a reader brings to a text as knowledge relative to the content domain of the text, and the latter, a *formal schema*, refers to another type of knowledge relative to the rhetorical organizational structures of various kinds of texts (Carrell, 1987).

So it is natural that the texts containing a reader's cultural norms, which provide familiar contents for him/her, should be more easily comprehensible than those describing unfamiliar conventions. Likewise, the texts possessing familiar organizational features would be easier to understand than those having unfamiliar rhetorical patterns. With respect to the relationship between content and formal schemata, Carrell (ibid.) states that when both content and form are factors in foreign or second language reading, content schemata are generally considered more influential than formal schemata, and each of these components takes major, but different, roles in the comprehension of a text.

In the basic claims of schema theory, reading comprehension is perceived as an interactive process between the readers' background knowledge and the text (Barnitz, 1986; Carrell, 1984, 1985, 1987; Lee, 1986; Matambo & Roller, 1992). This suggests that in the processing of the text materials, readers tend to reconstruct contextual signification from their internalized units of knowledge and the clues provided by the input data. Consequently, as the text activates and builds on existing schemata, the reader spontaneously negotiates and infers the covert meaning of the text (Widdowson, 1990).

In terms of the essential processing methods taken up by a reader, the schema-theoretical approach is similar to the psycholinguistic model of reading. The differences between these two notions are that schema theory places a strong emphasis on the effects of the reader's prior background knowledge, while the psycholinguistic model presents the general method to reconstruct the meaning of a text. This model shows that the reader reprocesses the message encoded by the writer as a graphic display (Goodman, 1971 in Carrell & Eisterhold, 1983). In support of Goodman's view, Grellet (1981 in Paran, 1996) points out that reading is a mental activity involving constant guesses, which are later rejected or confirmed.

Thus, the psycholinguistic model spells out the cognitive processes of comprehending the texts underpinned by the guidelines that every input is mapped against existing schemata.

Ⅲ. OUTLINE OF EMPIRICAL RESEARCH

1. The General Format of TOEFL

The TOEFL test has a standardized form designed to measure a test-taker's English language proficiency, of which the computer-based test (CBT) format comprises four sections: (a) listening comprehension, (b) structure and written expression, (c) reading comprehension and vocabulary, and (d) the test of written English (TWE). The reading comprehension section consists of short, medium-length and longer texts with several global and/or specific questions regarding the content and vocabulary set forth on the passages concerned.

In the paper-based test (PBT) format of the TOEFL, a vocabulary section was separated from the reading comprehension, involving the questions that asked the test-taker to choose one word or phrase among four multiple options which best keeps the meaning of the original sentence given if it is substituted for the underlined expression. As a result of his psychometric research on reading comprehension tests, Davis (1972) concluded that lexical knowledge is a scaffolding part of reading ability. This is based on the fact that the interdependent qualities of a test-taker's vocabulary power and reading comprehension skills derived from the high correlations between individual scores on these two sub-tests. Accordingly, the high degree of the correlations validated the decision of the ETS on combining vocabulary and reading comprehension sections.

2. Study Questions for Reading Test Materials

It is widely recognized that the ETS has not officially announced the validity of the TOEFL on the basis of any empirical research findings. In spite of this, the TOEFL score reports have been regarded valid for two years from their test dates for gauging a foreign speaker's English language proficiency. However, the ETS (1976) confirmed that the English proficiency level measured by the TOEFL is only

a linguistic competence that may change greatly according to the lapse of time with new experiences obtained, and hence, would not be a reliable predictor of academic performance at the college level.

This statement indicates that a TOEFL score has a valid foundation concerning a test-taker's level of language abilities for a certain period of time from a test date. But, given the cogency of schema theory, we cannot rule out the possibility that the contents presented by the reading comprehension sections themselves may have defects in the adequacy of test materials. So it would be necessary to scrutinize the problems related to this critical approach.

In order to get the better of such shortcomings, if any, there are two interrelated questions that need to be addressed as follows:

(a) What defects can we find out in the reading test materials in relation to the tenets of schema theory?; and
(b) What solutions can we suggest to overcome such defects, if any, in the reading texts?

According to the elicitation framework noted above, this article intends to address the first question above by analyzing the reading comprehension texts presented to test-takers and the test results obtained from an experimental study on this reliability issue, thereby to throw light on the problem-solving suggestion posed in the second question with the evaluation of the inquiry findings derived from the first question.

Ⅳ. METHODS AND PROCEDURES

1. Materials

Three sets of reading passages with their attached twenty-five multiple choice or separate questions were selected from the text materials provided for the examinees at the TOEFL test centers. The contents of these input data are composed of the basic concepts and principles relative to general biology (4/5 out of the total 25 questions) and natural sciences (1/5) (see Appendix A). In this process much attention was paid to whether a certain passage incorporates any

content which may undermine the validity of the reading comprehension test according to the tenets of schema theory.

It was presupposed to recognize the probability that a test-taker can get unfair advantages in solving the multiple choice questions about the reading passages containing any content domain covered by his/her prior background knowledge closely related to the individual major field of study in college education. In addition, a questionnaire (see Appendix B) was designed to obtain each subject's personal judgements on the reasons why he/she was considered to be at a more advantageous or disadvantageous position in taking this reading examination, compared with the other group participants, in case any subject had such a view due to his/her internal and/or external factors.

2. Subjects

This research was conducted with the two separate groups of forty Korean college students (juniors and seniors) at the high intermediate level of English proficiency indicated by their TOEIC (Test of English for International Communication) scores ranging from 700 to 800. The majors of twenty subjects (Group A) out of the total belong to the fields of biology, and the other twenty students (Group B), as a comparable group, have humanities or social science majors.

3. Procedures

Forty subjects took the test of twenty-five reading comprehension questions about three independent passages for forty minutes in a classroom. A perfect mark of all multiple choice and other questions was one hundred score based on four points assigned to each question. In this scoring, possible discrepancies each passage and question -- a global or specific type -- possessed in a degree of linguistic difficulties were disregarded on the ground that each subject's normal performance capability may also be influenced by his/her internal and/or external factors during the reading test. Shortly after the reading comprehension test, the two groups were requested to answer the questionnaire noted above.

V. RESULTS AND DISCUSSION

1. Results

Even though there appear to be some individual differences among all the subjects' English proficiency, the two groups (Group A - the fields of biology; Group B - the fields of humanities and social sciences) divided by their own majors demonstrated mutually contrastive score results as shown in Table 1 below:

TABLE 1

Score Results on Reading Comprehension Test

Group A (n=20)	Scores	SD
(Student ID No.)		
01.		76
02.		84
03.		80
04.		88
05.		92
06.		80
07.		96
08.		72
09.		80
10.		92
11.		84
12.		84
13.		80
14.		88
15.		76
16.		96
17.		92
18.		84
19.		88
20.		80
Mean Score	84.6	5.06
Group B (n=20)	Scores	SD

(Student ID No.)		
01.		68
02.		64
03.		72
04.		64
05.		76
06.		80
07.		56
08.		68
09.		64
10.		68
11.		72
12.		76
13.		80
14.		64
15.		68
16.		72
17.		84
18.		80
19.		72
20.		76
Mean Score	71.2	6.79

The descriptive results of the questionnaire survey are summarized in Table 2 below:

TABLE 2

Summary Results of Questionnaire Survey

Group A	% (Subject No.)
A-1: 17 subjects answered advantageous positions	
A-2: Reasons for advantageous positions	
1. English proficiency level	5.88 (1)
2. Familiarity with the contents of texts	76.47 (13)
3. Familiarity with the rhetorical form of texts	17.64 (3)
4. Years of college attendance	0 (0)
5. Other reasons	0 (0)

Group B	% (Subject No.)
B-1: 14 subjects answered disadvantageous positions	
B-2: Reasons for disadvantageous positions	
1. English proficiency level	0 (0)
2. Unfamiliarity with the contents of texts	78.57 (11)
3. Unfamiliarity with the rhetorical form of texts	14.28 (2)
4. Years of college attendance	0 (0)
5. Other reasons	7.14 (1)

2. Discussion

This experiment produced the noteworthy results. It was meaningful that the two groups demonstrated a relatively substantial gap -- 13.4 points -- between the mean scores of reading comprehension test, coupled with a marked difference -- 1.73 points -- in their standard deviations. The numerical outcomes above were supported by the questionnaire survey intended to confirm their individual recognition concerning a more advantageous or disadvantageous position in taking the reading test.

As a whole, these empirical findings posit the high probability that professional background knowledge gained in the subjects' major fields of study may lead them to get noticeable advantages for comprehending the reading text of which the contents are in close proximity to their specialized areas. On the basis of this, it can be argued that the content domain of reading passages used for the TOEFL tests should not be restricted to any major field of study connected with college education; a standardized reading comprehension test cannot be validated in case a test-taker's content schemata framed by such advanced learning may be called upon in tackling such examination questions.

Ⅵ. CONCLUSION

As set forth earlier, the research questions for the test materials were:

(a) What defects can we find out in the reading test materials in relation to the tenets of schema theory?; and

(b) What solutions can we suggest to overcome such defects, if any, in the reading texts?

Through the study on the question (a), it was found that the TOEFL reading test materials have incorporated any content domain providing unfair advantages for the test-takers whose major fields of study are closely related to such a subject-matter of the reading text. It is taken for granted that this defect critically lower the degree of reliability of the standardized examination.

The question (b) aimed to solve the problem raised in the question (a). Given the main causes of such a shortcoming described earlier, the broad-ranged content domains of the TOEFL reading comprehension section need to maintain a high degree of their neutrality, so that any test-taker may not get higher scores than those based on his normal competence to validate the credibility of the standardized test. Here it is suggested that future research should concentrate on how to accomplish such neutrality and/or universality in designing the test materials.

As a consequence, all foregoing confirmations have demonstrated that the culture-specific background knowledge recognized as the essence of schema theory should be reformulated in order to cover an individual's new knowledge structures acquired by his or her professional education.

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(APPENDIX A)

Reading Comprehension Test of the TOEFL

Questions 01~05

Magnesium is another mineral we now obtain by collecting huge volumes of ocean water and treating it with chemicals, although originally it was derived only from brines or from the treatment of such magnesium-containing rocks as dolomite, of which whole mountain ranges are composed. In a cubic mile of seawater there are about four million tons of magnesium. Since the direct extraction method was developed about 1941, production has increased enormously. It was magnesium from the sea that made possible the wartime growth of the aviation industry, for every airplane made in the United States (and in most other countries as well) contains about half a ton of magnesium metal. And it has innumerable uses in other industries where a lightweight metal is desired, besides its long-standing utility as an insulating material, and its use in printing inks, medicines, and tooth-pastes.

01. What is the main topic of this passage?
(A) Uses of seawater
(B) Treatment of seawater
(C) Chemical properties of magnesium
(D) Derivation and uses of magnesium

02. According to the passage, magnesium was first obtained from
(A) rocks found on land.
(B) great amounts of ocean water.
(C) the sea floor.
(D) major industrial sites.

03. According to the passage, which of the following was a direct consequence of the new method of obtaining magnesium?
(A) The development of insulation materials
(B) Increased airplane production
(C) Improved medical facilities
(D) The development of cheap inks for printing

04. According to the passage, why is magnesium important to industry?
(A) It is strong.
(B) It conducts heat well.
(C) It weights little.
(D) It is inexpensive to produce.

05. It can be inferred from the passage that during the past fifty years the demand for magnesium has
(A) declined greatly.
(B) remained stable.
(C) increased slightly.
(D) risen dramatically.

Questions 06~15

Like fats, amino acids are formed within living cells using sugars as starting materials. But while fats are made up only of carbon, hydrogen, and oxygen atoms, all available in the sugar and water of the cell, amino acids also contain nitrogen. Most of the earth's supply of nitrogen exists in the form of gas in the atmosphere. Only a few organisms, all microscopic, are able to incorporate nitrogen from the air into compounds -- ammonia, nitrites and nitrates -- that can be used by living systems. Hence, the proportion of the earth's nitrogen supply present to the living world is very small.

→ **Plants integrate the nitrogen in ammonia, nitrites and nitrates into carbon-hydrogen compounds to form amino acids. ■ Animals are able to synthesize some of their amino acids, using ammonia as a nitrogen source.** The amino acids they cannot synthesize, the so-called essential amino acids, must be obtained either directly or indirectly from plants. ■ For adult human beings, the essential amino acids are lysine, tryptophan, theronine, valine, isoleucine, methionine, phenylalanine, and leucine.

→ ■ People who eat meat usually get enough protein and the correct balance of amino acids. ■ People who are vegetarians, whether for philosophical, esthetic or economic reasons, have to be careful that they get enough protein, and in particular, the essential amino acids. ■ Until recently, agricultural scientists concerned with the world's hungry people concentrated on developing plants with a high caloric

yield. ■ Increasing recognition of the role of plants as a major source of amino acids for human populations has led to emphasis on the development of high-protein strains of food plants and of plants with essential amino acids, such as "high-lysine" corn. ■

Another approach to the right balance of amino acids is to combine certain foods. Beans are likely to be deficient in tryptophan and in the sulfur-containing amino acids, but they are a good-to-excellent source of isoleucine and lysine. Rice is deficient in isoleucine and lysine but provides adequate amounts of the other essential amino acids. Thus rice and beans make just about as perfect a protein menu as eggs or steaks, as some nonscientists seem to have known for quite a long time.

06. The main purpose of the passage is to
(A) discuss the role of nitrigen and amino acids in the life cycle.
(B) introduce the essential units of the life cycle.
(C) explain the importance of amino acids for humans.
(D) introduce the role and significance of amino acids.

07. Look at the word available in the passage. Underline the word or phrase in the **bold** text that is closest in meaning to available. [In original: Click on the word or phrase in the **bold** text that is closest in meaning to available.]

08. The cell provides all of the following EXCEPT
(A) nitrogen.
(B) hydrogen.
(C) oxygen.
(D) carbon.

09. Look at the word incorporate in the passage. Underline the word or phrase in the **bold** text that is closest in meaning to incorporate. [In original: Click on the word or phrase in the **bold** text that is closest in meaning to incorporate.]

10. The nitrogen supply available to the living world is small because
(A) there is simply not enough nitrogen in the air.
(B) only a few organisms are capable of absorbing nitrogen.
(C) onle a few organisms can incorporate nitrogen into usable compounds.

(D) it is not energy-efficient for some organisms to absorb nitrogen.

11. Amino acids are made up of
(A) ammonia.
(B) carbon-hydrogen compounds
(C) nitrates.
(D) nitrites.

12. The word they in the passage most likely refers to
(A) plants.
(B) carbon-hydrogen compounds.
(C) ammonia.
(D) animals.

13. The passage supports which of the following statements?
(A) Animals are the only source of protein.
(B) Plants are the only source of essential amino acids.
(C) Animals are able to synthesize certain types of essential amino acids.
(D) Animals are the only source of amino acids.

14. The passage implies that vegetarians refuse to eat meat for all of the following reasons EXCEPT that
(A) They want to lose weight.
(B) they don't want animals to suffer.
(C) they want to revitalize the fur trade.
(D) they don't want to strengthen the leather industry.

15. The following sentence can be added to paragraph 2 or 3.

It is dangerous to limit one's diet to only one type of food.

Where would it best fit in the paragraph?
Mark on the square [■] to add the sentence to paragraph 2 or 3. Paragraphs 2 and 3 are marked with an arrow [→]. [In original: Click on the square [■] to add the sentence to paragraph 2 or 3.]

Questions 16~25

→ In every living cell, many hundreds of chemical reactions proceed simultaneously. ■ Many are mutually incompatible, as can be demonstrated by destroying the structure of cells and mixing their enzymes in a test tube. ■ In the cell, however, anabolic and catabolic pathways operate in harmony because biochemical reactions are spatially localized and compartmentalized within specific subcellular organelles. ■ A living cell is the most intensely concentrated set of chemical reactions known. A cell carries out many more chemical reactions than any apparatus devised by chemical engineers, and all within the space of a few cubic micrometers. ■ The cell's unique chemical versatility results from the compartmentalization of biochemical pathways within organelles.

→ ■ In order to study th specific functions of any organelle type, the organelle must be dissected free from all other cell structures and collected in large quantities. ■ Cell biologists can prepare pure samples of any organelle type by the technique of preparative centrifugation. ■

Small particles, ranging in size from cells to macromolecules, can be separated by centrifugation if the particle types differ in size and density. Particles suspended in fluid and then subjected to strong gravitational force will move through the fluid at varying rates, the largest, densest particles settling most rapidly. Forces up to 400,000 times the force of gravity can be generated by rotating the tube at very high speeds in an ultracentrifuge. Thus, subcellular structures, such as mitochondria, nuclei, and intracellular membranes, can be separated into purified fractions by spinning fragmented cells at appropriate centrifugal forces.

In order to determine which enzymatic pathways are present in mitochondria, a tissue such as rat liver is minced into small pieces and homogenized -- that is, the cells are gently broken up by grinding the tissue in a glass tube. The resulting suspension of cell organelles is then placed in an unbreakable test tube and spun in the centrifuge at low speed for 10 minutes, so as to drive the bulkiest structures, the nuclei, to the bottom. All the lighter organelles remain suspended in the fluid, which is called the supernatant. The supernatant is transferred to another centrifuge tube and spun at a higher speed which sediments particles such as mitochondria and lysosomes into a pellet. The supernatant, containing ribosomes and various membranes, is discarded and the pellet is retained.

16. The author discusses primarily
(A) the process of dissecting a cell.
(B) the recent technological advances in studying the cell.
(C) the different chemical reactions occurring in the cell.
(D) the method which the cell biologists use to dissect cells.

17. Look at the word Many in the passage. Underline the word or phrase in the **bold** text that Many refers to. [In original: Click on the word or phrase in the **bold** text that Many refers to.]

18. The chemical reactions are mutually
(A) compatible.
(B) beneficial.
(C) antagonistic.
(D) destructive.

19. The structure of the cell transcends
(A) natural processes.
(B) human ingenuity.
(C) artificial intelligence.
(D) cosmic forces.

20. The word versatility in the passage is closest in meaning to
(A) efficiency.
(B) proficiency.
(C) utility.
(D) flexibility.

21. The following sentence can be added to paragraph 1 or 2.

Chemical chaos results, and the enzymes are soon inactivated.

Where would it best fit in the paragraph?
Mark on the square [■] to add the sentence to paragraph 1 or 2. [In original: Click on the square [■] to add the sentence to paragraph 1 or 2.] Paragraphs 1 and 2 are marked with an arrow [→].

22. Chemical reactions in a cell are possible because
(A) they are spatially localized.
(B) they occur one after the other.
(C) they do not happen in isolated areas.
(D) they do not occur at the same time.

23. Centrifugation consists of
(A) separating the organelles within the cell.
(B) preparing pure samples of the organelles.
(C) separating the organelles through spinning.
(D) suspending the organelles through grinding.

24. the bulkiest structure in a cell is the
(A) nucleus.
(B) mitochondrion.
(C) lysosome.
(D) ribosome.

25. Look at the word minced in the passage. Underline the word or phrase in the **bold** text that is closest in meaning to minced. [In original: Click on the word or phrase in the **bold** text that is closest in meaning to minced.]

[APPENDIX B]

A Questionnaire for Advantageous or Disadvantageous Position

(Directions) This is a questionnaire designed to confirm whether you, as a test-taker, personally think you were at a more advantageous or disadvantageous position than one belonging to the other group in this reading comprehension test, considering the basic information given below. Please mark on one of the following sections, "Advantageous", "Disadvantageous" or "None of these", and choose one of the main reasons for your own judgement set forth thereafter.

[Basic Information for Group-A & Group-B]

[Group-A]

(a) Total number/college grades; 20/juniors or seniors
(b) English proficiency level; TOEIC 650~750 score range
(c) Major fields of study; fields of biology

[Group-B]

(a) Total number/college grades; 20/juniors or seniors
(b) English proficiency level; TOEIC 650~750 score range
(c) Major fields of study; fields of humanities/social sciences

[ ] Advantageous [ ] Disadvantageous [ ] None of these

A. Your main reason for choosing an "Advantageous" position:

[ ] English proficiency level
[ ] Familiarity with the contents of the texts
[ ] Familiarity with the rhetorical form of the texts
[ ] Years of college attendance
[ ] Other reasons (please specify)

B. Your main reason for choosing a "Disadvantageous" position:

[ ] English proficiency level
[ ] Unfamiliarity with the contents of the texts
[ ] Unfamiliarity with the rhetorical form of the texts
[ ] Years of college attendance
[ ] Other reasons (please specify)

예시언어(*Examples in*): ***English***
적용가능 언어(Applicable Languages): **English**
적용가능 수준(Applicable Levels): **College/Higher**

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