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Linguistic intelligence and logical intelligence: Which is determinant for logical connector (LC) comprehension by EFL readers?

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Abstract: The label of ‘logical connectors’ (LCs) or ‘conjunction’ suggests that these expressions constitute an area where linguistic intelligence and logical/mathematical intelligence are likely to intersect. This paper is the first to explore the relationship between these two intelligence types and EFL undergraduates’ use of LCs in both their L1 (Arabic) and L2 (English). Two instruments (the Multiple Intelligence Inventory and the Logical Relations Reading Test) were administered to 200 English-major undergraduates. The results revealed that these students had significantly higher logical/mathematical intelligence than linguistic intelligence. Nonetheless, linguistic intelligence had a stronger correlation with their reading comprehension performance in both their L1 and L2. The findings of this study and their implications are helpful for EFL instructors and invite further in-depth research that addresses the relationship between intelligence types and EFL learning.

Introduction
Logical connectors (LCs), as well as words and phrases (e.g., in addition, because, therefore, however, etc.), which show the direction of the logical relationships between and among propositions constitute an invaluable source for the reader’s comprehension of text (Graesser, Gernsbacher and Goldman 2003; Ozono and Ito 2003). Understanding the factors that impact readers’ ability to invest LCs and their contribution to text comprehension is of paramount significance for EFL learners and instructors. The importance attached to understanding these factors is usually motivated by the fact that successful reading is the most commonly used channel of language learning for EFL learners, who are inadequately exposed to the target language (L2) for obtaining knowledge and building skills deemed necessary for academic accomplishments. Nonetheless, researchers (e.g., Goldman and Murray 1992, Schleppegrell 1996, Steffani and Nippold 1997, Kusuyama 2003, Ozono and Ito 2003) concur that ‘mastering appropriate use of LCs is extremely difficult’ (Goldman and Murray 1992: 505).

Effective foreign language (FL) learning, which is inherently a linguistic process, can hardly be claimed to function in absence of intelligence. Traditional accounts of intelligence, however, which use IQ tests to capture the essence of intelligence, are inadequate in providing an explanation for the type of intelligence at work in language learning. Instead, Gardner’s (1983) theory of Multiple Intelligences (MI) provides more useful insights into the functions of intelligence in communicative competence (Rahimi & Qannadzadeh 2010) than these traditional accounts. Linguistic intelligence, associated with writers, poets and eloquent speakers, involves an individual’s ability to use language effectively as a means of expression. Logical-mathematical intelligence, on the other hand, is often associated with scientific and mathematical thinking, and involves the ability to detect patterns, reason deductively and think logically (Gardner, 1983).

LCs have recently been studied in EFL research, based on the assumption that their label suggests that both linguistic intelligence and logical/mathematical intelligence may influence their use frequency in writing. Findings suggest, however, that linguistic intelligence has less contribution to their use frequency than logical intelligence. Since the common belief is that using these linguistic elements is influenced by the learners’ language proficiency level or linguistic competence, this study sets out to examine the extent to which the two types of intelligence (a) the...
logical/mathematical and (b) the linguistic, contribute to the use of logical connectors in EFL text comprehension in both L1 (Arabic, in this study) and L2 (English).

**Literature review**

Rahimi and Qannadzadeh (2010: 2013) assert that ‘No single empirical study has been found in the existing literature with regard to the relationship between the usage of logical connectors in SL writing and any type of intelligence. Nor is there a piece of research concerning the relationship between logical/mathematical intelligence and any category of cohesive devices in SL writing.’ This study therefore adopts a holistic approach in reviewing the literature that addresses LCs at a general level.

Halliday and Hasan’s (1976) seminal work, *Cohesion in English*, has motivated researchers with varied interests related to text construction and comprehension to show a great interest in understanding the contribution of certain linguistic elements to text. Especially during the late 1970s and 1980s, a plethora of research articles emerged addressing cohesion and coherence. Recently, research has witnessed a shift toward rigorous investigations that concern more specific text components among which LCs is a major one (Goldman and Murray 1992, Ozono and Ito 2003). Early research focused on LCs within the cohesion theory framework through studying LCs in addition to other cohesive devices representative of cohesive relations (e.g., reference, ellipsis, substitution and lexical cohesion). More recently, however, LCs have been investigated on their own because of their distinct nature in that their appropriate use requires not only linguistic, but also logical knowledge (Rahimi and Qannadzadeh 2010).

These investigations are motivated by the assumption that linguistic competence in the absence of a logical understanding of the direction of a logical relationship might be insufficient for meaning construction or reconstruction when two or more ideas are linked together using a LC (Steffani and Nippold 1997).

Reading and discourse processing research acknowledges the contribution of LCs to text comprehension, as they belong to one of three text-internal features readers use towards comprehension: (a) cohesion, (b) coherence, and (c) rhetorical organisation (Graesser et al. 2003). According to Graesser et al. (2003), cohesion refers to linguistic elements that include LCs, coherence is the a-linguistic knowledge that relates text elements together (e.g., time, space, causality, etc.), and rhetorical structure helps in identifying the global organisation of text using common patterns (e.g., problem and solution, comparison and contrast, etc.). LCs, in light of this proposal, function as a bridge between cohesion and coherence through their structural role (Meyer 1975) and semantic role (van Dijk and Kintsch 1983). Text, accordingly, is a construct whose cohesion is determined locally while coherence is determined globally.

LCs are more difficult than other linguistic elements. Nunan (1999), for example, reported that LCs are more difficult for students compared to other cohesive devices. Richardson (1989) compared the ability of 40 Arab EFL learners and 15 British students to infer deleted linguistic elements (e.g., article, verb, connectors, etc.). The results revealed that despite L1 differences, all the students followed the same order in supplying missing elements correctly, with LCs being the least correctly inferred for both student groups. Hartnett (1986) divided cohesive ties into two subclasses: static ties and dynamic ties. These two types differ in the kind of cohesive relations included and their respective linguistic expressions, as well as in the textual role/function these ties serve and in the difficulty they cause writers and readers. According to Hartnett (1986), static types of cohesive ties cause a relatively lower level of difficulty for the writer to construct and for the reader to reconstruct than do dynamic ties that are constructed using sequential (e.g., *before*), adversative (e.g., *however*), and causal (e.g., *therefore*) LCs. Dynamic ties express rhetorical manipulation of the topic through specifying the writer’s internal representation of the environment to indicate how the topic develops, changes or relates to something else.

To invest LCs effectively, readers need to identify them (Widdowson 1997), possess background knowledge about the topic addressed (Nunan 1999), have the world knowledge required to construct the situation model based on the textbase (Kintsch 1985) and determine the relationship between propositions, or how events are related (Goldman and Murray 1992).
Aidinlou and Pandian (2011) empirically investigated the importance of LCs in the reading comprehension performance of 45 upper-intermediate proficiency EFL students. The researchers used three different versions of a reading passage from the International English Language Testing System (IELTS): original, local-conjunctions-free and global-conjunctions-free. Students presented with the unmodified passage performed best, whereas the lowest performance was by students presented with the global-conjunctions-free passage. This demonstrated that LCs used to link text components at a global level are more influential than local-level LCs. This finding, however, was contradicted by Al-Surmi (2011) who examined the impact of LCs on the overall representation of information, by using a regular text on one group and a version of the same text devoid of LCs on another. Al-Surmi reported that there was no effect for the presence or absence of LCs on the overall representation of ideas.

These recent findings contradict earlier findings that suggest an important role for LCs not only in the time required for text processing, but also in shaping a clear representation of text ideas at a global level. For example, Haberlandt (1982, cited in Sanders and Noordman 2000) measured the processing time when LCs (e.g., however) are used in a text and found that sentences that include connectors are read more quickly than sentences devoid of them. Irwin (1986) reported that explicit marking of causal relations had a positive effect on the reading comprehension of college and school students from different grades. Irwin (1986) also reported that recall of causal relationships by native, fifth-grade speakers on a delayed, prompted recall task was helpful in recalling ideas from text. These findings are in line with Irwin’s (1986) contention that low proficiency readers find difficulty in processing texts at a global level, since they exhaust working memory with local textual constraints. They depend on LCs to construct global coherence (Irwin, 1986). Chung (2002) found LCs more beneficial to readers below the advanced proficiency level, since they contribute to discourse at a macro- rather than a microstructure level, as suggested by van Dijk and Kintsch (1983).

One very recent promising view towards developing an understanding of LC contribution to text construction (in writing) and text reconstruction (in reading) has linked LC use by language learners, especially in EFL contexts, to intelligence. Gardner distinguishes linguistic intelligence from mathematical/logical intelligence in that whereas the former is associated with ‘[s]ensitivity to the sounds, rhythms, and meanings of words; sensitivity to the different functions of language,’ the latter refers to ‘[s]ensitivity to, and capacity to discern, logical or numerical patterns; ability to handle long chains of reasoning’ (Gardner and Hatch 1989: 6). Linguistic intelligence, in other words, first relates to the language user’s comprehension of syntax, phonology and pragmatics to convince another/others of a course of actions, as exhibited by poets (Gardner 1983). Mathematical/logical intelligence, however, relates to understanding and using logical structures, which include patterns and relationships as well as statements and propositions. This kind of intelligence, accordingly, involves perceiving recurrent patterns that include numerical and other patterns (Gardner 2006). Smith (2001) suggested considering mathematical/logical intelligence, which is less apparent than other intelligences, in understanding the language learning process.

Rahimi, Mirzaei, and Heidari (2012) studied the impact of 80 successful EFL undergraduates’ MI on reading-strategy use. The results revealed a significant positive relationship between different intelligence types (linguistic, logical-mathematical, spatial, interpersonal and intrapersonal) and use of memory strategy, as well as between interpersonal intelligence and compensation and social strategy use.

Of more relevance to the current study is Rahimi and Qannadzadeh’s (2010) exploration of the relationship between use frequency of LCs in the writing of English-major EFL undergraduates using both LC token and type, on the one hand, and students’ linguistic and logical/mathematical intelligences, on the other. They found that EFL students with higher logical/mathematical intelligence tend to use more logical connectors in their essay writing. Rahimi and Qannadzadeh (2010: 2017) noted that linguistic intelligence ‘turned out to be less significant to the token rate of logical connectors in EFL essay-writing than the logical intelligence, though the students with higher linguistic intelligence possibly tend to avoid repetition in using logical connectors. They also concluded that ‘The role of logical/mathematical intelligence in SLL, which was thought to be less apparent than that of the other intelligences (Smith 2001), was proved to be more significant’ (p. 2018).
Given this finding, it is the purpose of this study to examine the assumption about the kind of contribution that these two intelligence types make to EFL undergraduates’ reading comprehension performance from a reader’s perspective. It is the researcher’s belief in this paper that addressing LCs from a reader’s perspective is quintessential. Whereas EFL learners may avoid a given connector in writing when they believe its use is troublesome, this is not likely to happen when they are confronted with a text that already has a LC in it that they need to understand.

The study

Research questions
This study is driven by the following two questions:
• Is there any correlation between EFL readers’ logical/mathematical intelligence or linguistic intelligence and L1 reading comprehensibility of LCs?
• Is there any relationship between EFL readers’ logical/mathematical intelligence or linguistic intelligence and L2 reading comprehension of LCs?

Participants
The sample of this study comprised a total of 200 (164 female and 36 male) English-major undergraduates who were recruited at a public university in Jordan based on convenience sampling from three sections (two sections for Academic Writing and one for Advanced Academic Writing). The participants, all native speakers of Arabic, had an average of 14 years of formal English instruction. The participants represented the four academic levels. On a 4-point scale, the majority (n = 91) had high GPAs (above 3.00) whereas others (n = 31) had much lower GPAs (below 2.00), and the remaining group had average GPAs (2.00–3.00). Students’ exposure to English was mainly in formal education that had lasted for 13–14 years.

Instruments
Two instruments were used to elicit data for the purpose of answering the questions posed by this study: a questionnaire and a reading test. The two types of intelligence addressed in this study were the linguistic and the logical/ mathematical.

For these two types of intelligence, this study adopted the first two domains of Walter McKenzie’s (1999) multiple intelligence (MI) inventory (available online at http://surfaquarium.com/MI/inventory.htm) with 10 items representing each domain, following Gardner’s (1991) framework. The original questionnaire was written in English. Despite the fact that the questionnaire was not expected to pose any linguistic complexity and that the study participants were all English-majors, the questionnaire was translated into students’ L1 (Arabic) in order to avoid any ambiguity or misunderstanding. Back translation was used to ensure that the Arabic version was equivalent to the original one. Its validity was confirmed by three professors with expertise in EFL instruction. Reliability was verified by distributing the questionnaire twice to 50 students who shared the participants’ characteristics, yielding a Cronbach’s alpha coefficient of 0.83, which indicates the adequacy of the instrument.

The second instrument, aimed at eliciting data about students’ use of LCs in reading comprehension, was Ozono and Ito’s (2003) Logical Relations Reading Test that consisted of six short reading comprehension paragraphs with a blank space in each. These blank spaces called for the use of each of the connectors for example, however, and therefore representing illustrative, adversative and causal logical relation types, respectively. According to this test, the different short reading paragraphs had a comparable average number of words (M = 69.3), and the target LC (for example, however, or therefore) appeared in the fourth sentence of each passage. The test used a four-alternative multiple-choice format with the LC in addition added as a distracter in each question. Students were required to read each passage carefully and select the most appropriate LC (for example, however, or therefore) in light of understanding the semantic relation it conveys and its appropriateness for the context (more details in Ozono and Ito, 2003). Since this test included six passages, a student’s maximum score on the test was 6.
Data collection

Students were approached in their regular classes. They were informed about the purpose of the study and requested to sign the informed consent form. Then they were presented with the survey of intelligences: linguistic and logical/mathematical. They were required to read each item carefully and respond by writing X next to each statement they identified with. Items they did not identify with were left blank. Students’ Xs on each type of intelligence were added up to indicate a student’s intelligence out of 10. Following this, students were presented with the Logical Relations Reading Test in English and instructed to read each paragraph carefully and fill in the blank spaces using the correct alternative (A, B, C, or D) in 9 minutes. After an interval of three weeks, the same procedure was carried for the Arabic version of the Logical Relations Reading Test. Data from both the questionnaire and the Logical Relations Reading Test were fed into SPSS Software (version 20) for further analyses.

Findings

The results (Table 1) indicated that EFL readers had higher logical intelligence \( (M = 6.72/10,\ SD = 1.57) \) than linguistic intelligence \( (M = 5.82,\ SD = 1.98) \). This difference, the paired sample \( t \)-test indicated, was statistically significant, \( t (199) = 7.47, p < 0.001 \). By the same token, their mean score on the English Logical Relation Test, which was slightly below the pass score \( (M = 2.80/6,\ SD = 1.56) \), was lower than the mean score on the Arabic Logical Relation Test \( (M = 4.32,\ SD = 1.42) \). The difference in students’ scores on the two versions of the test (Arabic and English) was statistically significant, \( t (113) = –4.81, p < 0.001 \). That is, the students’ performance differed significantly in relation to both: the two types of intelligence and the two versions of the Logical Relation Test.

The results of Pearson correlation (Table 2) showed a weak, positive, yet insignificant correlation between logical intelligence and performance on the English Logical Relation Test \( (r = 0.140, p = 0.14) \). However, there was a significant positive correlation between logical intelligence and the reading comprehensibility of LCs in Arabic (L1). As for their linguistic intelligence, the correlation was positive with EFL readers’ comprehensibility of LCs in both English \( (r = 0.195, p = 0.04) \) and Arabic \( (r = 0.228, p = 0.02) \).

In addition, correlation was also calculated between the two intelligences, yielding high, positive significant correlation \( (r = 0.454^{**}, p = 0.001) \) as show in Table 3.

Table 1: Mean and standard deviation of intelligences and LC comprehensibility

<table>
<thead>
<tr>
<th></th>
<th>Logical intelligence</th>
<th>Linguistic intelligence</th>
<th>Arabic LC</th>
<th>English LC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M</strong></td>
<td>6.72</td>
<td>5.82</td>
<td>4.49</td>
<td>3.26</td>
</tr>
<tr>
<td><strong>SD</strong></td>
<td>1.57</td>
<td>1.98</td>
<td>1.35</td>
<td>1.34</td>
</tr>
</tbody>
</table>

Table 2: Correlations between the two types of intelligence and comprehensibility in L1 and L2

<table>
<thead>
<tr>
<th></th>
<th>English LC</th>
<th>Arabic LC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical</td>
<td>0.140</td>
<td>0.216*</td>
</tr>
<tr>
<td>Linguistic</td>
<td>0.195*</td>
<td>0.228*</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level (2-tailed)

Table 3. Correlations between logical intelligence and linguistic intelligence

<table>
<thead>
<tr>
<th></th>
<th>Linguistic intelligence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logical</td>
<td>0.381**</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed)
Discussion and implications
Motivated by the intersection LCs constitute – as their label suggests – between two intelligence types, this study aimed at exploring the relationship between each of the two types of intelligence, logical/mathematical and linguistic, and EFL readers’ comprehensibility of LCs in each of L2 (English) and L1 (Arabic). The results showed that students had a higher logical/mathematical than linguistic intelligence. The correlation between the logical intelligence and the comprehensibility of LCs in L2 was positive yet insignificant, whereas the linguistic intelligence had a significant correlation with L1 reading comprehensibility. This suggests that the problems EFL readers face in reading comprehension are associated with their linguistic intelligence more than with their logical intelligence. This finding is supported by the results suggesting that in L1 reading comprehension as well, the correlation was higher between students’ comprehensibility of LCs and their linguistic compared to their logical intelligence. These findings lend support to Gardner’s (1983) theory of Multiple Intelligence that suggests linguistic intelligence as a main factor in EFL learning.

Compared to previous findings addressing the relationship between the two intelligence types and EFL students’ use of LCs (e.g., Rahimi and Qannadzadeh, 2010), the findings of the current study suggest that whereas students’ logical intelligence was significantly higher than their linguistic intelligence, the contribution of linguistic intelligence to LC comprehensibility had a higher correlation with students’ reading comprehension across both L1 and L2.

The difference in students’ comprehensibility of LCs is attributed to linguistic competence. That is, although the L2 version of the Logical Relation Test was purposefully constructed with the aim of not imposing any linguistic difficulty for the study participants, the results suggest that students’ comprehension of L1 text was easier, leading not only to higher scores on the test, but also a higher correlation with the linguistic intelligence. The point is: if the variability in students’ performance is attributable to logical intelligence rather than the linguistic intelligence, one would reasonably expect a comparable performance on L1 and L2 versions of the test.

Given the findings of the current study, it can be concluded that EFL reading instructors should have a little concern about their students’ ability to relate events or propositions to each other logically if students are fully aware of the meaning of each proposition. EFL students’ problems towards effective investment of LCs in reading comprehension, in a nutshell, are attributable to linguistic more than logical factors.

In actual EFL instruction, accordingly, teachers should work on developing students’ reservoir of vocabulary as an essential requirement for comprehension. This recommendation is in line with the understanding that LCs mark or signal a logical relationship rather than create it. Their use is most effective and essential when there is an ambiguity in the semantic relationship between two ideas. EFL readers, therefore, should depend heavily on these expressions when they find it difficult to construct meaning out of the propositions or sentences they link.

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References