

Reading comprehension as a complex phenomenon. An approach based on assessment, inference, and foreign language

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Abstract

As foreign language teachers, we have observed that reading comprehension is a complex phenomenon worth studying. Here, we address reading comprehension from the point of view of several disciplines: education (for assessment), logic (for inference), and linguistics (for foreign language), within an experimental framework. The objective was to analyze and compare whether the properties of a test (length, complexity, and inference) and the attributes of a test-taker (test taking strategies, metacognitive awareness of reading strategies, and academic fields) have an effect on reading comprehension performance in native (Spanish) and foreign language (Italian). A quantitative cross-sectional study was performed on a sample of 35 students from a foreign languages centre; we used generalized linear mixed models to analyse the data. We found that the attributes of the test had an effect on performance in both languages, while the attributes of the test-takers had an effect only in foreign language.

Come insegnanti di una lingua straniera, abbiamo osservato che la comprensione della lettura è un fenomeno complesso da studiare. In questo contributo, ci avviciniamo alla comprensione della lettura dal punto di vista di diverse discipline: educazione (valutazione), logica (inferenze), e linguistica (lingua straniera), dentro un ambito sperimentale. Il nostro scopo è analizzare e comparare se le caratteristiche di una prova (lunghezza, complessità ed inferenza) e dei *test-takers* (strategie per la risoluzione delle prove, consapevolezza metacognitiva delle strategie di lettura, ed aree disciplinari) hanno un effetto sulla *performance* in lingua materna (spagnolo) e in lingua straniera (italiano). Abbiamo realizzato uno studio quantitativo, trasversale, su un campione di 35

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studenti di un centro di lingue straniere; abbiamo usato modelli lineari generalizzati misti per analizzare i dati. Abbiamo trovato che le caratteristiche della prova hanno un effetto in entrambi le lingue, mentre le caratteristiche dei *test-takers* hanno un effetto soltanto in lingua straniera.

Keywords: multiple-choice tests; generalized linear mixed models; education; logic; Linguistics

Parole-chiave: prove a scelta multipla; modelli lineari generalizzati misti; educazione; logica; Linguistica

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1. Introduction

As foreign language teachers, we have observed that reading comprehension is a complex phenomenon. To place this statement in context, let us consider a common circumstance in the classroom: after taking a test, it is usual for students to come to us with questions like “Why is my answer wrong?” and “How can I know (in a multiple-choice test) that the right answer is actually the only right answer?”, or a harder one, “Why is my answer wrong if you are asking me to respond according to my own point of view (say, after a reading comprehension test)?”. Situations like these have triggered this research, and hence, in this work we try to model and understand some of the key components of reading comprehension from an interdisciplinary approach.

However, since this phenomenon is a complex one, in so far as it “is woven together” (Morin, 1999, p. 16), we assume Morin’s stance (1999) about the principles of pertinent knowledge and so we try to operate and organize the construction of knowledge in an interdisciplinary way. The fact that we require an approach of this sort is understandable because «an interdisciplinary approach is justified only by a complex system [...], and] by definition, interdisciplinary study draws insights from relevant disciplines and integrates those insights into a more comprehensive understanding» (Newell, 2001, pp.1-2). Thus, we address the phenomenon of reading comprehension from different, but often convergent, scientific disciplines: education, logic, and linguistics. From the perspective of education, we focus on the assessment of reading comprehension; from the point of view of logic, we assume that reading comprehension requires some sort of inference; and, since we are concerned with reading comprehension in a foreign language, we also need to consider the inputs from linguistics. Now, in order to integrate these different approaches, we have developed an experimental framework that implements multiple-choice tests specially designed to meet the requirements of inference and foreign language. Then, we analyze the results by using a statistical method that tests the interactions of the components involved in this phenomenon. Our purpose was to analyze and compare whether the properties of a test (length, complexity, and inference) and the attributes of a test-taker (test taking strategies, metacognitive awareness of reading strategies, and academic fields) have an effect on reading comprehension performance in native (Spanish) and foreign language (Italian).

We have organized this paper in three sections. In the first one, we present a set of preliminary concepts that underlie this research (e.g. reading comprehension, inference, and assessment). In the second part, we describe the overall methodology we have employed. Finally, in the third section, we display and discuss some of the obtained results and we also provide some concluding remarks.

2. Preliminaries

Reading comprehension

There are three general models that represent how reading comprehension is carried out, namely: bottom-up, top-down, and interactive models.

Bottom-up models [...] depict reading as a mechanical process in which the reader decodes the ongoing text letter-by-letter, word-by-word, sentence-by-sentence. [...] Top-down models, in contrast, assume that the reader actively con-

trols the comprehension process, directed by reader goals, expectations and strategic processing. [...] *Interactive models* [assume] that useful elements from bottom-up and top-down views can be combined in some massively interactive set of processes (Grabe, 2009, p. 89).

In this study, we consider the interactive perspective in which bottom-up and top-down processes are incorporated simultaneously, for reasons that will be clear in the following paragraphs.

Despite its inherent complexity, reading comprehension is a phenomenon in which readers – in order to derive meaning from printed word, go through three levels of representation: *surface form*, *text base*, and *situation model* (Kintsch as cited in Pearson & Cervetti, 2017).

- The *surface form* represents the linguistic structure of the text (i.e., the actual words and phrases) and is the result of decoding (Pearson & Cervetti, 2017);
- The *text base* corresponds to the propositional representation of the text at the micro, macro, and superstructure levels. «The microstructure is the local level of discourse, that is, the structure of the individual propositions and their relations. The macrostructure is more global in nature, characterizing the discourse as a whole» (Kintsch & van Dijk, 1978, p. 365). The superstructure refers to a kind of “schema” or “form” of the text (van Dijk, 1992);
- The *situation model* corresponds to the text representation in which previous experiences are integrated in order to create coherence; it is a cognitive “image” of the fragment of the world dealt with in the discourse; it encompasses all the information about a situation and, therefore, allows the full understanding of the text (van Dijk, 1992).

According to this interactive model, when a reader builds up a situation model (by decoding a given text base), she performs different types of inferences depending on the degree of certainty, whether they are plausible, necessary, or probable (van Dijk & Kintsch, 1983). For the sake of clarity and consistency, we assume the previous taxonomy, but we employ the more logic-laden expressions of abduction (for plausible inference), deduction (for necessary inference), and induction (for probable inference).

Inference

We take it that «an inference is an action whereby [a] reasoner moves from belief in the premises of an argument to belief in the conclusion of the argument» (Cook, 2009, p. 151); and that conclusion may be obtained, according to Peirce (as cited in Pietarinen & Bellucci, 2016), by way of three stages:

First, there is the abductive guess; then follows the deductive derivation of empirically testable consequences and predictions of that guess; finally, at the inductive level, the predictions are subjected to a test or verification of how well they conform to our experience (Introduction section, para. 1).

For Peirce, imagination is an important factor in abductive reasoning and «its role in scientific discovery is indispensable» (Pietarinen & Bellucci, 2016, line 188). Abduction is:

That mode of reasoning particularly suited for the cases in which the facts themselves have already largely run out and one must therefore look for some other, collateral means of settling upon some compelling hypotheses in the rational process of scientific guessing that deals with fundamental uncertainty (Pietarinen as cited in Pietarinen & Bellucci, 2016, lines 153-156).

Deduction, on the other hand, is:

A finite sequence of statements within a formal system where each statement in the sequence is either an axiom, an assumption, or the result of applying a rule of inference to one or more preceding statements. The final statement is the conclusion of the argument that has been derived, and each assumption is a premise of the argument derived (Cook, 2009, p. 88).

Finally, about induction we can say that:

For valid deductive arguments the premises *logically entail* the conclusion, where the truth of the premises provides a *guarantee* of the truth of the conclusion. Similarly, in a good inductive argument the premises should provide some *degree of support* for the conclusion, where such support means that the truth of the premises indicates with some *degree of strength* that the conclusion is true (Hawthorne, 2014, para. 1).

For a more detailed explanation of these types of inference consider Adler & Rips (2008: for deduction, pp. 187-269; for induction, pp. 282-353; and for abduction, pp. 451-566); in Italian context, Lumbelli (2007) considers pertinent the *connective inferences* «to the question of distinguishing text-required readers' integration from inadequate readers' integration» (p. 85).

Assessment through tests

Reading comprehension «is a phenomenon that can only be observed *indirectly*» (Pearson & Cervetti, 2017, p.13). In order to evaluate it, therefore, students must be asked to perform specific tasks that show the degree of comprehension (Pérez Zorrilla, 2005): multiple-choice tests are a frequently used option.

Multiple-choice tests are determined by a set of items regularly made up of a *stem* (in the form of a question) and three or more *alternatives* (the alternatives contain the correct answer and two or more *distractors*) (McMillan, 2008). In this research, we distinguish two further elements within the stem: a body (i.e. a fragment of written information) and a trigger question (i.e. an inference indicator).

Now, at this point, an analogy may be in order, because reading comprehension tests require, at least, two parts: a test and a test-taker. In Ancient Rome, Janus was the god of beginnings and transitions. He had two faces, one on the front and the other one at the back of his head, the former was looking forward, toward the future; the latter was looking backwards, into the past. Reading comprehension is a “Janus-like” phenomenon because it also has two parts: one looking to the test design, one looking to the test-taker. The face that looks for the design provides us with a set of attributes pertaining to the test; while the face that watches upon the test-takers (i.e. students), gives us a set of attributes related to their performance.

Therefore, performance of reading comprehension may be the product of the attributes of a test, the attributes of test-takers, or both. With respect to the attributes of the test, we consider up to three elements: body length, body complexity, and trigger inference. Concerning the test-takers attributes, we also consider three factors: test-taking strategies, metacognitive awareness of reading strategies, and academic field. Up next we explain these attributes.

Tests' attributes

1. *Body length.* Even though the length of a text is a relative quality that depends on the textual genre (for example, legal texts' shortness can be an index of semantic density, Mortara Garavelli, 2001), and on the interpretive constraints (cf. Sabatini, 1999), it may be defined by using different metrics, such as the number of lines (Fortus, Coriat, & Fund, 1997, for example, used a range: from 17 to 28 lines), the number of words (Chujo & Utiyama, 2005, for example, used 26 different lengths for their study), or the number of pages (Mangen, Walgermo, & Brønnick, 2013, for example, considered a four page text as a short text). In this study, we also define the body length by the number of lines (see Fortus et al., 1997) using the next rule: a text is a short text if it is made up of four or less lines; otherwise, it is a long text if it is made up of five to eight lines.
2. *Body complexity.* According to Ferrari (2003), there are two criteria for identifying complexity: a quantitative criterion, determined by a numerical index of readability also called index of difficulty; and a qualitative criterion, understandability, determined by two additional properties—cohesion (a property related to the mechanisms that ensure the union between the parts of the text at a text base level) and coherence (a property related to the logical and conceptual processes that allow the production of meaning). In this study, we use the second criterion, and so we have performed a short term analysis with the purpose of ranking the understandability of the texts: we asked fourteen (seven for Spanish and seven for Italian) experts (writers, editors, and teachers) to evaluate, judge, and label different text bodies either as simple or complex.
3. *Trigger inference.* As we mentioned above, inferences may be classified into deductive (deduction) and non-deductive inferences (abduction and induction). Usually, multiple-choice reading comprehension tests are designed only after deductive inferences (Platas-García, Castro-Manzano, Reyes-Meza, & Gaona-Gordillo, 2018), but here we also consider non-deductive trigger inferences.

Example of Tests' attributes: a question in Italian

ZeroRelativo è un portale ideato da Paolo Severi dedicato al baratto dove molti oggetti non muoiono in discarica, ma rinascono ad ogni scambio: vecchi sci, elettrodomestici, mobili, libri, cd, biciclette e molto altro. C'è anche la possibilità di barattare giorni in case al mare o in montagna oppure servizi e consulenze. I barter – gli utenti che barattano o donano all'interno di ZeroRelativo – possono scegliere se donare senza volere nulla in cambio, oppure indicare da subito nell'annuncio l'oggetto o la prestazione che desiderano ricevere in cambio. Bastano pochi clic per inserire il proprio annuncio, rispondere a quelli già presenti oppure semplicemente leg-

gere informazioni approfondite sulla storia del baratto e su esperienze concrete di scambi (Adattato da Di Bari, 2008).

Secondo il testo, cosa si conclude necessariamente:

- A. che i barter non ricevono soldi in cambio a servizi e oggetti. (Correct answer).
- B. che i barter donano oggetti almeno una volta per poter barattare.
- C. che i barter inseriscono i loro annunci in maniere molto originali.
- D. che i barter devono seguire un codice etico per fare gli scambi.

Body length: long.

Body complexity: simple.

Trigger inference: deduction.

Test-takers' attributes

1. *Test taking strategies.* These strategies are mental operations that the test-takers select consciously (at least to some degree) for their use in accomplishing language tasks. These strategies alone are «usually not inherently effective or ineffective. Rather, their successful use depends first on whether they are appropriate for the given task» (Cohen, 1994, p. 119). They can be classified in different ways, for example: Nevo (as cited in Cohen 1991) and Cohen (1998). For this study we use the five categories described by Platas-García, Castro-Manzano, & Reyes-Meza (2016), namely: coincidence (a strategy in which the test taker attempts to answer a trigger question by looking for matches between our sets of beliefs and the alternatives), elimination (a strategy that attempts to answer a trigger question by discarding alternatives), association (a strategy that looks for textual similarities between the body and the alternatives), randomness (a strategy that appeals to random choices), and relevance (a strategy that tries to use the content of the body in order to prove the right answer).
2. *Metacognitive awareness of reading strategies.* In order to measure test-takers' cognizance of their reading strategies, Mokhtari & Reichard (2002) designed the *Metacognitive Awareness of Reading Strategies Inventory* (MARSIS). They explain that their purpose was to assess «the degree to which a student is or is not aware of the various processes involved in reading and to make it possible to learn about the goals and intentions he or she holds when coping with academic reading tasks» (Mokhtari & Reichard, 2002, p. 251). In this study, we use this instrument because we suspect there is a close relationship between test-takers' reading strategies and their performance in reading comprehension tests. The reading strategies measured by the MARSIS are global reading strategies (for example, how does someone decides what to read more closely and what to ignore); problem-solving strategies (for example, what does someone do when the text becomes too hard); and support-reading strategies (for example, what actions does someone take while reading) (Mokhtari & Reichard, 2002).
3. *Academic fields.* We know that «academic background can have an effect on reading comprehension (...) [and also we know] that particular groups of students may be disadvantaged by being tested on

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fields outside their academic field» (Alderson & Urquhart, 1988, p. 182). Therefore, we also consider the test-takers' academic field to check whether this attribute has an effect on their performance.

Reading comprehension in a foreign language

A reader in a foreign language is also a reader in her own native language, so the student's ease for reading in her native language determines the ease with which she will read in a foreign language (García Hernández, 1990). In fact, in a study performed by Nevo, in which a multiple-choice reading comprehension test in a foreign language was administered, she found that «respondents transferred test-taking strategies from their first language to the foreign language» (Cohen, 1998, p. 101).

Even though the native language has an important role in the process of reading in a foreign language, reading in a foreign language requires more effort from the reader because of unknown vocabulary, sentence structure (Cohen, 1994), idioms and implicit cultural references (Daloiso, 2013). As such, there are differences in the processes used by native and non-native readers; compared to native readers, non-native readers have lower automation level of decoding, which prevents the simultaneous integration of meaning; their attention is focused on the decoding of words and phrases, and they lack familiarity with the socio-cultural context of the text in a foreign language (cf. Acquaroni, 2004).

In this research, we considered two romance languages: Italian as a foreign language and Spanish as a native language. These languages are close to each other in so far as they share structural similarities, lexical transparency, and a grammatical basis that has common roots (Marangon, 2009). However, this closeness can both help and hinder the reading comprehension. For instance, although similarities might be assumed to be helpful, there is no shortage of counterexamples. For one, there are interferences of Spanish (native language) that cause errors when learning, speaking and reading in Italian (foreign language) due to negative transfers that appear at some relevant levels of the language, as reported by Maggioni (2010): phonological area, morphological area and lexical area.

In the lexical area we can find the *false friends* which are words that look or sound similar to other words that readers know (synforms) (Laufer, 1991) and therefore, it is common to transfer the meaning in the source language to a new word in a target language. Three groups of false friends can be distinguished: (1) synonyms (for example, words that have a very similar form, but different gender: the 'salt' is masculine in Italian (*il sale*), while feminine in Spanish (*la sal*)); (2) homonyms (for example, equivalent words in the form but with a less similar meaning: *cercar* means, in Spanish, 'to enclose', while *cercare*, in Italian, means 'to look for'); and (3) paronyms (for example: in Italian, *largo* means 'wide', while in Spanish *largo* means 'long').

So, considering the closeness of these two romance languages and the influence of native language on the process reading in a foreign language, we supposed that the test-takers' performance could be similar when they read in Italian or in Spanish (including the effects of the mentioned attributes of the test and the test-taker).

3. Methodology

Considering the previous remarks, we therefore carried out an experimental study. So, we performed a quantitative cross-sectional study on a sample of undergraduate students coming from a centre for teaching and learning foreign languages.

Instruments

We used two instruments:

1. *Inferential Reading Comprehension Test*. Consisted of two parts - the first in Italian, the second in Spanish - each containing twelve questions with four alternatives (only one was the correct answer). Each question was designed after the requirements of length, complexity, and inference. Furthermore, each question was attached a short list of test taking strategies to be selected.
2. *Metacognitive Awareness of Reading Strategies Inventory (MARS)*. We used a Spanish version of the MARS (Gómez, Solaz, & Sanjosé, 2014). This questionnaire has 30 items and uses a Likert scale ranging from 'never' to 'always'.

Sample

The sample was composed by 35 undergraduate students (19 female and 16 male) that, at the time of the study, were learning Italian as a foreign language at an intermediate level (2.5 years of study) and whose native language was Spanish. The mean age of the participants was 23.0 years (SD \pm 2.2). They were undergraduate students from different academic fields: Social Sciences and Humanities (19), Administration (8), and Engineering (8).

Procedure

The application of the instruments was in a classroom setting. First, we asked students to sign a form, so that all participants gave their informed consent. Then, we applied a short questionnaire in order to obtain general information (gender, age, academic field). Finally, we applied the two instruments in the following order: first, the *Inferential Reading Comprehension Test* (first the Italian part, then the Spanish part); then, we applied the *MARS*. Mean time to answer both instruments was about 60 minutes: 31 minutes for the Italian part, 19 minutes for the Spanish part, and 10 minutes for the *MARS*.

Statistical technique

Since we wanted to provide a global measure of the interactions of the elements involved in this complex phenomenon of reading comprehension, we adopted a statistical technique suitable for this task, namely, a Generalized Linear Mixed Models (GLMM). We used R (R Core Team, 2017) with the *glmer* function (Generalized Linear Mixed Effects Regression) of the *lme4* (Linear Mixed-Effects Models using 'Eigen' and S4) package (version 1.1-13; Bates et al., 2017).

We chose this statistical technique because ‘linear models, including regression, analysis of variance (ANOVA), and their multivariate extensions are perhaps among the most widely used statistical techniques in the social and behavioral sciences’ (Holmes & Hernandez, 2016, p. 1). Recent research using GLMM includes, but is not limited to, studies in education (Linton, Pangle, Wyatt, Powell, & Sherwood, 2014; Pinheiro, Rodrigues-Motta, & Franco, 2014), linguistics (Paradis, Rice, Crago, & Marquis, 2008; Korecky-Kröll & Buchegger, 2018), cognition (Caçola, 2014; Nicenboim, Vasishth, Gattei, Sigman, & Kliegl, 2015; Guerra & Mellado, 2017), and moral reasoning (Neldner, Crimston, Wilks, Redshaw, & Nielsen, 2018).

For this study, we considered *performance*, defined as the number of correct answers on the reading comprehension instruments, as the dependent variable. The model error distribution was binomial and the link function used was *logit*. The independent variables were, for the test’s attributes, length (a factor with two levels: long and short), complexity (a factor with two levels: simple and complex), and inference (a factor with three levels: deduction, induction, and abduction). For the test-taker’s attributes, the independent variables were the test taking strategies (a factor with five levels: coincidence, elimination, association, randomness, and relevance), the MARSI level (a factor with two levels: high and medium), and academic field (a factor with three levels: Social Sciences and Humanities, Administration, and Engineering).

All the interactions between these variables were considered. The identity of the participant was included as a random variable. We calculated the maximal model and then we determined the minimal adequate model by a step-wise model simplification by using a sequential removal of non-significant terms. All of this was done for each language separately.

4. Results and discussion

To discuss some of the main results we will refer to our analogy with the Roman god Janus, hence, our discussion will also come in two parts: one related to the attributes of the test; the other, to the attributes of the test-takers. Now, in order to begin with an interpretation of these outcomes, we make use of Mill’s methods as to isolate some probable causes of the obtained results, namely: the Method of Agreement and the Method of Difference (cf. Macleod, 2018), Mill’s methods are instrumental for the narrative and understanding of causal inference and probabilistic causation in educational research (Cohen, Manion, & Morrison, 2018).

Regarding the test’s attributes, we report the following findings by applying Mill’s Methods on the results given in Table 1 in which the interactions in bold represent cases of positive agreement (i.e. results with significant differences in both languages); the interactions underlined, represent null agreement (i.e. results without significant differences in both languages); and in the interactions in italics, represent a laden-difference (i.e. results with significant differences only in Italian, but not in Spanish).

Terms	Italian			Spanish				
	<i>±SE</i>	<i>p</i>	<i>p</i>	<i>±SE</i>	<i>p</i>	<i>p</i>		
Complexity*Length*	0.246	0.116	4.649	0.031	-0.356	0.128	7.941	0.004
Inference								

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<i>Complexity*Length</i>	0.245	0.109	5.028	0.024	0.118	0.123	0.923	0.336
<u>Complexity*Inference</u>	0.190	0.111	2.983	0.084	0.179	0.121	2.197	0.138
Length*Inference	-0.312	0.110	8.194	0.004	-0.252	0.122	4.291	0.038
<i>Complexity</i>	-0.323	0.107	9.306	0.002	-0.168	0.118	2.015	0.155
Length	0.441	0.106	17.888	<0.001	-0.223	0.119	3.554	0.059
<u>Inference</u>	-0.069	0.106	0.422	0.515	0.155	0.119	1.709	0.191

Note: The stars indicate the interaction between the terms (independent variables). In column one, the bold font represents cases of positive agreement (i.e. results with significant differences in both languages); the underlined font represents null agreement (i.e. results without significant differences in both languages); and the italic font represents a laden-difference (i.e. results with significant differences only in Italian, but not in Spanish).

Table 1: Effects of Complexity, Length and Inference on Performance

First, we have found that the variable *Body length*, taken by itself or with a couple of interactions, produces some significant differences in performance in both languages (Italian and Spanish), namely: ‘complexity*length*inference’, and ‘length*inference’ (in Table 1 these results are indicated in bold font). Well, this result is interesting because it showed the relation between the length of a text and other variables that should be considered when designing a reading comprehension test. This is an important result given the fact that, as Alderson (2000) has stated, «a problem all reading-test developers face is how long the texts should be on which they base their tests. Text length is a surprisingly under-researched area» (p. 108)

Second, we have found that the variable *Body complexity* produces some significant differences in performance in foreign language (Italian), but not in native language (Spanish) when considered both alone and in the interaction ‘complexity*length’ (in Table 1 these results are indicated in italic font). This result could be due to the skills that students developed in order to maintain cohesion and coherence when they read simple or complex texts in foreign language. Related to the length, Baghaei & Carstensen (2013) say: «short and long text processing skills in reading in a foreign language do not develop linearly as a result of increased reading ability. That is, long text and short text processing strategies are two distinct skills which develop independently» (p. 8). Now, knowing that length and complexity are variables that interact very closely, it can be inferred that students who read simple texts or complex texts in a foreign language also use distinct skills.

Third, we have found that the variable *Trigger inference* considered both alone and in the interaction ‘length*inference’ does not produce any significant difference in performance neither in foreign language (Italian) nor in native language (Spanish) (in Table 1 these results are indicated in underline font). This is interesting because, arguably, reasoning per se is not affected by language; for example, in a research of deliberate reasoning in a foreign language, Mækela & Pfuhl (2019) conclude: «we found similar deliberate reasoning in one’s native and a second language, and the reasoning was perceived as similarly effortful» (p. 10). Related to this, Bassetti & Cook (2011) asked this question: “Does Learning an Additional Language result in Conceptual Changes?” and they answered with two possibilities:

[The first is] that learning another language does not have any conceptual effects. [...] If the bilinguals differ from monolinguals, it is then only in how they think about reality in order to encode it for speech, [...], not in how they

think. The other possibility is that [...foreign language] learning affects non-linguistic cognition [...in fact,] adults can learn new concepts through exposure to another language. (p. 9)

The above results can be better understood with a graphic (see Figure 1), in which we can observe the greater or lesser probability of obtaining correct answers depending on the interactions of different test's attributes.

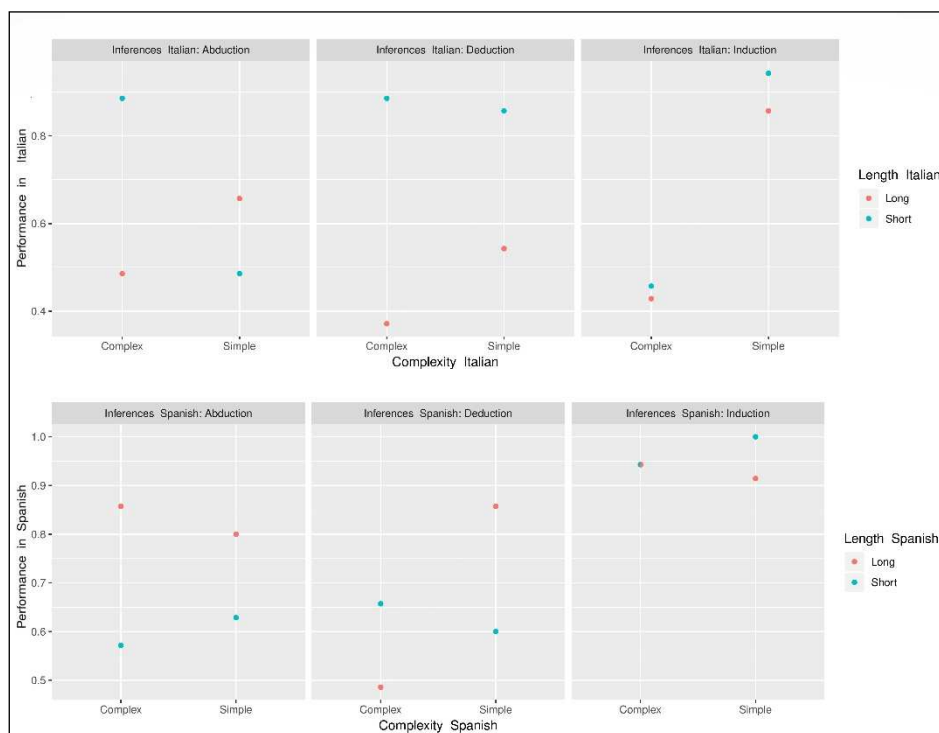


Figure 1: Interaction of Complexity, Length, and Inference on Performance proportion

We can visually appreciate, for example, the following interactions and tendencies:

1. When the body length is *long*, the body complexity is *complex*, and the trigger inference is *inductive*, the performance is better in native language but worse in foreign language. One possible explanation of this interaction is that when the students read in their native language, they have some advantages, namely: a high automation level of decoding; and a familiarity with the socio-cultural context of the text (cf. Acquaroni, 2004). These advantages are clear when the text is long-complex and the inference (inductive) requests a prediction based on understood information.
2. When the body length is *short*, the body complexity is *simple*, and the trigger inference is *inductive*, there is a good performance in both languages. In this second interaction we find the same type of inference (i.e. induction) as in the interaction above, but now the difference is that the texts are short and simple. This text combination (short and simple) is interesting because this result suggests that induction, with short and simple texts, looks for a probable level of certainty (cf. van Dijk & Kintsch, 1983), and this phenomenon occurs in both languages.

- When the body length is *short*, the body complexity is *complex*, and the trigger inference is *abductive*, there is also a different performance in both languages: better in foreign language than in native language. In a study with a test in English as a foreign language, a similar result was found by López, Ropero & Peralta (2011): they report that students mentioned that if the texts were very short, that made it easier for them to answer the questions, even if they were of high of difficulty. Therefore this result shows a relation of abduction and complexity (in the sense of difficulty of understandability, cf. Ferrari, 2003), especially in a foreign language, in which the reader uses her prior knowledge of the topic with the purpose of imagining (cf. Pietarinen & Bellucci, 2016) the best explanation for the situation presented in the test.

That does it for the first side of this Janus-type situation. Now, with respect to the other side, the side facing to the test-takers’ attributes, we can identify the following findings by using Mill’s methods on the results in Table 2 in which the interactions in italics represent a laden-difference (i.e. results with significant differences only in Italian, but not in Spanish); and the interactions underlined represent null agreement (i.e. results without significant differences in both languages).

Terms	Italian			Spanish				
		±SE		<i>p</i>	±SE			<i>p</i>
<i>Test taking strategies*Level of MARS</i> <i>I*Academic field</i>	-0.211	0.108	3.832	0.050	-0.131	0.129	1.033	0.309
<u>Test taking strategies*Level of MARS</u> <u>I</u>	-0.040	0.108	0.140	0.708	-0.160	0.127	1.584	0.208
<u>Test taking strategies*Academic field</u>	-0.018	0.109	0.027	0.868	-0.091	0.126	0.527	0.467
<u>Level of MARS</u> <u>I*Academic field</u>	0.201	0.108	3.503	0.061	-0.134	0.137	0.955	0.328
<u>Test taking strategies</u>	0.129	0.106	1.488	0.222	-0.002	0.121	3e-04	0.986
<u>Level of MARS</u>	-0.038	0.104	0.135	0.713	0.110	0.131	0.706	0.400
<i>Academic field</i>	-0.262	0.107	8.177	0.016	-0.171	0.134	1.621	0.202

Note: The stars indicate the interaction between the terms (independent variables). In column one, the underlined font represents null agreement (i.e. results without significant differences in both languages); and the italic font represents a laden-difference (i.e. results with significant differences only in Italian, but not in Spanish).

Table 2: Effects of Test taking strategies, Level of MARS, and Academic Fields on Performance

First, we have found that the variable *Academic field* produces some significant differences in performance in foreign language (Italian) but not in native language (Spanish) if it is to be considered both alone or in the interaction ‘test taking strategies*level of MARS*academic fields’ (in Table 2 these results are indicated in italic font). This result is interesting because we know that readers in foreign language make high efforts in reading (cf. Daloso, 2013), probably, they use their prior knowledge of their academic fields as a resource to help them understand the text; particularly, to understand unknown vocabulary (cf. Cohen, 1994). As an example, we can consider the case of the Test Of English as Foreign Language (TOEFL). Hale (1988) wrote:

Even though TOEFL passages are taken from general reading materials, there are still passages that show a greater tendency than others to favor students in a particular major-field group. These are passages that are believed to contain somewhat technical concepts and terminology in the major-field area of the students who show better performance (p. 47).

Second, we have found that the variables *Test taking strategies* and *Level of MARSI* have the same behaviour in both languages: they do not produce any significant difference in performance neither in foreign language (Italian) nor in native language (Spanish) if they are considered both alone or in the interactions ‘test taking strategies*level of MARSI’; ‘test taking strategies*academic fields’; and ‘level of MARSI*academic fields’ (in Table 2 these results are indicated in underline font).

Now, the fact of not having found significant differences in both languages (with none of the three variables, including the academic field), does not necessarily mean that there is no relation at all between these attributes; and so we wondered that maybe there is some hidden variable in this second face of our Janus-type situation; in other words, maybe there are possible test-takers’ attributes that influence the performance but that we did not consider them since the beginning of the research.

Considering this last issue, we analyzed other two variables at our disposal, namely: gender (i.e., male or female) and resolution time (i.e. the time employed in answering a test measured in minutes). Using a GLMM with five terms (test taking strategies*level of MARSI*academic field*gender*time), again, we did not find interactions with significant differences in both languages either. The results with significant differences were, in Italian: ‘test taking strategies*level of MARSI*academic fields’; ‘test taking strategies*gender*time’; ‘level of MARSI*academic field*time’; ‘academic field’. Whereas in Spanish we had: ‘test taking strategies*level of MARSI*academic field*gender*time’; ‘level of MARSI*gender*time’; ‘test taking strategies*gender’. However, despite this effort, we did not find anything worth reporting.

As above, in Figure 2 we can observe the greater or lesser probability of obtaining correct answers depending on the interactions of test-takers’ attributes.

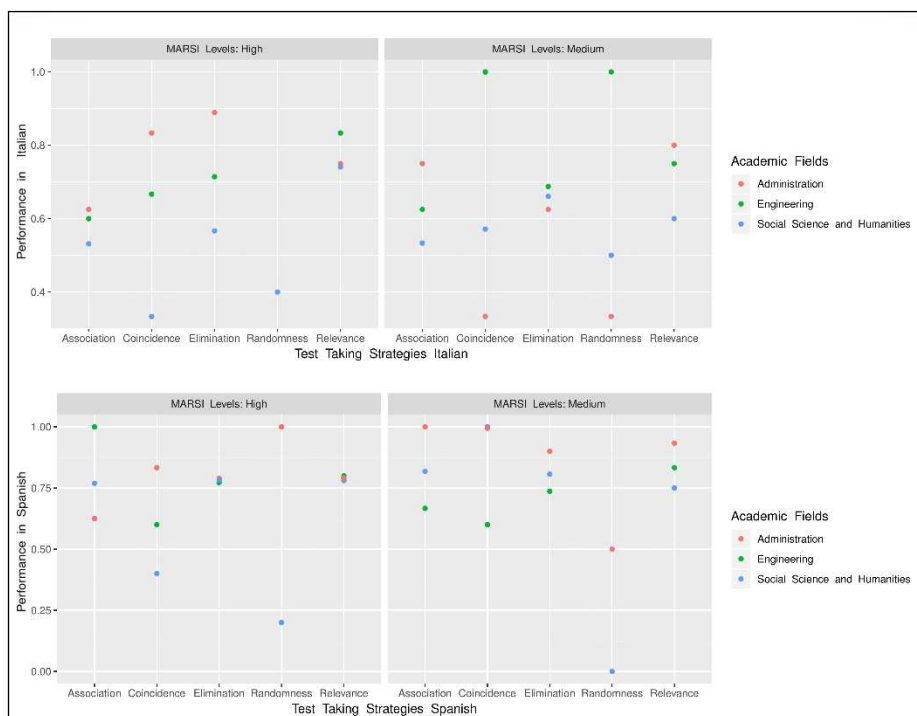


Figure 2: Interaction of Test taking strategies, Level of MARSİ and Academic fields on Performance proportion. Source: Personal elaboration

We can visually appreciate, for example, the following interactions and tendencies:

1. When the level of MARSİ is *high*, the students of the three academic fields (Administration, Engineering, and Social Science and Humanities) coincide with the selection of two test taking strategies, namely: *elimination* and *relevance*; and in both cases, the performance is up to 75% of probability of obtaining correct answers. This situation indicates, on the one hand, that the strategy of *elimination* is useful on multiple-choice test; in fact, the simple principle of elimination is this: «successive cues are used to eliminate more and more alternatives and thereby reduce the set of remaining options, until a single option can be decided upon» (Todd & Gigerenzer, 2000, p. 735). And on the other hand, that the strategy of *relevance* is a legitimate strategy in inferential reading comprehension tests because it is described as the requirement that the premises in an inference be actually used to reach the conclusion; that is, that the body of the text has to be used to find the right answer among the possible choices (Platas-García et al., 2016).

5. Concluding remarks

We have explored the process of reading comprehension. Since this is a complex phenomenon, we have implemented an interdisciplinary approach. Our findings indicate that there is an effect of both the attributes of the tests and the traits of the students when performing inferential reading comprehension tests; however,

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while the attributes of the tests provide more explanatory power, the attributes of the test taker require further exploration.

Indeed, since we have found that the attributes of the test-takers only present a difference within foreign language, in future research we should analyze why is this the case, and so, maybe we should explore the interactions and effects of other variables, like fluency in reading (cf. Grabe, 2010), motivation (cf. Guerra & Guevara, 2017), or emotion (cf. Graffigna et al., 2008), which would require a refinement of the instruments used to analyze the attributes of the test takers, and would include the field of psychology in our interdisciplinary approach. Additionally, we could also take advantage of the similarity between romance languages in order to design a reading comprehension test using the intercomprehension approach (see Bonvino & Faone, 2016).

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