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Multimodal metadiscourse in digital academic journals on linguistics, engineering and medicine

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Abstract

The main objectives of this study are, first, to study the interactive metadiscourse devices used in engineering, medicine and linguistics and the identities represented; second, to identify the visual metadiscourse elements employed in the three identities constructed in the three specific settings and, finally, to classify and compare the multimodal metadiscourse used to cohere the different parts of digital academic discourse with the aim of guiding the reader textually as well as visually. To this end, academic papers were collected from journals which belonged to the specific fields of linguistics, engineering and medicine. This corpus was analysed to identify and classify the data. The results showed that there were in fact differences in the way academic writers used multimodal metadiscourse and constructed and represented their identity. The study revealed that engineers used visual metadiscourse more frequently, while linguistic researchers preferred the use of textual metadiscourse. Finally, conclusions were drawn.

Keywords: multimodality; metadiscourse; academic English; textual metadiscourse; visual metadiscourse; multimodal metadiscourse

Introduction

In this study I focus on the elements that guide readers in digital academic papers, that is, textual and visual devices. Regarding textual devices, it is well known that academic discourse has been analysed from the point of view of textual metadiscourse (Hyland 2005; Mur-Dueñas 2011) but visual metadiscourse (Kumpf 2000; D'Angelo 2016) has received less attention. Moreover, multimodal discourse has been the focus of many researchers (Kress and van Leeuwen 1990; Kress 2004, 2010; Stivers and Sidnell 2005). Nevertheless, the analysis of multimodal digital metadiscourse in English for specific purposes has received little attention till now. To fill this gap, this paper has focused on the multimodal study of the metadiscourse devices used in digital academic papers specialised in the fields of linguistics, engineering and medicine. It is, on the one hand, a descriptive work that describes, classifies and interprets the different multimodal elements that can be found in the genre of academic language published in digital journals. On the other hand, it is a prescriptive study that identifies how multimodal metadiscourse is used in digital academic English in different fields of knowledge, showing different patterns that could be helpful for academic researchers.

Thus, I pay attention to the analysis of multimodal metadiscourse used to guide readers, that is, the combination of textual metadiscourse devices (Hyland 2005) and visual metadiscourse elements (Kumpf 2000) in digital academic papers. The hypothesis of this study is that writers with different academic backgrounds but the same mother tongue (English) guide readers in different ways, thus constructing and representing their academic identity in different ways in digital academic papers.

Therefore, the main objectives are, first, to study the textual metadiscourse devices used in engineering, medicine and linguistics and the identities represented; second, to identify the visual metadiscourse elements employed in the three identities

constructed in the three specific fields of study and, finally, to classify and compare the multimodal metadiscourse used to cohere the different parts of digital academic discourse with the aim of guiding readers textually as well as visually and constructing the particular academic identity of linguists, engineers and medical doctors. The research questions posed by this study are the following:

1) How do academic writers guide readers in digital academic discourse?
2) Are there any dissimilarities in the ways knowledge is disseminated and readers guided in different fields of study? In what respect?

This article is organised as follows. First, after identifying the objectives and research questions in the introduction, the following section explains the different approaches to textual metadiscourse and visual metadiscourse. Second, in 'Corpus and methods' the different academic papers that were compiled and the procedure followed in the study are described. Third, the quantitative results are shown and some examples from the corpus are discussed in the section 'Results and discussion', and finally the conclusions are drawn in the last section.

Textual metadiscourse and visual metadiscourse

Metadiscourse has been studied by many researchers who focus on rhetorical stylistics (Crismore et al. 1993; Lorés Sanz 2004) or on discourse studies for writing pedagogies or applied linguistics (Hyland 2005; Diani 2008; Carrió-Pastor 2016). Hyland (2005, 37) defines metadiscourse as "a cover term for the self-reflective expressions used to negotiate interactional meaning in a text, assisting the writer (or speaker) to express a viewpoint and engage with readers as members of a particular community".

Most of the authors that focus on metadiscourse use two main categories to distinguish its different functions: textual (or interactive) and interpersonal (or

interactional). In this study, one of my interests is textual devices, those that guide readers and make a text easy to understand, organising information. This category is divided into five subcategories, as can be seen in Table 1:

Table 1. Classification of textual devices (Mur-Dueñas 2011)

Textual markers	**Definition**	**Examples**
Logical markers	Devices that provide coherence to the text. It is divided into additive, contrastive and consecutive	*moreover, also, similarly,* etc.
Frame markers	Devices that provide cohesion and make it possible to understand speech acts. It is divided into sequencers, topicalisers, discourse labels and announcers	*finally, previously, regarding,* etc.
Endophoric markers	Devices which are useful to refer to different parts of the text. It is divided into anaphoric and cataphoric	*see Table X, noted above,* etc.
Evidential markers	Devices that show the evidence about the propositions. It is divided into personal and impersonal	*past research, previous, following X*, etc.
Code glosses	They are used to give examples or explain parts of the text that are very specific for readers. It is divided into reformulation and exemplification.	*that is, for example, in other words,* etc.

Textual devices endow texts with cohesion, establishing the semantic links that allow us to interpret texts using our knowledge about language in a coherent way (Dahl 2004; Hyland 2005). The internal relationship of texts is important to guide readers, but some researchers have also paid attention to the relationship between text and images (Martinec and Salway 2003; Unsworth 2006; Unsworth and Cleirigh 2009 and Martinec 2013). Nowadays most texts are digital and images are used to make more visual our ideas, but cohesion and coherence should also be taken into account (Lemke 1998). In this sense, in cohesion, images are a means of illustrating and providing extra information to textual devices and, regarding coherence, these interlinked images give meaning to texts.

In this vein, some researchers have studied the relationship of texts and images from a metadiscoursal perspective. For example, Kumpf (2000) considers that visual

metadiscourse is complementary to textual metadiscourse, and by taking into account readers' needs they give writers the standards to be used to map the design of documents. Also Van Leeuwen (2004) highlights that nowadays speech acts should be renamed 'communicative acts' given that image, language and typography are combined.

Additionally, the analysis of visual and textual metadiscourse has been a topic of interest in different genres, for example, De Groot, Nickerson, Korzilius and Gerritsen (2016: 165) developed a working model of visual metadiscourse in photos used in English management statements. Also, Alejo González (2005) analysed commercial websites, D'Angelo (2008, 2010) studied visual, interactive and interactional metadiscourse in posters and Bernad-Mechó (2017) focused on a multimodal study of metadiscourse in academic lectures.

Visual metadiscourse is useful to show scientific findings but academic researchers should be aware of its correct use as well as they are aware of the use of textual metadiscourse. Hence, in this paper I refer to the analysis of textual and visual metadiscourse as multimodal metadiscourse. This idea is based on multimodality, a functional analysis of language that includes visual communication, oral and written language, and gesture. Kress and van Leeuwen (1990) are the precursors of multimodality studies, taking the sign, that is, a fusion of form and meaning, as its basic unit (Kress 2004, 2010). I believe all the strategies that confer coherence and cohesion in digital academic discourse should be analysed and discussed to provide some help to academic researchers who do not have any restrictions when it comes to including images in digital academic papers. I also think that speakers' choices of communication strategies, their arrangement of linguistic and visual elements, and their use of specific items should reflect how they construct their identity and wish to transmit information in order to guide readers. Thus, this paper focuses on the multimodal analysis of the metadiscourse devices

used in digital academic papers that disseminate knowledge in the specific fields of linguistics, engineering and medicine with the aim of identifying different ways of constructing academic identities, depending on the expected readers.

Corpus and method

The corpus used in the study consisted of two hundred and fifty-two academic papers which were gathered from English journals included in Journal Citation Reports (2017-2018 editions). To be eligible for inclusion in the corpus, it was established that at least 60% of the authors should be native speakers of English. This percentage was adopted after initially studying the papers and noting that there were very few academic papers in engineering and medicine of which between 70% and 100% of the authors were native English speakers.

The corpus was divided into three subcorpora that each concerned a specific field of knowledge, as it was considered that authors from different fields of knowledge would show different identities and ways of guiding readers. The three disciplines were chosen to compare hard sciences (engineering), soft sciences (linguistics) and medicine, as in this specific field of knowledge academic papers combine the characteristics of soft and hard sciences. The corpus was saved in text format, for its automatic analysis, and in PDF format for the manual analysis of the figures and tables. Table 2 shows the data of the three corpora used in this study:

Table 2. Data analysed in the study

Specific field of study	Number of papers	Number of words
Engineering	64	620,833
Medicine	108	454,572
Linguistics	80	635,370
Total	252	1,710,775

First, the corpus was analysed with the help of a specific tool (METOOL) and then manually to identify and classify the images from the corpus. METOOL was designed through a joint project (FFI2016-77941-P, funded by Ministerio de Economía y Competitividad, Spain) to compile, tag, identify and analyse metadiscoursal devices. It is not yet available in open access as the tagging of the base corpus that will allow the automatic identification of metadiscoursal devices is still in progress. The tool extracts frequencies, collocations and allows us to study markers and their functions (Carrió-Pastor 2016, 2019). This process is now being tested to identify false positives and to check its accuracy. Thus, in the first part of the study the different subcategories of textual markers collected were counted and checked in METOOL to ensure the data retrieved was accurate.

As a second part of the analysis, manual tagging of the visual elements was carried out in order to observe the images and how they were arranged within the text. In the case of textual metadiscourse, the taxonomy proposed by Hyland (2005) was used to classify textual devices, but I could not find in previous research a taxonomy for visual metadiscourse that could be adequate for classifying visual metadiscourse in academic papers. Kumpf (2000) proposes a taxonomy, but it is applied to the editing of papers rather than to the visual organisation of texts and guiding readers. D'Angelo (2010) also describes the organisation of images, but taking into account the structure of academic posters and De Groot, Nickerson, Korzilius and Gerritsen (2016) focus on photos included in annual reports in companies.

Once visual metadiscourse devices were identified, the number of tables and images (i.e. graphs, pictures, figures) were counted to know the total number of visual aids used by academic authors in the three specific fields of knowledge. Then, four subcategories of visual metadiscourse were established taking into account the

relationship between textual markers and visual markers and the disposition of visual markers in the paper:

- *Logical cohesion* refers to whether or not it is appropriate to include visual metadiscourse to guide readers. The fact that these visual devices should add, contrast or show a consecutive order and complement textual metadiscourse was taken into account; specifically, they are correlated to logical markers.
- *Spatial cohesion* identifies their right or wrong position in the paper; visual devices are included and mentioned by textual markers in a sequencing manner, mainly by frame markers, and they are referred to by endophoric markers and code glosses.
- *Visual adequacy* is a subcategory that identifies the correct use or overuse of images to guide readers, thus complementing the textual categories of evidential markers and code glosses. This subcategory reinforces the evidence of the data shown in the research by giving examples of the information described in the research paper.
- *Endophora* refers to the phenomenon of visual elements that are described or referenced within the surrounding text. This is closely connected to endophoric markers and evidentials.

The taxonomy of categories and subcategories of multimodal metadiscourse was used to pair the textual subcategories to the visual ones (Table 3):

Table 3. Categories and subcategories of multimodal metadiscourse

Textual metadiscourse	**Visual metadiscourse**
Logical markers: - Additive - Contrastive - Consecutive	Logical cohesion
Frame markers: - Sequencers - Topicalisers - Discourse labels - Announcers	Spatial cohesion

Endophoric markers: - Anaphoric - Cataphoric	Endophora Spatial cohesion
Evidential markers: - Personal - Impersonal	Visual adequacy Endophora
Code glosses: - Reformulation - Exemplification	Visual adequacy Spatial cohesion

It should be noted that in visual metadiscourse, "[…] writers may make decisions on visual ways in which they may help readers understand and interpret the whole document. […] they represent areas in which writers can exert control or choice in varying degrees" (Kumpf 2000, 404). In the results, I included those visual elements that were incorporated by academic writers to exert control and guide readers.

Thus, the different categories and subcategories were studied taking into account the occurrences found in the corpus and the nature of the relationship between visual metadiscourse and textual metadiscourse, checking the connection between textual and visual devices. Then, the occurrences were identified and normalised to 1,000 words, as the three subcorpora analysed contained different numbers of total words and visual devices. After the normalisation of the occurrences, statistical analysis was carried out to check the relevance of the data with the help of http://vassarstats.net/newcs.html. In this case, the results were normalised to 10,000 words for these calculations. A contingency table was used, which is a type of table in a matrix format that displays the multivariate frequency distribution of the variables. A chi-square test was also conducted on the contingency table to test whether or not a relationship exists between variables. I also established the *p*-value <0.05 and Cramer's V, which is a measure of the association between two nominal variables, giving a value between 0 and +1 (inclusive). Finally, the occurrences of visual metadiscourse were normalised taking into consideration the total

number of papers collected for each subcorpus in order to identify the average number of tables and figures used in engineering, medicine and linguistics.

Results and discussion

The results of the identification of textual metadiscourse are shown in Table 4. The first column includes the categories and subcategories of textual metadiscourse analysed, then the second, third and fourth columns show the occurrences and the normalised frequencies (N) to 1,000 words. Finally, the last column shows the total occurrences and N of textual metadiscourse:

Table 4. Results of the analysis of textual metadiscourse

Textual metadiscourse	**Engineering** Occurrences (N)	**Medicine** Occurrences (N)	**Linguistics** Occurrences (N)	**Total** Occurrences (N)
Logical markers:	9,256 (14.90)	7,491 (16.47)	9,937 (15.63)	26,684 (15.59)
Additive	6,607 (10.64)	5,830 (12.82)	5,351 (8.42)	17,788 (10.39)
Contrastive	1,342 (2.16)	1,177 (2.58)	3,006 (6.61)	5,525 (3.22)
Consecutive	1,302 (2.09)	479 (1.05)	1,575 (2.47)	3,356 (1.96)
Frame markers:	1,055 (1.69)	710 (1.56)	1,900 (2.99)	3,665 (2.14)
Sequencers	376 (0.60)	301 (0.66)	670 (1.05)	1,347 (0.78)
Topicalisers	210 (0.33)	141 (0.31)	349 (0.54)	700 (0.40)
Discourse labels	55 (0.08)	87 (0.19)	132 (0.20)	274 (0.14)
Announcers	414 (0.66)	181 (0.39)	749 (1.17)	1,344 (0.78)
Endophoric markers:	1,172 (1.88)	245 (0.52)	948 (1.49)	2,365 (1.38)
Anaphoric	406 (0.65)	150 (0.32)	515 (0.81)	1071 (0.62)
Cataphoric	766 (1.23)	95 (0.20)	433 (0.68)	1,294 (0.75)
Evidential markers:	2,418 (3.89)	2,027 (4.45)	2,876 (4.52)	7,321 (4.27)
Personal	1,343 (2.16)	1,260 (2.77)	1,885 (2.96)	4,488 (2.62)
Impersonal	1,075 (1.73)	767 (1.68)	968 (1.52)	2,810 (1.64)
Code glosses:	2,191 (3.52)	1,065 (2.34)	3,949 (6.21)	7,205 (4.21)
Reformulation	714 (1.15)	313 (0.68)	1,051 (1.65)	2,078 (1.21)
Exemplification	1,476 (2.37)	752 (1.65)	2,897 (4.55)	5,125 (2.99)
Total	16,092 (9.40)	11,538 (6.74)	19,610 (11.46)	47,240 (27.61)

Table 4 reveals that the most frequent textual devices were logical markers (15.59 per 1,000 words), followed by evidential markers (4.27) and code glosses (4.21). The narrative form of academic discourse may justify the frequent use of logical markers. The least used subcategory was endophoric markers (1.38), and hence it seems that academic

authors do not frequently refer to previous or subsequent parts of the text, preferring the use of additive, contrastive or evidential markers to present the data.

If we look at the different specific fields of knowledge, linguists (11.46) used more textual markers than engineers (9.40) or medical doctors (6.74); only in additive markers and in cataphoric and impersonal markers were more frequencies observed in engineering. This could be because linguists are conscious of the importance of textual markers to guide readers and to illustrate their ideas and previous theoretical background, as also noted by Dahl (2004).

If we compare the results of the subcategories of markers to identify differences in the identities of academic writers depending on their academic 'culture', we can observe that in engineering, medicine and linguistics the frequencies are quite similar, excluding some cases such as exemplification and contrastive markers, which are more commonly used in linguistics. This data shows us that academic discourse shares the same textual patterns, using similar devices to add new information, providing personal evidence about the propositions of the research, citing other researchers' work, and exemplifying to clarify findings.

After obtaining these results, statistical analysis was carried out to study their relevance and the results can be seen in Table 5. A contingency table was used to perform a Chi-square analysis:

Table 5. Statistical analysis of the frequencies of textual markers

Chi-square	*p*-value	Cramer's V
27.89	0.0005	0.1305

Cramer's V, which is a measure of the strength of association among the levels of the row and column variables, was also calculated. As the *p*-value is <0.05, the data obtained in the analysis of the categories of textual markers is significant.

To identify if the results could shed some light on the differences in textual metadiscourse between digital articles and their paper equivalent, previous research that analysed textual markers was consulted. For example, Alejo González (2005, 42) analysed digital language in commercial websites and observed that textual markers were "present on a smaller scale than expected, even though there are certain exceptions like endophoric markers and code glosses because they constitute local coherence". D'Angelo (2010) focused on the study of textual metadiscourse in academic posters and she also observed that researchers used more frequently logical markers and evidentials. These findings contrast with the ones shown here, but coincide with Hyland's (1998) study on academic papers and Mur-Dueñas' paper (2011), in which a higher frequency of evidentials, code glosses and logical markers was identified in academic papers.

Thus, it may be stated that textual metadiscourse is used similarly in digital articles and their paper equivalent given that the argumentative flow of metadiscourse tends to be traditional and guides the reading process by indicating discourse organisation and clarifying propositional connections and meanings. But we did find some differences in digital academic papers. For example, they have increasingly become multimodal rather than monomodal, that is, in the way evidence about previous research is shown. Most digital papers do not include the traditional devices *past research, following X*, etc.; as an alternative, hyperlinks to the references are inserted in the paper and thus the reader can consult the original article. Also, some endophoric markers, e.g. *see Table X*, are also hyperlinks that guide readers to different sections of the paper. Additionally, digital papers show key statements of the articles and readers can give their opinion or feedback, taking part in the flow of discourse. In fact, these changes may affect the ways readers follow the ideas of the paper, making it easier to check evidential and endophoric markers.

Regarding visual metadiscourse, Table 6 shows raw numbers and the normalised frequencies (the average number of visual metadiscourse elements per paper) taking into consideration the number of papers compiled for each corpus.

Table 6. Occurrences of tables and figures

Visual metadiscourse	**Engineering** Occurrences (N)	**Medicine** Occurrences (N)	**Linguistics** Occurrences (N)	**Total** Occurrences (N)
No. Tables	354 (5.53)	152 (1.40)	296 (3.70)	802 (3.18)
No. Figures	179 (2.79)	129 (1.19)	242 (3.02)	550 (2.18)
Total	533 (8.32)	281 (2.60)	538 (6.72)	1,352 (5.36)

A number of tables in the three domains were found, engineering being the field of knowledge that contained more tables (5.53) and linguistics the one with more figures (3.02). The average number of visual metadiscourse elements was 5.36 visual devices per paper. The high number of figures in linguistics may be due to the fact that the papers compiled belonged to the field of applied linguistics. Linguists are, thus, conscious about the importance of visual discourse; this is in line with Van Leewen's work (2004, 17), who indicates that "[…] visual communication increasingly fulfils a syntactic role […] while language is increasingly reduced to a lexical role."

Then, it was checked the correct use or misuse of these devices. This was a complementary analysis to detect if there were differences in the wrong use of visual metadiscourse in engineering, medicine and linguistics that could indicate different patterns in the dissemination of knowledge. Table 7 shows the occurrences and normalised frequencies of the right and wrong use of visual metadiscourse.

Table 7. Occurrences of visual metadiscourse

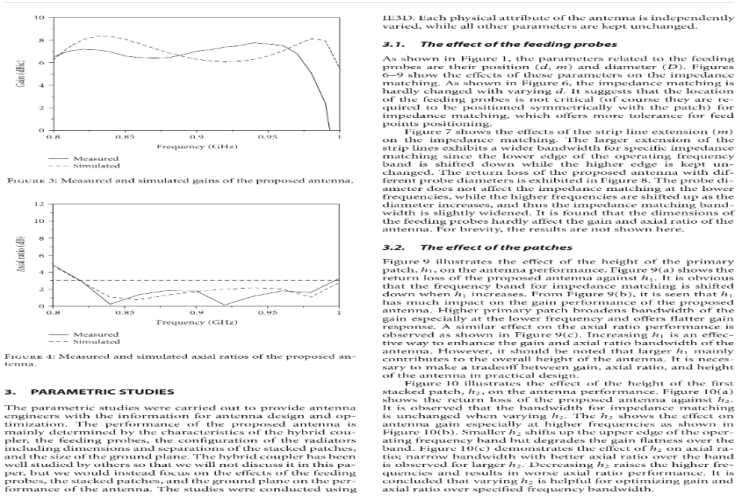
Visual metadiscourse	**Engineering** Occurrences (N)	**Medicine** Occurrences (N)	**Linguistics** Occurrences (N)
Right use of logical cohesion (following an order)	512 (8.00)	267 (2.47)	532 (6.65)
Wrong use of logical cohesion (not following an order)	21 (0.32)	14 (0.12)	6 (0.07)
Right use of spatial cohesion (position in the text)	127 (1.98)	74 (0.68)	125 (1.56)
Wrong use of spatial cohesion (not right position in the text)	13 (0.20)	4 (0.03)	8 (0.10)

Visual adequacy (no overuse of images)	509 (7.95)	279 (2.58)	536 (6.70)
Visual abuse (overuse of images)	24 (0.37)	2 (0.01)	2 (0.02)
Right use of endophora	508 (7.93)	274 (2.53)	530 (6.62)
Wrong use of endophora	25 (0.39)	7 (0.06)	8 (0.10)

It can be observed that the total number of occurrences does not correspond to the total number of tables and figures indicated in Table 6. This is due to the fact that most figures or tables were classified into two or more categories as they met two or more conditions (e.g. no visual abuse, visual adequacy, right use of endophora and logical cohesion) and were complementary. Low frequencies were obtained in the wrong use of logical cohesion, spatial cohesion, visual adequacy and endophora in medicine and linguistics, whilst most misuse was found in engineering papers, so it may be considered that authors were conscious of the importance of guiding readers in a multimodal way in digital academic English.

Some examples of the wrong use of visual devices in engineering papers can be seen in Figures 3 and 4, below.

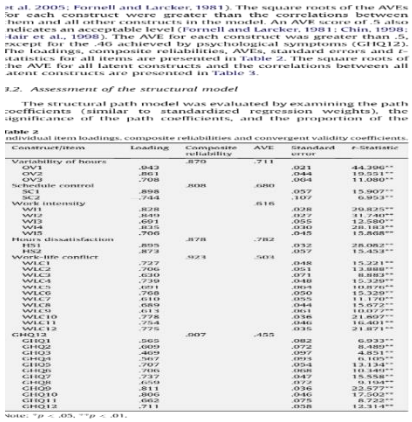
Figure 3. Example of wrong logical cohesion and endophora



In Figure 3, the figures are placed before a new section of the paper, without any comment or reference to the data shown, without following an order that guides readers or connects with textual markers in a coherent way. Figure 4 below also shows an

example of incorrect spatial cohesion. The figures are not shown in a sequence, guiding readers in discourse and are placed in a distorted way that readers will not find attractive. Additionally, the figures display so much information and data that it is not understandable, which therefore also makes it an example of visual abuse. Engineering papers included more frequencies of wrong logical cohesion, wrong spatial cohesion, visual abuse and wrong use of endophora.

Figure 4. Example of wrong spatial cohesion and visual abuse



After the full data extraction of visual devices, then the normalised frequencies of the correct use of visual and textual metadiscourse devices were compared in Table 8 to discern differences in the three fields of knowledge.

Table 8. Normalised frequencies of textual and visual metadiscourse

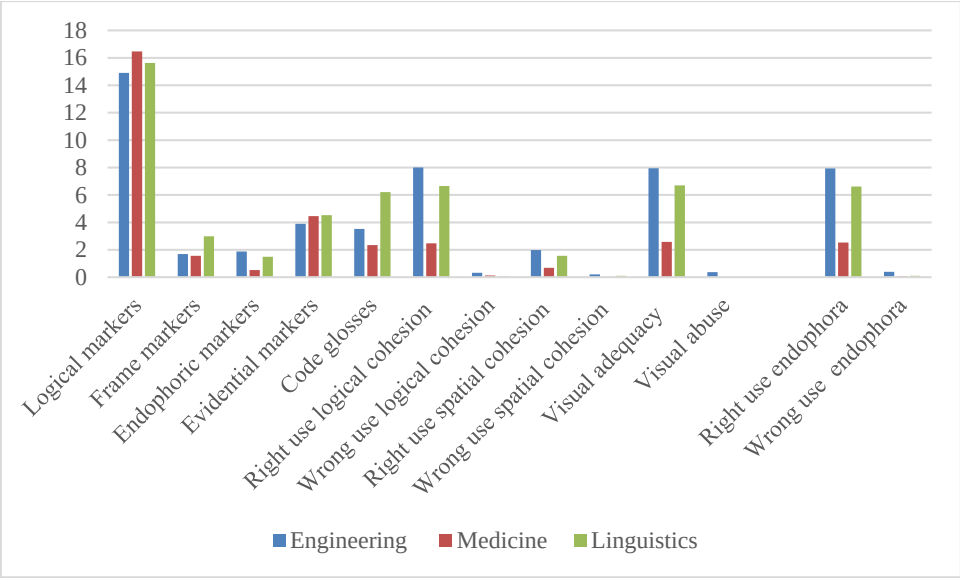
Multimodal metadiscourse	**Engineering N**	**Medicine N**	**Linguistics N**
Logical markers	14.90	16.47	15.63
Logical cohesion	8.00	2.47	6.65
Total	22.90	18.94	22.28
Frame markers	1.69	1.56	2.99
Spatial cohesion	0.60	0.12	0.26
Total	2.29	1.68	3.25
Endophoric markers	1.88	0.52	1.49
Spatial cohesion	0.70	0.15	0.15
Endophora	5.80	1.51	4.52
Total	8.38	2.18	6.16
Evidential markers	3.89	4.45	4.52
Visual adequacy	4.25	1.53	2.90
Endophora	2.13	1.02	2.10
Total	10.27	7.00	9.52
Code glosses	3.52	2.34	6.21
Visual adequacy	3.70	1.05	3.80
Spatial cohesion	0.68	0.41	1.15

Total	7.90	3.80	11.16

It should be noticed that engineers used more multimodal metadiscourse devices than medical researchers and linguists, with the exception of the multimodal markers that give examples or explain parts of the text, which were preferred by linguists. The most frequent in engineering, medicine and linguistics were logical devices, as academic writers were conscious of the importance of including markers that increased the logical flow of digital discourse. Papers on medicine used less multimodal metadiscourse and in this vein, Dahl (2004, 1819) explains "Since medical reporting is so formally organised, the content presented is forced into information categories in a given sequence, and no extra processing effort is needed by the expert reader to orient him or herself within the text." Following this argument, our findings may mean that engineers write disorganised papers as they need to use a higher number of textual and visual metadiscourse devices to guide readers. This could also support the finding that most of the occurrences of wrong use of visual metadiscourse were found in engineering papers. Dahl (2004) also indicates that research in medicine has a long tradition and this is not the case in other specific fields of knowledge such as engineering and linguistics.

To illustrate this idea, Figure 5 compares the data of the correct use or misuse of multimodal metadiscourse in engineering, medicine and linguistics.

Figure 5. Data of multimodal metadiscourse in different fields of knowledge



It can clearly be observed in the chart that engineers are the ones who used more multimodal metadiscourse, followed by linguists and medical doctors. Although digital academic discourse entails some malpractices such as visual abuse, wrong use of endophora, logical and spatial cohesion, it should be noted that, on the whole, the frequent use of metadiscourse devices to organise the text may be interpreted as a positive characteristic (readers are guided by authors) or as a negative one (the organisation of the paper does not orient readers and more organisational devices should be included)

Linguists and engineers used logical markers, evidentials and code glosses (exemplification) quite frequently, explaining the specific terms or giving examples of concepts to readers, and referring to tables or figures. These frequencies, although not very high, also indicated that linguists and engineers referred to visual information in their research, whereas medical researchers explained data in a simpler way, outlining the results in numbers but using fewer visual aids than in linguistics and engineering.

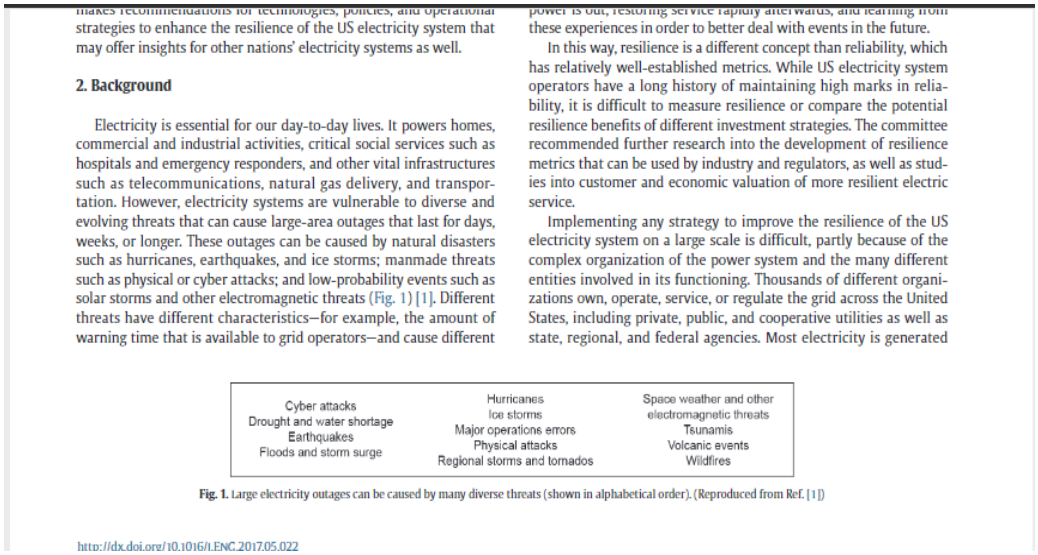
After re-checking manually the corpus, it was observed that medical journals preferred short papers that described an experiment or proposed a cure or a drug, showing data in a descriptive way and following a similar structure, with direct information on the results and very brief theoretical background. Thus, the academic identity of medical

journals encourages researchers to be brief and synthesise their ideas. In contrast, linguists and engineers used textual markers more frequently, describing, giving examples and providing evidence in a more textual way. After this analysis, it could be said that engineers, medical researchers and linguists used coherence devices quite frequently, but low frequencies were obtained in devices that provided cohesion and referred to different parts of the paper. Perhaps this is an aspect that should be taken into consideration by engineers to guide readers and show the sequence or labels of academic discourse.

The results showed there are in fact differences in the way academic writers use multimodal metadiscourse, depending on their academic culture. The study revealed that engineering writers preferred the use of visual metadiscourse while linguistic researchers chose textual metadiscourse to guide readers in digital academic discourse. This finding coincides with Lemke's analysis (1998, 89), when he indicates, "They (hard scientists) combine, interconnect, and integrate verbal text with mathematical expressions, quantitative graphs, information tables, abstract diagrams, maps. Drawings […]". Linguists preferred textual metadiscourse to explain ideas or give examples more than visual aids. Medical doctors used less multimodal metadiscourse in articles and this could be due to the sound organisation of papers or to their brevity.

Looking closely at the use of multimodal metadiscourse in the field of engineering, logical markers (14.90) and logical cohesion (8.00) were the most frequently used categories. We can see an example of multimodal metadiscourse in example (1):

> (1) "*However*, electricity systems are vulnerable to diverse and evolving threats that can cause large-area outages that last for days, weeks, or longer. These outages can be caused by natural disasters […] such as solar storms and other electromagnetic threats (*Fig. 1*)" [Eng. 9]



makes recommendations for technologies, policies, and operational strategies to enhance the resilience of the US electricity system that may offer insights for other nations' electricity systems as well.

2. Background

Electricity is essential for our day-to-day lives. It powers homes, commercial and industrial activities, critical social services such as hospitals and emergency responders, and other vital infrastructures such as telecommunications, natural gas delivery, and transportation. However, electricity systems are vulnerable to diverse and evolving threats that can cause large-area outages that last for days, weeks, or longer. These outages can be caused by natural disasters such as hurricanes, earthquakes, and ice storms; manmade threats such as physical or cyber attacks; and low-probability events such as solar storms and other electromagnetic threats (Fig. 1) [1]. Different threats have different characteristics—for example, the amount of warning time that is available to grid operators—and cause different

power is out, restoring service rapidly afterwards, and learning from these experiences in order to better deal with events in the future.

In this way, resilience is a different concept than reliability, which has relatively well-established metrics. While US electricity system operators have a long history of maintaining high marks in reliability, it is difficult to measure resilience or compare the potential resilience benefits of different investment strategies. The committee recommended further research into the development of resilience metrics that can be used by industry and regulators, as well as studies into customer and economic valuation of more resilient electric service.

Implementing any strategy to improve the resilience of the US electricity system on a large scale is difficult, partly because of the complex organization of the power system and the many different entities involved in its functioning. Thousands of different organizations own, operate, service, or regulate the grid across the United States, including private, public, and cooperative utilities as well as state, regional, and federal agencies. Most electricity is generated

Fig. 1. Large electricity outages can be caused by many diverse threats (shown in alphabetical order). (Reproduced from Ref. [1])

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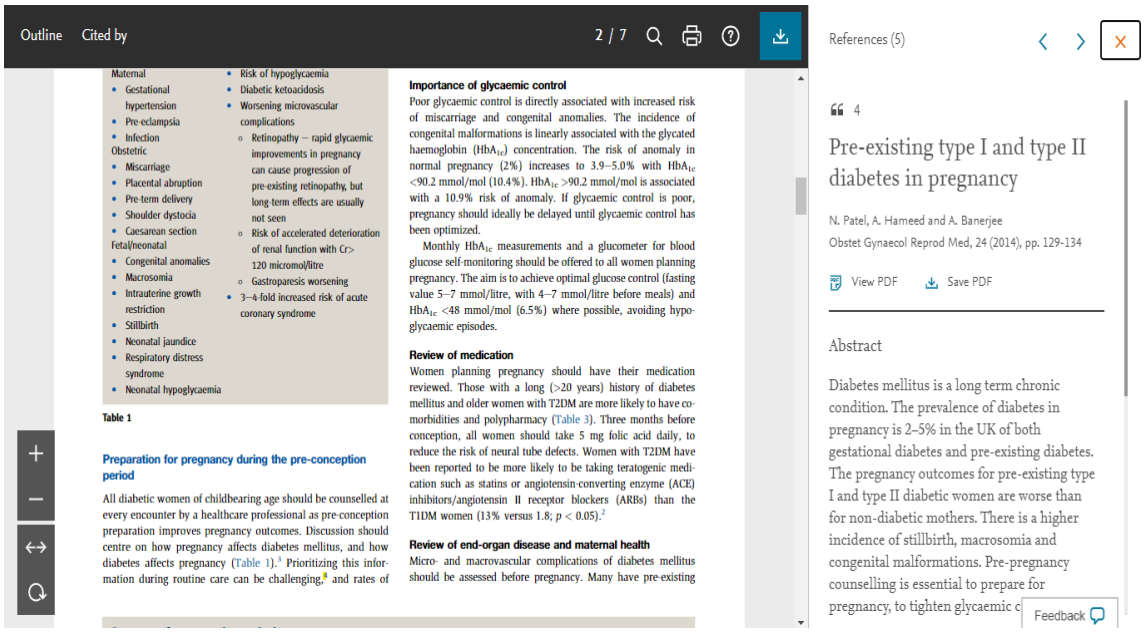
In the example, the engineers used a logical marker to contrast their point of view, including a visual device (Figure 1) to complement the consecutive flow of discourse. Thus, it can be seen that the writers were aware of the importance of guiding the reader textually and visually, expounding their proposition in the figure.

In the field of medicine, the devices that showed evidence about propositions, that is, evidential markers (4.45), visual adequacy (1.53) and endophora (1.02) were quite frequently used. An example from the medicine corpus can be observed in (2), this is one example of the fact mentioned above, that is, due to the digital nature of the paper, the evidence about the proposition is shown clicking on a number and the evidence (another paper) is shown on the right side of the screen. So, in this case, digital discourse incorporates a new way to provide evidence to readers. Additionally, visual metadiscourse (a table) is used to complement in a more visual way the theoretical background of the paper:

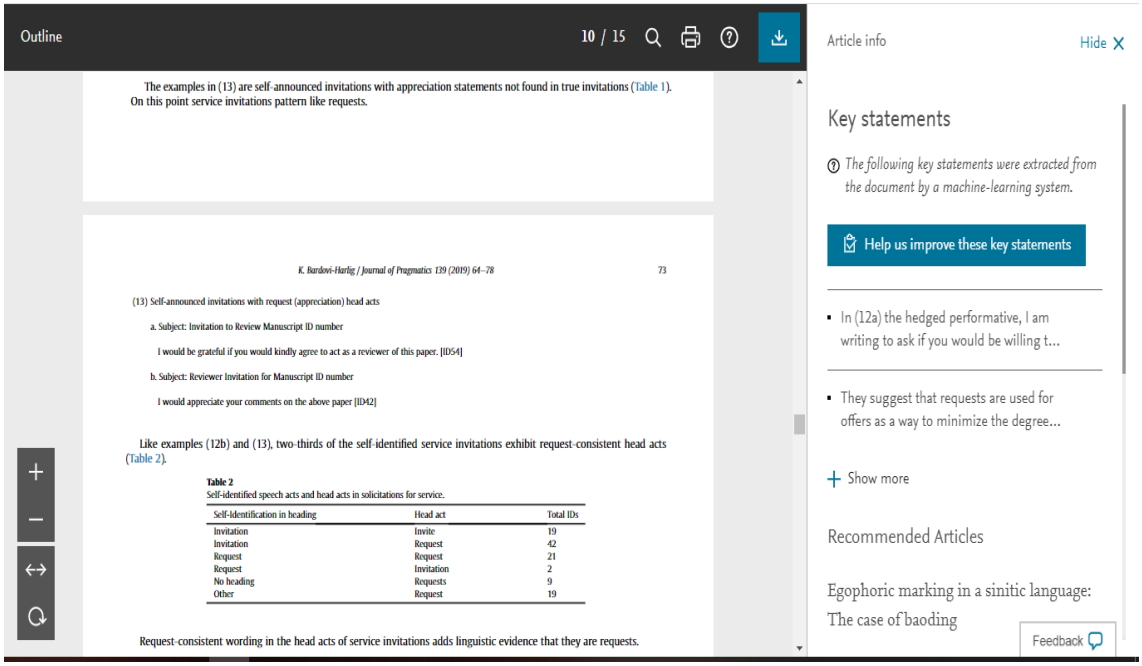
(2) "All diabetic women of childbearing age should be counselled at every encounter […]. Discussion should centre on how pregnancy affects diabetes mellitus, and how diabetes affects pregnancy (*Table 1*).[3] Prioritizing this information during routine care can be challenging,[4]" [Med 23]



In the sample, medical researchers support their propositions with the findings of previous studies, providing evidence of this fact citing the publications. Medical doctors are aware of the importance of supporting hypotheses on previous findings to gain credibility and to reinforce their identity as researchers.

Linguists, who are aware of the importance of guiding readers and signposting scientific discourse for both their own as well as their interlocutor's benefit (Hyland 1998), used more textual devices than engineers and medical doctors. The most commonly used multimodal metadiscourse devices in the linguistic corpus were code glosses (6.21) in textual metadiscourse and visual adequacy (3.80) and spatial cohesion (1.15) in visual metadiscourse. Surprisingly, linguists used reformulation and exemplification to guide readers more frequently than providing evidence. An example can be seen in (3):

(3) "*Like examples (12b)* and *(13)*, two-thirds of the self-identified service invitations exhibit request-consistent head" [Ling 37]



It can be observed in the example that digital academic papers may interact with readers. On the right side of the screen, readers are shown key statements from the document and some articles are also recommended. Thus, readers are guided to get extra information about the research topic of the article by authors and editorials, offering them the option to get extra information, give feedback or help editors improve key statements. Additionally, readers have the opportunity to give feedback and see key statements. Digital papers provide more information to readers accessible at the click of a button, organising information depending on the needs of readers.

This paper has focused on the analysis of multimodal metadiscourse with the aim of pinpointing different identities in digital academic discourse, as Diani (2008, 182) explains: “Not enough attention, however, has been paid to the different types of textual voices involved in the presentation of academic research, and to the role they play in the construction of the writer’s identity in different disciplinary domains”. I believe the way authors organise digital academic discourse conditions the flow of ideas through the text and this could be caused by the academic culture of the writer and the expected readers.

Additionally, academic writers should be conscious of the nature of digital papers that offers new resources to readers and also to writers.

Conclusions

This paper has focused on the way knowledge is disseminated in digital academic discourse nowadays. As Kress (2004, 110) pointed out, human beings have undergone a change in the way we obtain and disseminate knowledge: "[…] that is, from the constellation of mode of writing and medium of book / page, to the constellation of mode of image and medium of screen". Thus, nowadays digital academic discourse is a way to transmit information using text and images that guide readers. In a way, academic writers have transformed the mode of showing readers their findings and this entails changes. Academic writers should be aware of the way they guide readers using texts and images, trying to persuade them about the usefulness of their findings. A balanced way of using multimodal metadiscourse devices is advisable after this study to avoid abuse of information. This aspect should also be considered by editors of journals, who sometimes suggest changes in the disposition of images without taking into account the fact that the combination of text and images should be harmonious in order to guide readers and be attractive to them. This should not be a problem in digital papers.

Three objectives were posed at the beginning of this study. The first was to compare the textual metadiscourse devices used in engineering, medicine and linguistics and the identities that authors represented, which are aspects that have been shown in Tables 1 and 4 and Figure 5. Second, the paper sought to identify the visual metadiscourse elements employed in the three identities studied here, and to this end I have proposed a classification of visual academic metadiscourse (see the Methodology section and Tables 3 and 7).

I intended to study multimodal metadiscourse when used to construct the singular academic identity of linguists, engineers and medical doctors, and to this end, I have identified different frequencies and patterns in the corpus analysed (see Table 8 and Figure 5). The research questions have also been answered in the Results and discussion section, for example, showing that engineers sometimes make abusive use of visual metadiscourse while linguists prefer textual metadiscourse and medical doctors do not make extensive use of multimodal metadiscourse given the fixed structure and length of their research papers. In fact, I have shown that there are dissimilarities in the way knowledge is disseminated, depending on the importance granted to providing references to some parts of the research (i.e. endophoric markers in engineering), to exemplifying and describing ideas (i.e. code glosses in linguistics), to referring to previous research (i.e. evidentials in medicine and linguistics) or to illustrating findings (i.e. visual adequacy, logical cohesion and endophora in engineering).

Finally, the traditional analysis of metadiscourse has focused on textual elements but I propose to include visual metadiscourse and study multimodal metadiscourse in different specific fields of knowledge, as it seems clear that academic writers publish their findings in dissimilar ways in digital academic discourse. Academic writers should also be conscious of the characteristics of digital papers; references are directly available as well as hyperlinks can guide readers to different parts of the paper. As Lemke (1998, 89) states, "The 'concepts' of science are not verbal concepts, though they have verbal components. They are semiotic hybrids, […]. The actional, conversational, and written textual genres of science are historically and presently, fundamentally and irreducibly multimedia genres." Here I have only included tables and figures in the multimodal analysis, but I am aware of the fact that there are journals that use other multimodal devices to show readers findings. This could be interesting for future studies.

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