

## A Cross-disciplinary Study of Metadiscourse Markers in Research Articles

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Research Paper

IJEAP- 2410-2085 DOR: [20.1001.1.24763187.2024.13.4.5.6](https://doi.org/20.1001.1.24763187.2024.13.4.5.6)

Received: 2024-10-30

Accepted: 2024-12-21

Published: 2024-12-30

**Abstract:** Metadiscourse Markers (MDMs) serve as rhetorical tools that authors employ to facilitate audience understanding (interactive MDMs) and to foster engagement between authors and readers within a text (interactional MDMs) (Hyland, 2005). This study examines the variation in MDM usage across different disciplines, specifically in the post-method sections of 120 Research Articles (RAs) categorized as soft-pure (English literature), soft-applied (applied linguistics), hard-applied (pharmacology), and hard-pure (mathematics). The corpus, comprising 793,873 words, was analyzed using the AntConc concordancer, and the Kruskal Wallis Test was applied for statistical evaluation. The findings revealed significant cross-disciplinary differences and highlighted distinct patterns in the utilization of MDMs across various RAs. Specifically, soft-applied texts contained the highest number of both interactive and interactional MDMs. The analysis of these results provided important insights for English for Academic Purposes (EAP) programs as well as academic reading and writing courses. It emphasizes the need for students to adapt to the contemporary trend of using more accessible language to engage a wider audience. This approach is especially relevant in today's competitive academic landscape, where clear communication is essential for effectively disseminating research findings and maximizing their impact. Additionally, the paper proposes directions for future research to address identified limitations and delimitations.

**Keywords:** Academic Writing, Cross-Disciplinary Variation, Metadiscourse, Research Article

### Introduction

Do authors of academic texts belonging to various disciplines use metadiscourse markers differently? It has been the question asked by many researchers studying metadiscourse in academic texts (Hyland, 2018). Academic text is a means of communication between an author and an audience about a topic in their field of study (i.e., discipline) (Greene & Lidinsky, 2021). Metadiscourse Markers (MDMs) are rhetorical tools used by authors to direct their audiences toward an intended interpretation of a text (interactive MDMs) and engage with audiences (interactional MDMs) (Hyland, 2005). The related empirical literature could be classified into two groups. The first group investigated cross-disciplinary variation in using MDMs without justifying their choice of discipline. For example, Khedri and Kritsis (2018) selected Research Articles (RAs) of applied linguistics and chemistry without mentioning any rationale for this choice. The second group considered a science classification model. However, this model was either based on the authors' personal interpretations of the nature of sciences or that it was a rather outdated model. For instance, Sarani et al. (2017) supposed that disciplines could be grouped into humanities and nonhumanities. They justified that these two groups of science were "generally associated with different research paradigms" (p. 138). Farnia and Gerami (2021) followed the traditional soft-hard science categorization model and selected RAs of "two engineering disciplines, i.e., mechanical and industrial, as representatives of hard science journals, and two disciplines in social sciences and humanities, i.e., psychology and management as representatives of soft science journals"

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(p. 267). Exploring MDMs in academic texts of various disciplines (i.e., assessing cross-disciplinary variation in using MDMs in academic texts) could provide insights for academic reading and writing courses. In other words, it offers specific patterns of using MDMs in academic texts of every discipline or science category. To this end, the studies assessing cross-disciplinary variation need to select particular disciplines systematically by following a solid up-to-date science categorization model and providing convincing justifications.

The current study addresses the identified gaps in the reviewed literature. It follows Becher and Trowler's (2001) science categorization model to select RAs of soft-pure (English literature), soft-applied (applied linguistics), hard-applied (pharmacology), and hard-pure (mathematics) sciences to study cross-disciplinary variation in using interactive and interactional MDMs. Becher and Trowler's (2001) model considers multiple relevant factors (e.g., inquiry objectives, research procedures, and results) to classify disciplines into one of the four science categories of soft-pure (i.e., purely social sciences and humanities with subjective and holistic views, e.g., literature), soft-applied (i.e., applied social sciences usually attempting to offer practical utilizations of social concepts e.g., how to use the linguistic concepts in real life situations), hard-pure (i.e., pure atomistic sciences employing objective views to often deal with quantities, e.g., mathematics), and hard-applied (i.e., applied atomistic sciences mostly offering concrete procedures to employ hard-pure concepts if real world, e.g., how to use mathematics and physics in constructing buildings). The researchers studied Becher and Trowler's (2001) model carefully to ensure that the selected disciplines fit the model categories properly. English literature, recognized as a humanities discipline, generally studies literary concepts like allegory and analogy in English poems, stories, plays, etc. Applied linguistics is an applied humanities discipline often concerned with using, teaching, and learning linguistic elements. Pharmacology is a clinical discipline studying how to make and use medications. Mathematics is a pure atomistic science studying theories about quantities, shapes, formulas, etc. It is noteworthy to mention that the corpus selection procedure of the study was also conducted in a way to include the texts that matched the characteristics of each science category. For example, the English literature RAs which followed value-free and statistical approaches were not included. According to Hyland's (2005) interpersonal model, there are five interactive MDMs used to help audiences comprehend a text as intended by authors and five interactional MDMs used to involve authors and audiences and engage with them. An examination of the frequencies and functions of each category of MDMs within RAs across the four science disciplines may reveal distinct patterns of metadiscourse usage pertinent to various academic fields. These findings could inform the development of academic reading and writing strategies, particularly in the context of English for Academic Purposes (EAP) courses, given the critical importance of addressing reading and writing needs in such programs (Atai & Abbasi, 2023). Additionally, the study's findings could contribute to a broader understanding of academic communication, potentially influencing how scholars across disciplines approach writing and engagement with their audiences. The research could also play a significant role in enhancing the EAP curricula by providing crucial insights that better prepare students for academic success.

## Literature Review

### Theoretical Literature

Academic text is a medium for conveying information between authors and their audiences regarding a subject within their area of expertise (Greene & Lidinsky, 2021). Both authors and writers need to be aware of the conventions of their respective disciplines, as this knowledge enables authors to produce texts that are appropriate and facilitates audiences in understanding these texts effectively. In this context, "academic" refers to the individuals engaged in a particular field of study, including both authors and their audiences, while "text" denotes a structured arrangement of linguistic elements, such as phonemes, lexemes, and syntactic constructions, designed to convey information from a sender (an author) to a recipient (an audience) (Georgakopoulou & Goutsos, 2022).

An RA represents a specific genre of academic writing that serves as a vehicle for disseminating scholarly information to the public (Swales & Feak, 2012). “It discusses other scholars’ writing, is vetted by other scholars (peer reviewers), and is based in the concerns of a discipline” (Belcher, 2019, p. 10). It typically comprises an “abstract, introduction, methods, results, discussion, references, and tables and figures” (Ary et al., 2014, p. 652). The sections dedicated to results and discussion may either be presented as distinct entities or integrated into a singular section. They typically constitute the largest segment of an article and hold significant importance for readers (Ary et al., 2014). The sections pertaining to results, discussion, and conclusion are referred to as the post-method sections, as they follow the method section within an academic article. The post-method sections are often regarded as the most difficult parts to compose, as they encompass the authors’ interpretations and arguments. In these sections, authors tend to engage both their audiences and themselves more actively (Belcher, 2019). Additionally, “given the complexities of presenting intricate findings, explicating the reasoning behind knowledge claims, and making compelling connections between findings and conclusions”, post-method sections are particularly well-suited for examining metadiscourse (Cao & Hu, 2014, p. 18). In summary, research articles, particularly their post-method sections, serve as excellent subjects for the examination of metadiscourse, as they play a crucial role in academic communication and present significant writing challenges.

The notion of metadiscourse, as a major theme in recent applied linguistics research (Estaji & Azizbeigi, 2024), is grounded in the understanding of writing and speaking as forms of social interaction and communicative involvement (Hyland, 2018). This concept “allows writers to guide, direct, and interact with their readers and demonstrate a concern for their ability to understand a text as it is intended” (Hyland & Jiang, 2022, p. 1). This research examines metadiscourse as a rhetorical instrument that facilitates the interaction between a text (which serves as a medium for meaning negotiation), its author (the originator of the message), and its audience (the recipient of the message). In other words, authors employ specific words or phrases, i.e., MDMs, to refer to themselves, show their perspectives, acknowledge and involve their audience, and facilitate the audience’s comprehension of the text as it was meant to be understood.

In his interpersonal model, Hyland (2005) classified MDMs into two distinct categories: interactive and interactional groups. Interactive markers serve the purpose of structuring a text, such as by arranging its contents, to guide the audience towards the author’s intended understanding of the text. Interactional markers are utilized to refer to and involve both authors and audiences within a text. Table 1 presents a compilation of MDMs derived from Hyland’s (2005) framework, along with their respective functions and illustrative examples.

**Table 1**

*Hyland’s (2005) Interpersonal Model of Metadiscourse (p. 49)*

Category	Function	Example
Interactive	To guide the reader through the text	Resources
Transitions	express relations between main clauses	in addition; but; thus; and
Frame markers	refer to discourse acts, sequences, or stages	finally; to conclude; my purpose is
Endophoric markers	refer to information in other parts of the text	noted above; see Fig; in section 2
Evidentials	refer to information from other texts	according to X; Z states
Code glosses	elaborate prepositional meanings	namely; e.g.; such as; in other words
Interactional	To involve the reader in the text	Resources
Hedges	withhold commitment and open dialogue	might; perhaps; possible; about
Boosters	emphasize certainty or close dialogue	in fact; definitely; it is clear that
Attitude markers	express writers’ attitude to a proposition	unfortunately; I agree; surprisingly
Self-mentions	explicit reference to author(s)	I; we; my; me; our
Engagement markers	explicitly build a relationship with a reader	consider; note; you can see that

This study adheres to Hyland’s (2005) interpersonal model, which provides an extensive catalog of MDMs along with pertinent functions and illustrative examples. Several metadiscourse investigations (e.g. Farnia & Gerami, 2021; Kawase, 2015; Lee & Casal, 2014) have adhered to this framework in recognizing occurrences of metadiscourse markers.

This research utilizes the framework established by Becher and Trowler (2001) for the categorization of scientific disciplines, which serves as a basis for selecting the corpus. The details of this model are illustrated in Table 2.

**Table 2**

*Becher and Trowler's (2001) Model of Science Categorization (P. 36)*

Disciplinary groupings	Nature of knowledge
Pure sciences (e.g. physics): 'hard-pure'	Cumulative; atomistic (crystalline/tree-like); concerned with universals, quantities, simplification; impersonal, value-free; clear criteria for knowledge verification and obsolescence; consensus over significant questions to address, now and in the future; results in discovery/explanation.
Humanities (e.g. history) and pure social sciences (e.g. anthropology): 'soft-pure'	Reiterative; holistic (organic/river-like); concerned with particulars, qualities, complication; personal, value-laden; dispute over criteria for knowledge verification and obsolescence; lack of consensus over significant questions to address; results in understanding/interpretation.
Technologies (e.g. mechanical engineering, clinical medicine): 'hard-applied'	Purposive; pragmatic (know-how via hard knowledge); concerned with mastery of physical environment; applies heuristic approaches; uses both qualitative and quantitative approaches; criteria for judgment are purposive, functional; results in products/techniques.
Applied social science (e.g. education, law, social administration): 'soft-applied'	Functional; utilitarian (know-how via soft knowledge); concerned with the enhancement of [semi-] professional practice; uses case studies and case law to a large extent; results in protocols/procedures.

This study adopts the model proposed by Becher and Trowler (2001), moving away from the conventional soft-hard classification. This model introduces a novel classification of scientific disciplines, grounded in a logical framework that facilitates distinct separations among various scientific categories based on "characteristics in the objects of enquiry; the nature of knowledge growth; the relationship between the researcher and knowledge; enquiry procedures; extent of truth claims and criteria for making them; the results of research" (pp. 35-36). Furthermore, the model provides extensive insights into the characteristics of knowledge within each scientific category, supplemented by numerous examples that facilitated our identification of disciplines during the corpus selection process.

### Empirical Literature

This section examines pertinent empirical literature concerning the dependent variables, i.e., the frequency and function of MDMs in academic texts, as well as the independent cross-disciplinary variable and the control variables, including the influences of language and text genre. Additionally, the potential application of metadiscourse frameworks and scientific categorization models within these studies is considered.

Existing scholarly research has demonstrated the influence of both language and genre in academic texts on the utilization of MDMs by authors. Lee and Casal (2014) investigated Hyland's (2005) interactive and interactional (MDMs) by analyzing 200 master's theses across five different engineering disciplines (i.e., chemical, civil, electrical, industrial, and mechanical engineering): 100 in English and 100 in Spanish. They employed AntConc software for the analysis of their corpus and subsequently verified the results through manual examination. The researchers noted variations in the application of MDMs across the two groups of texts. For instance, English texts incorporated a greater number of interactive markers aimed at enhancing audience understanding, yet they employed a reduced frequency of interactional markers intended to foster engagement with their audiences. While Lee and Casal (2014) undertook an extensive investigation involving various types of MDMs within a substantial corpus, they failed to provide rationales for their adherence to Hyland's (2005) interpersonal model, the utilization of AntConc software, and the choice of texts from engineering fields. Kawase (2015) conducted a study on Hyland's (2005) interpersonal MDMs within the introductory sections of academic texts in the field of applied linguistics, authored by eight individuals. Each of these authors produced both a Ph.D. dissertation and an RA. The findings indicated that research articles incorporated a greater number of interactive and interactional markers compared to dissertations. He ascribed this

discovery to the generic characteristics present in the two collections of academic texts. Nevertheless, he examined a limited corpus derived from RAs within a specific discipline and failed to explicitly outline the data analysis methodology employed, such as whether he utilized software tools or performed a manual analysis. In summary, the linguistic features and genre characteristics of academic texts influence the utilization of MDMs. In this study, these factors are held constant as they do not constitute the primary focus of the research.

A number of scholars have evaluated the differences across disciplines in the application of MDMs within academic texts, without adhering to a science classification framework. Estaji and Vafaeimehr (2015) analyzed attitude markers, hedges, and boosters in the introductions and conclusions of 21 electrical and mechanical engineering RAs. They found minimal differences in marker frequency, with boosters being the most common. The authors recommended that academic writing courses emphasize effective metadiscourse marker use to improve students' writing skills. They did not provide justifications for their corpus selection and for limiting their study to analyzing just three of Hyland's (2005) interactional MDMs. Khedri and Kritsis (2018) examined interactive and interactional MDMs in 36 RA introductions of applied linguistics and chemistry. They found that chemistry RAs, unlike applied linguistics RAs, had fewer markers due to the discipline's objective nature. The authors highlighted the need for novice authors to grasp their field's rhetorical conventions. However, they did not justify their corpus selection. They acknowledged the limitations of their small corpus, which affected the generalizability of their findings, and called for further research on using MDMs in other disciplines. Boginskaya (2022) examined Hyland's (2005) interactional MDMs in 73 abstracts from applied linguistics RAs and 73 abstracts from engineering RAs, all authored in English by Russian scholars. The study identified the presence of hedges, boosters, attitude markers, and self-mentions, while noting the absence of engagement markers. Additionally, it was found that the abstracts from applied linguistics RAs contained 4.5 times more MDMs than those from the engineering sub-corpus, reflecting the applied linguists' superior proficiency in composing English texts. The study also acknowledged its limitations, specifically the sample size and the selection of only two disciplines, and recommended that future research should explore other categories of MDMs and consider different sections of RAs from various fields.

Some researchers have investigated the variations in the utilization of MDMs in scholarly texts across different disciplines, following unsolid science classification models. Sarani et al. (2017) analyzed hedges, boosters, and attitude markers in the discussion and conclusion sections of 66 RAs from humanity and nonhumanity disciplines. After manually analyzing their corpus, they found that nonhumanity texts had more boosters and fewer hedges and attitude markers, indicating a focus on objectivity, while, overall, humanity texts used more interactional markers, emphasizing reader engagement. The authors linked these differences to the disciplines' natures, with nonhumanity texts prioritizing empirical evidence. However, the study had limitations, including an oversimplified categorization of disciplines, a small sample size affecting generalizability, and a lack of rationale for the chosen MDMs. Farnia and Gerami (2021) examined interactional MDMs, specifically hedges and boosters, in the discussion sections of 30 RAs from soft (psychology, management) and hard sciences (mechanical, industrial engineering). Soft science authors used hedges more often, while hard science authors preferred boosters, reflecting the subjective nature of soft sciences versus the objective stance of hard sciences. The study presented findings in tables but lacked extracts from the corpus to provide evidence and did not specify whether the analysis was manual or software-based. The authors acknowledged limitations in generalizability due to the small sample size.

An examination of the relevant literature provided significant insights and identified research gaps. It is essential for both readers and writers of academic texts to understand MDMs, as these elements improve comprehension and foster engagement between writers and readers (Hyland, 2005). The effective application of these markers is shaped by various factors, including language, genre, and the specific discipline involved. The latter impact, identified as cross-disciplinary variation, has not been analyzed using a well-established science categorization system. It appears that previous related studies may not have adhered to any specific science categorization framework (e.g., Khedri & Kritsis, 2018) or have followed conventional soft-hard science categorization (e.g., Farnia & Gerami, 2021).

Moreover, The reviewed literature exhibited certain limitations and shortcomings, such as a restricted corpus size and a lack of justification for corpus selection. These issues may potentially undermine the validity and generalizability of the findings. The current study addressed the identified issues to present more solid results and findings.

### The Present Study

This research seeks to explore interactive and interactional MDMs as delineated by Hyland's (2005) interpersonal model within the post-method sections of various academic disciplines, specifically soft-pure (English literature), soft-applied (applied linguistics), hard-applied (pharmacology), and hard-pure (mathematics) sciences. The choice of Hyland's model is justified by its extensive compilation of MDMs, which are supplemented with numerous examples and insights. In addition, Becher and Trowler's (2001) classification of science is employed, as it represents a more contemporary approach compared to the conventional soft-hard dichotomy. This model is particularly valuable as it provides a rationale for categorizing disciplines into soft-pure, soft-applied, hard-applied, and hard-pure categories, thereby offering significant guidance for the classification of various fields of study. The selected disciplines are intended to align with the model while also highlighting under-researched areas within the scientific landscape. Notably, MDMs have been infrequently examined in the contexts of English literature, pharmacology, and mathematics. The post-method sections of RAs are chosen for analysis due to their prominence as a medium of academic discourse (Swales & Feak, 2012), with particular emphasis on the challenges authors face in articulating their arguments and engaging with their audience in sections such as results, discussion, and conclusion (Belcher, 2019). This study ultimately aims to address the following research question:

What are the differences in the frequency and function of Hyland's (2005) interactive and interactional MDMs among the four groups of academic texts based on Becher and Trowler's (2001) model of science classification (i.e., hard-pure, hard-applied, soft-applied, and soft-pure sciences)?

## Methodology

### Corpus

The study's corpus, as detailed in Table 3, comprises the post-method sections of 120 RAs. The selection of these RAs was conducted using a quota sampling technique, which involved four distinct categories: soft-pure (English literature), soft-applied (applied linguistics), hard-applied (pharmacology), and hard-pure (mathematics) sciences, with each category containing 30 RAs. RAs were chosen due to their prevalence as public mediums for academic discourse (Swales & Feak, 2012). The post-method sections of these articles encompass the results, discussion, and conclusion, which are considered to reflect the authors' interpretations and arguments, with a notable engagement of both the authors and their audience in these segments (Belcher, 2019). All selected texts were authored in English and published in high-ranking journals (classified as Q1 according to the 2024 SCImago Journal & Country Rank). Consequently, the influence of language (Lee & Casal, 2014) and the indexing of the publishing journal (Gholami & Ilghami, 2016) on the use of MDMs was accounted for. The rationale for employing the quota sampling technique stemmed from identifying text groups within the population, as outlined by Becher and Trowler's (2001) model. This model categorizes texts into soft-pure, soft-applied, hard-applied, and hard-pure classifications, highlighting the diverse nature of academic texts based on their disciplinary characteristics. By utilizing quota sampling, researchers ensure that each text group is adequately represented in the sample, allowing for a more comprehensive and balanced analysis that accounts for the varying characteristics and emphases of different disciplines. This makes the findings more likely to be generalizable and reflective of the broader academic landscape. This model was utilized due to its robust justification for categorization and its practical guidance in situating disciplines within the appropriate scientific categories. The researchers rigorously assessed Becher and Trowler's (2001) model to ensure accurate categorization of selected disciplines.

English literature examines literary concepts within texts, while applied linguistics focuses on linguistic elements as an applied humanities discipline. Pharmacology, as a clinical discipline, studies medications, and mathematics explores theories of quantities and shapes as a pure science. The corpus selection process included texts matching each discipline's characteristics, excluding English literature articles with value-free and statistical approaches. This selection captures the diversity of academic discourse and enhances the generalizability of the findings.

**Table 3***The Corpus*

	English Literature	Applied linguistics	Pharmacology	Mathematics	Overall
No. of RAs	30	30	30	30	120
Word count	161,795	131,780	116,300	383,998	793,873

### Data Analysis

The researchers utilized AntConc version 4.2, a concordance software, to determine the frequency of instances of MDMs in accordance with Hyland's (2005) interpersonal model. AntConc is a user-friendly, free tool that provides frequency counts of words and phrases while displaying the context in which these terms appear. The choice of Hyland's (2005) model is justified due to its comprehensive enumeration of MDMs, along with valuable guidance for their application. Each researcher independently analyzed half of the corpus, comprising 60 RAs. To verify the accuracy of the identified instances of MDMs, the researchers manually reviewed the data produced by the software, ensuring alignment with the criteria established in Hyland's (2005) model. For instance, the term "first" was excluded as a frame marker in the expression "first language" because it served as an adjective rather than indicating a sequence or stage within the text. Furthermore, to ensure consistency between the analyses conducted by the two researchers, each examined a sample of 32 RAs, totaling 252,887 words, which represented 31.85% of the overall corpus, prior to the main data analysis phase. The same sampling methodology was applied in selecting the sample for reliability analysis, resulting in the selection of 8 RAs from each category. Following the methodology outlined by Field (2018), intraclass correlation was computed using IBM SPSS Statistics version 27, yielding high single and average measure values of 1 (as shown in Table 4), which is justifiable given that both researchers adhered to the same criteria set forth by Hyland's (2005) model. This high level of agreement, as indicated by the intraclass correlation, is significant within the context of the study's goals as it demonstrates the reliability and consistency of the analysis process. Ensuring high reliability is crucial for validating the findings and supporting the overall credibility of the research, thereby reinforcing the robustness of the study's conclusions. Subsequently, the researchers normalized the data to a standard of 10,000 words for each category to facilitate comparisons across the corpora and employed descriptive statistics to present the frequencies in appropriately formatted tables. The selection of the sample for correlation analysis and the normalization of the data was conducted after a thorough review of the data analysis sections in relevant studies (e.g. Khedri & Kritsis, 2018; Lee & Casal, 2014; Sarani et al., 2017). Finally, In alignment with Pallant (2020) and taking into account the non-normal distribution of the dataset (refer to Table 5), the Kruskal-Wallis Test was utilized to evaluate variations across different disciplines. This non-parametric test was chosen because it does not assume normality, making it suitable for our dataset. Given the nature of our data, which involves comparisons across multiple groups, the Kruskal-Wallis Test is appropriate. It allows for the comparison of more than two independent groups without requiring the assumption of normal distribution. It is important to highlight that the threshold for statistical significance was established at  $p < 0.05$ .

**Table 4**

*Intraclass Correlation for Reliability Analysis*

	Intraclass Correlation	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig.
Single Measures	1.00	.99	1.00	25004.34	9	9	.00
Average Measures	1.00	.99	1.00	25004.34	9	9	.00

**Table 5**

*Tests of Normality*

Frequency of MDMs	Kolmogorov-Smirnov			Shapiro-Wilk		
	Shapiro-Wilk	df	Sig.	Shapiro-Wilk	df	Sig.
Cross-disciplinary variation	.37	40	.00	.43	40	.00

**Results**

To evaluate the cross-disciplinary differences among the four text quotas, the results from the Kruskal-Wallis Test are initially presented (refer to Table 6). Subsequently, the frequencies of MDMs, as outlined in Hyland’s (2005) interpersonal model, are analyzed, taking into account a sample size of 10,000 words for each quota to facilitate comparative analysis across the corpora (see Table 7). This information is utilized to address the research question.

**Table 6**

*The Kruskal-Wallis Test Results*

Null Hypothesis	Sig.	Decision
The distribution of frequency of metadiscourse markers is the same across quotas of texts.	.009	Reject the null hypothesis.

**Table 7**

*Frequencies of MDMs in the Texts of Different Disciplines (Per 10,000 Words)*

Metadiscourse Category	Soft-pure texts	Soft-applied texts	Hard-applied texts	Hard-pure texts
Interactive	328.37	401.12	374.29	361.30
Transitions	299.26	349.29	343.33	271.56
Frame markers	11.55	15.17	9.97	62.31
Endophoric markers	1.73	13.12	5.67	15.02
Evidentials	2.34	2.80	1.37	0.28
Code glosses	13.47	20.71	13.92	12.10
Interactional	117.98	178.17	43.42	95.96
Hedges	21.50	18.43	11.17	6.69
Boosters	4.88	4.70	2.23	6.79
Attitude markers	3.27	8.27	3.43	7.29
Self-mentions	73.17	125.89	24.24	67.34
Engagement markers	15.14	20.86	2.32	7.83

The results of the Kruskal-Wallis Test, as presented in Table 6, indicate that the distribution of MDMs varies significantly among the four categories of texts: soft-pure, soft-applied, hard-applied, and hard-pure texts (sig. = .009). Table 7 reveals that soft-applied texts contain the highest number of both interactive and interactional MDMs, i.e., 401.12 and 178.17, respectively, when compared to the other text categories. Nevertheless, hard-pure texts include the lowest frequency of interactive MDMs

(361.30), and hard-applied texts comprise the least number of interactional MDMs (43.42). Specifically, the soft-applied texts frequently featured transitions, evidentials, code glosses, attitude markers, self-mentions, and engagement markers, with respective frequencies of 349.29, 2.80, 20.71, 8.27, 125.89, and 20.86. In contrast, hard-pure texts exhibited the highest frequencies of frame markers, endophoric markers, and boosters, i.e., 62.31, 15.02, and 6.79, respectively. Furthermore, soft-pure texts had the greatest number of hedges, i.e., 21.50, relative to the other text categories.

### Discussion

This research sought to examine the variations in the application of Hyland's (2005) interactive and interactional MDMs among RAs from four distinct fields: soft-pure (English literature), soft-applied (applied linguistics), hard-applied (pharmacology), and hard-pure (mathematics) sciences. To achieve this objective, a corpus comprising the post-method sections of 120 RAs, totaling 793,873 words, was analyzed using the AntConc concordancer. The frequencies of MDMs were subsequently compared across the four categories of texts through the application of the Kruskal-Wallis Test. The findings are discussed, juxtaposed with existing literature, and interpreted to address the research question.

The research question asked about the variations in the use of MDMs across different disciplines, specifically focusing on the post-method sections of research articles in soft-pure (English literature), soft-applied (applied linguistics), hard-applied (pharmacology), and hard-pure (mathematics) fields. The findings from the Kruskal-Wallis Test indicated a statistically significant difference in the distribution of MDMs among these RA groups ( $\text{sig.} = .009$ ). This suggests that the application of MDMs in the post-method sections varies notably across the distinct categories of science represented in the RAs. This research corroborates related literature (e.g., Boginskaya, 2022; Estaji & Vafaeimehr, 2015; Farnia & Gerami, 2021; Khedri & Kritsis, 2018; Sarani et al., 2017) indicating that the categories of MDMs are employed in distinct manners across academic texts from different fields of study.

Boginskaya (2022) investigated interactional MDMs within abstracts of applied linguistics and engineering RAs, revealing that applied linguists employed MDMs at a significantly higher rate than engineers. In contrast, the present study analyzed both interactive and interactional MDMs in the post-method sections of RAs across four disciplines: soft-pure (English literature), soft-applied (applied linguistics), hard-applied (pharmacology), and hard-pure (mathematics). By categorizing applied linguistics as a soft-applied and engineering as a hard-applied science, based on Becher and Trowler's (2001) framework, the present study expands upon Boginskaya's (2022) findings, asserting that interactional MDMs were more frequently utilized in the post-method sections of soft-applied texts compared to hard-applied texts. For example, in Excerpt 1 from the corpus, soft-applied authors utilized self-mentions "our" and "we" in a single sentence which indicates the authors' direct engagement with the topic, showcasing their active role in the research or discussion. However, in Excerpt 2, hard-applied authors used passive voice to avoid mentioning themselves which may indicate their inclinations for an objective tone.

*Excerpt 1.* "By contrast, guided by our research questions and the serendipitously produced accounts of emotion regulation in teacher narratives, we centered on how language teacher emotion regulation can be relationally enacted to strengthen teachers' relationships with their students." (an excerpt from a soft-applied text).

*Excerpt 2.* "Fasting blood glucose was measured, and IGTT was performed at the end of the study." (an excerpt from a hard-applied text).

Estaji and Vafaeimehr (2015) analyzed attitude markers, hedges, and boosters within the introductions and conclusions of 21 RAs in similar fields of electrical and mechanical engineering. Their findings indicated a negligible cross-disciplinary effect. Unlike Estaji and Vafaeimehr (2015), the present research examined all of Hyland's (2005) interactive and interactional MDMs within the post-method sections across various disciplines. The results from both Estaji and Vafaeimehr (2015) and the current investigation suggest that MDMs are employed comparably within RAs of related disciplines,

while their usage varies significantly across RAs from distinct disciplines. Khedri and Kritsis (2018) analyzed interactive and interactional MDMs within 36 RA introductions from the fields of applied linguistics and chemistry. Their findings indicated that RAs in chemistry exhibited a lower frequency of such markers compared to those in applied linguistics, a difference attributed to the more objective characteristics of the chemistry discipline. The results of this investigation align with those of the present study, particularly when we regard applied linguistics as a soft-applied science and chemistry as a hard-pure science. For instance, in Excerpt 3, soft-applied authors have frequently used self-mentions “we” and “our” to demonstrate their active participation in the research. They have also used frame markers “first,” “second,” and “third” to make the text easier to follow by breaking it down into manageable sections. Nonetheless, these markers were rarely found in hard-applied texts which made them less engaging and rather difficult to comprehend.

*Excerpt 3. “We set out to explore explicit definitions and implicit conceptualizations of LLS in three time periods, as well as investigate the reported roles of teachers and students in the literature we sampled, leading to several contributions to the field. First, findings from the content analysis showed an increasing number of definitions across the three time periods ... Second, supported by the content and corpus-based analyses, we reasoned that the role of teachers as resource providers ... Third, based on our findings and other recent discussions concerning conceptualizations and cumulative knowledge-building, we discussed a view of strategic learning.” (an excerpt from a soft-applied text).*

Sarani et al. (2017) analyzed 66 research articles from humanity and nonhumanity fields, finding that nonhumanity texts used more boosters and fewer hedges and attitude markers, indicating a focus on objectivity. In contrast, humanities articles featured more interactional markers to engage readers. The authors linked these differences to the disciplines’ inherent characteristics, with nonhumanity texts prioritizing empirical evidence. The current study had a different and systematic perspective in categorizing disciplines; thus, it is not rational to have a full comparison of the results of the two studies. However, we concur with the assertions made by Sarani et al. (2017) that the fundamental traits of different disciplines shape the utilization of MDMs by authors. The present research adopted a distinct and systematic approach to the categorization of disciplines in comparison to Sarani et al. (2017), making a comprehensive comparison of the findings from the two studies impractical. Nevertheless, we support the assertion made by Sarani et al. (2017) that the intrinsic characteristics of disciplines influence how authors utilize MDMs. For example, the current study showed that soft-applied texts aim to engage readers on a personal and interpretive level, requiring more interactional markers to create a collaborative and nuanced dialogue. In contrast, hard-applied texts focus on clear, objective, and technical communication, where the use of interactional markers is minimized to maintain precision and clarity. Farnia and Gerami (2021) analyzed hedges and boosters in the discussion sections of 30 RAs from soft and hard sciences. They found that soft science authors used hedges more often, while hard science authors preferred boosters, highlighting the subjective nature of soft sciences versus the objective approach of hard sciences. The current research categorizes soft sciences into two distinct groups: soft-pure and soft-applied sciences, while hard sciences are divided into hard-pure and hard-applied sciences. Based on the frequency analysis of hedges and boosters presented in Table 7, the ranking of RA groups, arranged from the highest to the lowest frequency of hedges, is as follows: soft-pure, soft-applied, hard-applied, and hard-pure. Conversely, the ranking of RA groups according to the frequency of boosters, from highest to lowest, is: hard-pure, soft-pure, soft-applied, and hard-applied. For instance, in Excerpt 4, soft-pure authors have used hedges multiple times in a single sentence to avoid making absolute statements and to acknowledge the possibility of different perspectives. In contrast, in Excerpt 5, hard-pure authors utilized boosters multiple times to show confidence and assertiveness in their statements. This study generally corroborates the findings of Farnia and Gerami (2021) concerning the application of hedges and boosters across different disciplines; nonetheless, it provides additional insights that are specific to particular fields of study. These insights could have significant implications for the development of tailored academic writing guidelines and training programs, ensuring that scholars in various disciplines are equipped with the appropriate tools and strategies for effective communication within their specific

fields. Additionally, this could address the deficiencies in Iranian EAP programs concerning their students' academic writing needs (Alavi et al., 2018).

*Excerpt 4.* “It is even possible that the Sirenaicks may have been founded as a direct result of Coryate’s trip through Europe.” (an excerpt from a soft-pure text).

*Excerpt 5.* “Certainly in each case  $H$  is continuous, and for all  $x, y$ , and  $t$ ,  $H_t(x)$  (cid:8)  $H_t(y) = H_t(x$  (cid:8)  $y)$ .” (an excerpt from a hard-pure text).

### Conclusion and Implications

An examination of how authors across various disciplines employ MDMs in their scholarly writings may reveal distinct patterns in their usage. Academic texts serve as a medium for communication between authors and their audience regarding specific topics within their respective fields. MDMs function as rhetorical instruments that guide readers toward a particular interpretation (interactive MDMs) or foster engagement between authors and readers within the text (interactional MDMs) (Hyland, 2005). While some scholars have investigated potential variations in MDM usage across different academic disciplines, their selection of texts has often lacked a systematic approach. Many have either chosen texts without adhering to a science categorization framework (e.g., Khedri & Kritsis, 2018) or relied on unsolid models (e.g., Farnia & Gerami, 2021). This research examined Hyland’s (2005) framework of interactive and interactional MDMs within RAs across four categories: soft-pure (English literature), soft-applied (applied linguistics), hard-applied (pharmacology), and hard-pure (mathematics), following Becher and Trowler’s (2001) classification of academic disciplines. Employing a quota sampling method, the study analyzed the post-method sections of 120 RAs, totaling 793,873 words, utilizing the AntConc concordancer. The post-method sections are deemed particularly suitable for investigating metadiscourse, as they encapsulate the authors’ arguments and reflect the engagement between authors and their audience (Cao & Hu, 2014; Belcher, 2019).

The results of the Kruskal-Wallis Test (see Table 6) revealed notable variations across disciplines (sig. = .009). Table 7 indicated that soft-applied texts had the highest counts of interactive (401.12) and interactional MDMs (178.17) among text categories. In contrast, hard-pure texts have the lowest interactive MDMs (361.30), while hard-applied texts have the fewest interactional MDMs (43.42). Soft-applied texts prominently featured transitions (349.29), evidentials (2.80), code glosses (20.71), attitude markers (8.27), self-mentions (125.89), and engagement markers (20.86). Hard-pure texts, on the other hand, had the highest frequencies of frame markers (62.31), endophoric markers (15.02), and boosters (6.79). Soft-pure texts led in hedges with a total of 21.50. The present study supports related literature (e.g., Boginskaya, 2022; Estaji & Vafaeimehr, 2015; Farnia & Gerami, 2021; Khedri & Kritsis, 2018; Sarani et al., 2017) demonstrating the varied applications of MDM categories in academic writings across diverse disciplines. Moreover, this study addresses previous research gaps and limitations by utilizing an extensive corpus comprising 120 RAs, totaling 793,873 words, from underexplored disciplines such as English literature, pharmacology, and mathematics, following Becher and Trowler’s (2001) robust science categorization model. Consequently, it is advisable for academic reading and writing programs, as well as EAP courses, to instruct students on particular patterns of MDM usage that correspond to the disciplinary emphasis of the texts. This may help students align themselves with a contemporary trend among scholars to employ more accessible language (Lei & Wen, 2020), thereby striving to engage a broader audience in the increasingly competitive landscape of academia (Paltridge, 2021). By mastering these patterns, students may enhance their academic performance and be better equipped to understand and produce scholarly texts that meet disciplinary standards. This could lead to improved grades, higher levels of educational achievement, and greater opportunities for academic recognition and career advancement. Furthermore, learning these patterns can prepare students for their future professional lives, where the ability to communicate complex ideas clearly and effectively is crucial. By employing more accessible language, they can bridge the gap between academic knowledge and practical application, making their research more relevant and impactful in real-world contexts.

This research encountered some limitations and delimitations. It is impractical to include every RA across all disciplines to create a fully representative corpus. We opted for a selection of 120 RAs, totaling 793,873 words, which constitutes a relatively substantial corpus. However, due to time and budget constraints, we could not incorporate additional RAs from various other fields. Consequently, caution should be exercised when generalizing the results, as further investigation is necessary to explore MDMs in other, less examined disciplines to validate and build upon the current findings. This approach will help to ensure a more comprehensive understanding of the subject matter and contribute to the development of a more inclusive and representative body of knowledge in the field of MDMs. Moreover, distinct sections of RAs may exhibit varying rhetorical patterns (Belcher, 2019). We focused on the post-method sections, which are considered particularly challenging to compose, as they encompass the authors' interpretations and arguments, with a greater frequency of engagement with both the audience and the authors themselves (Belcher, 2019). Future research could examine other sections or conduct comparative analyses of MDMs across different sections of RAs. Moreover, this study employed a predominantly quantitative methodology to analyze the occurrence of various interactive and interactional MDMs within a selection of RAs, complemented by a brief qualitative assessment. Future research endeavors might benefit from targeting a smaller sample size to investigate the specific functions of particular MDM categories more comprehensively. Such an approach could yield insightful data pertinent to pedagogical strategies in English for Specific Academic Purposes (ESAP) courses.

### Acknowledgment

The researchers recognize the substantial contributions of the authors whose academic texts form the foundation of the dissertation corpus.

### Declaration of Conflicting Interests

The authors of this text do not have any conflicts of interest to declare.

### Funding Details

It is declared that no funding was received for this research.

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