Choices of rhythmical patterns across academic and popular medical titles

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Over time, I would learn to listen for those wonderful moments when people spoke a kind of personal music, which left a rhythmic architecture of who they were. I would be much more interested in those rhythmic architectures than in the information they might or might not reveal.

(Smith, 2001, p. 36)

Abstract

Rhythm can be perceived as a resource for empowering language through fostering message communication during social exchanges, whether in written or spoken contexts. Despite its prominent role in creating musicality and playing on pathos, rhythm in written non-poetic genres has received scant attention. In such genres, rhythmical patterns vary depending on different functional motivations. For instance, popular articles involve more conversational features to reach a wider readership and they are likely to be more rhythmic. However, academic articles have specialized vocabulary, address restricted readerships and are expected to be less rhythmic. Academic articles have recently been subject to an increasing process of popularization to make the message accessible to a wider readership. To explore this possibility, the study investigates rhythmical patterns across academic medical titles (AMTs) and popular medical titles (PMTs). A corpus of academic and popular medical titles totaling 1127 words is compiled and annotated for rhythmical patterns. The analysis shows that genre determines rhythmical architecture in discourse, with more preference for alliteration, parallelism and repetition in PMTs than AMTs. Rhythmical patterns are more noticeable at the level of phonology than lexico-grammar. These findings may help novice medical researchers and journalists write titles, in compliance with the generic conventions of the community.

Keywords: Rhythm, popular medical titles, academic medical titles.

Resumen

Elección de patrones rítmicos en títulos médicos académicos y divulgativos

El ritmo puede percibirse como un recurso que potencia el lenguaje al fomentar la comunicación de mensajes durante los intercambios sociales, ya sea en contextos escritos u orales. A pesar de su papel prominente en la creación de musicalidad y en el uso del *pathos*, el ritmo en los géneros escritos no poéticos ha recibido escasa atención. En dichos géneros, los patrones rítmicos varían en función de diferentes motivaciones. Por ejemplo, los artículos divulgativos incluyen características más conversacionales para llegar a un público más amplio y suelen ser más rítmicos. Sin embargo, los artículos académicos tienen un vocabulario especializado, un público restringido y se espera que sean menos rítmicos. Recientemente, los artículos académicos han sido objeto de un creciente proceso de popularización para que el mensaje sea accesible a un público más amplio. Para explorar este cambio, el estudio investiga los patrones rítmicos en títulos médicos académicos y títulos médicos divulgativos. Se ha recopilado y anotado un corpus de títulos médicos académicos y divulgativos de 1.127 palabras para estudiar los patrones rítmicos. El análisis muestra que el género determina la arquitectura rítmica del discurso, con una mayor preferencia por la aliteración, el paralelismo y la repetición en los títulos médicos de divulgación que en los académicos. Los patrones rítmicos son más notables a nivel fonológico que a nivel léxico-gramatical. Estos hallazgos pueden ayudar a investigadores noveles del ámbito médico y a periodistas a escribir títulos que se ajusten a las convenciones genéricas de la comunidad.

Palabras clave: ritmo, títulos médicos divulgativos, títulos médicos académicos.

1. Introduction

Rhythm in language has played a tremendous role in creating musical prosody, which fosters learners' phonological skills and develops their "literacy acquisition" (Bhide et al., 2013, p. 120; Bonacina et al., 2015, p. 2). Although many studies have investigated the impact of rhythm on improving learners' literacies (David et al., 2007; Fotidzis et al., 2018), little attention has been given to the analysis of rhythmical patterns in professional settings —as for example across academic medical titles (AMTs) written by scholars and popular medical titles (PMTs) produced by journalists. Both academic and popular titles communicate medical knowledge, yet they display different features, reflecting the process of

popularization whereby scholarly knowledge is tailored to meet the needs of the public (Mingmin & Min, 2021). To study this, this paper compares rhythmical patterns across AMTs and PMTs, given their nominative, designative and advertising functions (Busch-Lauer, 2000, p. 77). The study aims first to investigate how rhythm is distributed across AMTs and PMTs and second to identify which rhythmical patterns, namely alliteration, parallelism, repetition and antithesis (Griffin, 2016), are characteristic of AMTs and PMTs, with a view to improving professionals' rhythmical awareness in selecting titles for their articles.

In section 2, the interdisciplinary nature of rhythm is highlighted, with an emphasis on how rhythm has been analyzed in discourse. Section 3 provides an account of the generic differences between PMTs and AMTs, reviews the notion of context, and describes its role in the choices language users make. While section 4 gives an account of the methodology and statistical tests applied in studying the differences across the two genres, section 5 displays the findings, along with the discussion. Section 6 is where the major findings of the study are summarized, coupled with the implications and the limitations.

2. Rhythm

Rhythm is deeply ingrained in musicology, with a focus on how unaccented beats are combined with accented ones in compositions (You, 1994, pp. 361-362), yet it has progressively become "indigenous to many cultural traditions" (You, 1994, p. 361) since it has increasingly been developed and applied in a variety of disciplines pertaining to the humanities and the sciences.

Among the areas in which rhythm has been a subject of enquiry is language, where discourses are characterized by their own rhythmical patterns (Balint et al., 2016). Rhythm has "a powerful emotional and mnemonic effect" (Skračić & Kosović, 2016, p. 42) on message receivers. In fact, rhythmical patterns trigger memories of previously construed events so that they get reactivated by language users (Hickey et al., 2020, p. 1-2). When single sounds or chunks of discourse are repeated, an echo is produced and the human brain reconstrues previous experiences. In this way, neural links get re-established and memories refreshed. Whether in spoken or written discourse, the way the message is structured reveals the generic identity of

its producers (Hyland, 2015, p. 33-34) and the community in which they operate.

Previous research has accounted for rhythmical architecture in language, starting from Abercrombie (1964, pp. 96-98), who defines rhythm as a series of beats repeated at regular intervals. Halliday (1967) develops Abercrombie's model of rhythm and accounts for English rhythm as grounded in grammar. The model rests upon English phonology, with four units of analysis, namely tone group, foot, syllable, and phoneme, and it is developed based on "the study of natural, connected speech" (Halliday & Matthiessen, 2014, p. 12). This model is not without its limitations, as it first relates to the analysis of intonation, which is characteristic of spoken rather than written discourse, so that any study of the rhythmic structure in written discourse "depends on the 'implication of the utterance'" (Halliday, 2002, p. 28). Second, there is a controversy over identifying "a rhythmic equivalent to an ictus into places where a silent stress is marked in the transcription", thus questioning Halliday's argument of foot isochronicity (Crystal, 1969, p. 382).

An alternative model is suggested by Griffin (2016), who accounts for rhythmical architecture in public speaking discourse and highlights its role as a means of self-empowerment through which language users "strengthen the presentation of their ideas" (Griffin, 2016, p. 184). In this model, rhythmical patterns are created by the organization of words at four levels, i.e., parallelism, repetition, alliteration and antithesis. This model is grounded not only in the phonological stratum but also at the intersection of the lexico-grammatical and semantic strata. To explain how Griffin's model (2016) permeates different strata, an account of the linguistic system is provided in Figure 1.

Figure 1. Linguistic strata (adapted from Halliday & Matthiessen, 2014, p. 26).

Figure 1 shows that language is modeled into four strata, i.e., semantics, lexico-grammar, phonology and phonetics, with the first two pertaining to the content plane and the last two belonging to the expression plane (Halliday & Matthiessen, 2014, p. 26). In the semiotic system, the content plane regarding language can be classified "into two content strata, the strata of semantics and lexicogrammar" (Matthiessen et al., 2010, p. 77). At the lexico-grammatical stratum, meaning is expressed through words, phrases, clauses and sentences. At the semantic stratum, "experience and interpersonal relationships are transformed into meaning" (Halliday & Matthiessen, 2014, p. 25). As for the expression plane, it can involve two strata in language, namely phonology and phonetics (Matthiessen et al., 2010, p. 94). At the phonetic stratum, there is "the interfacing with the body's resources for speech and for hearing", while at the phonological stratum, speech sounds are arranged "into formal structures and systems" (Halliday & Matthiessen, 2014, p. 25).

As for parallelism, i.e., a rhythmical pattern in Griffin's model (2016), it can be situated at the lexico-grammatical stratum (Figure 1) since it refers to how words, phrases, clauses and sentences are ordered. That is, it results in similar structures, creating a careful balance of text architecture and meaning (Griffin, 2016, p. 184). As Griffin (2016) does not specify subcategories of parallelism, this study further relies on Quirk et al. (2005) to account for the nature of parallel structures. In other words, parallelism can be perceived at different levels, including parallel adjective phrases (henceforth APs), noun phrases (henceforth NPs), verb phrases (henceforth VPs) and clauses, each pair of which necessarily includes identical structures (Quirk et al., 2005). In example 1 (Table 1), for instance, there is parallelism between the adjectives *rich* and *poor* coordinated via the conjunction *and*. The whole structure *rich and poor* is also parallel to another coordinated AP *intelligent and ignorant*.

Rhythmical pattern	Example	
Parallelism	(1)	**Rich and poor**, **intelligent and ignorant**, **wise and foolish**, **virtuous and vicious**, **man and woman** —it is ever the same, each soul must depend wholly on itself. (Elizabeth Cady Stanton, nineteenth-century suffragist.
Repetition	(2)	**As students, we need to** respond. **As students, we need to** care. **As students, we need to** step forward and share our positions.
Antithesis	(3)	And so, my fellow Americans: Ask not **what your country can do for you**—ask **what you can do for your country.**
Alliteration	(4)	Now is the time for **r**epentance, **r**estitution, and **r**econciliation. (Maggie Kuhn, founder of the Gray Panthers)

Table 1. Examples of rhythmical patterns (adapted from Griffin, 2016, pp. 183-185).

Repetition, also located at the lexico-grammatical stratum, refers to the lexical re-mentioning of "keywords or phrases at the beginnings or endings of sentences or clauses" (Griffin, 2016, p. 184). In example 2 (Table 1), the prepositional phrase *as students* is repeated three times, attributing a focal importance to the identity of these participants and highlighting their position in the process of message construal. The personal pronoun *we*, coupled with the semi-auxiliary *need to*, is reiterated to create rhythm and to foreground the actions to be undertaken.

Because Griffin (2016) does not specify finer levels of delicacy, this study relies on Brinton and Brinton (2010) to further analyze repetition into four categories, i.e., words, pronoun-verbs, affixes and roots, depending on the nature of the repeated item. Repetition can involve the reiteration of single words or a part of a relative clause where the relative pronoun and the following verb are mentioned again. It may also include the recurrence of an affix, which is "a morphological unit that does not carry the core meaning and is always bound to a root" (Brinton & Brinton, 2010, p. 393) or roots which are morphs having "the principal lexical or grammatical meaning" (Brinton & Brinton, 2010, p. 84).

Unlike parallelism and repetition, both of which function at the lexico-grammatical stratum of analysis, alliteration rather operates at the phonological stratum. Referring to the repeated use of the first sound in more than one word, alliteration serves a variety of functions, namely, to foreground a message, "to create a humorous tone", to produce "a mnemonic" effect and to create a more engaging discourse (Griffin, 2016, p. 185). In example 4 (Table 1), there is an alliteration of /r/ in *repentance, restitution,* and *reconciliation*. In verse, "[a]lliteration holds only within a verse constituent or between adjacent verse constituents" (Fabb, 1999, p. 223). In the present research, alliterative sounds, whether in adjacent or not immediately juxtaposed words (Fabb, 1999), distributed along the article titles are annotated.

Since Griffin's model (2016) does not classify alliterative sounds, this research relies on Katamba (1989) to categorize alliteration into plosives, nasals, fricatives, and approximants. Plosives "are made with the pulmonic egressive airstream mechanism" (Katamba, 1989, p. 6), yet nasals are produced when the air escapes through the nasal cavity. Fricatives are pronounced when the articulators come close together so as to leave a narrow channel through which the air escapes (Katamba, 1989, p. 7). They

can be classified into sibilants and non-sibilants, with sibilants being articulated with "high pitched fricative noise" (Katamba, 1989, p. 83). Concerning approximants, they are produced when "the articulators are brought near each other but a large enough gap is left between them for air to escape without causing turbulence" (Katamba, 1989, p. 7).

Concerning antithesis, it operates both at the level of lexico-grammar and semantics, as it implies contradictory messages, and it occurs when words, phrases or clauses are put "in contrast or opposition to one another" (Griffin, 2016, p. 185). In example 3 (Table 1), the opposition stems from changing the agent *your country* in the first clause with *you* in the second one, putting each one of them in a contradictory position to the other. The antithesis, thus, establishes contrast between the two juxtaposed ideas, which creates rhythm in the message and foregrounds the role of the second agent.

Rhythm has been investigated in different discourse types, such as literary discourse including Shakespeare's Sonnets (Goldsmith, 1950), music (Octofiany & Halim, 2022), advertising (Sekhar, 2017), news discourse (Mas Manchón, 2012) and public speaking discourse (Griffin, 2016). However, the literature lacks an account of rhythm in scientific discourse. This is why this study attempts to investigate rhythm in medical discourse, building on Griffin's model (2016), which enables the identification of rhythmical patterns at different linguistic levels of analysis.

3. AMTs and PMTs

Context determines how writers/speakers make different choices when they construe their messages (Choura, 2019; Sellami-Baklouti, 2013), revealing the conventions of "the social contexts" in which they function, and their values (Hyland, 2004, p. 4). That is, contextual factors activate lexico-grammatical choices at different linguistic layers (Figure 1). The linguistic system is deeply rooted in context, which can be viewed as being both "functionally diversified" and "extended along the cline of instantiation from instance to potential" (Halliday & Matthiessen, 2014, p. 25). That is, context stretches from the semiotic environment of the whole community, revealing its shared linguistic conventions, to the individual environment peculiar to a specific language user (Halliday & Matthiessen, 2014, p. 32). Put differently, context lies over the potential/instance cline, ranging from the context of culture to the context of situation, with in-between subpotentials

(Matthiessen et al., 2010, p. 77). Along this cline, genres, perceived as instance types (Mwinlaaru, 2017, p. 265), are defined as "socially recognized ways of using language", whereby community members sustain the cultural conventions of their communities (Hyland, 2002, p. 114). Thus, genre analysis, considered as "the study of situated linguistic behaviour in institutionalized academic or professional settings" (Bhatia, 2004, p. 22), reflects the rituals of a given linguistic community.

This study investigates rhythm in medical titles as this genre is understudied and previous studies have focused mainly on popular and academic articles (De Oliveira & Pagano, 2006; Nwogu, 1990). Titles are considered as "decisive instruments" marking readers' first impression. In Busch-Lauer's words (2000, p. 77), "it is the information content and the communicative effectiveness of titles that are clues for readers to decide whether a book, article or conference paper is worthwhile studying or not." Titles have three functions: first, a nominative role as they identify the research area; second, a designating role since they pinpoint the content of the research; and third, an advertising role because of their importance in appealing to the readership (Busch-Lauer, 2000).

Titles can be academic (Sword, 2012) and published in journals, or popular (Sapp, 1995) and presented in magazines. The comparison of academic and popular titles, in this research, is motivated by the increasing process of popularization in scientific discourse, by means of which "a discursive reconstruction of scientific knowledge" is made (De Oliveira & Pagano, 2006, p. 628) to make the message accessible to laypersons (Figini et al., 2019, p. 1). Although academic and popular titles may study similar subject matters, they display differences when it comes to the addresser-addressee relationship, the purpose, the structure and the style of the message (De Oliveira & Pagano, 2006, p. 628).

Journal article titles are produced by researchers. They are important for multiple reasons (Belcher, 2009). First, they are direct, clear and informative about the content of the article and they are "often the only part of your article provided to potential peer reviewers, who on its power will make a decision about whether to review your article" (Belcher, 2009, p. 203). Second, they involve searchable keywords and help in detecting an article as researchers enter keywords in electronic search engines to match the relevant titles. Third, they reveal the researcher's "argument and any policy implications" (Belcher, 2009, p. 203).

Concerning popular titles, they are written by journalists who are likely to employ more conversational features to create a lively and engaging style (Breeze, 2025; Myers, 1991, p. 1). In other words, they are more attractive and catchier, as they "are aimed at hooking readers more easily" (Alcaraz & Méndez, 2016, p.143). They include linguistic resources such as adjectives and imperative verbs, making the message more emotional and revealing "strong feelings like excitement or surprise" (Alcaraz & Méndez, 2016, p.143). They also involve personification of objects, revealed through the Saxon genitive, by means of which the journalists link linguistic features to "human beings with their emotions and innate curiosity" (Alcaraz & Méndez, 2016, p.143). Furthermore, popular titles display a closer addresser-addressee rapport, shown through the use of personal pronouns and possessives. In addition, they are characterized by a high frequency of verbal constructions and definite articles, highlighting the journalists' attempts at generalization. Proper nouns are frequent as well, indicating the level of expertise of the target audience and the subject matter of these titles addressing "global and already established concepts" (Alcaraz & Méndez, 2016, p.143).

This study focuses on popular and academic article titles in medicine, a discipline characterized by its "own discursive practices" (Samraj, 2013, p. 41). Pertaining to the hard domain of knowledge, medical science is not as hard as mathematics. That is, it is a science since researchers employ scientific methods to account for medical phenomena and generate findings. It is also an art because researchers rely on their "intuition and clinical judgment to determine the best diagnosis and treatment plan for each patient" (Gotti & Salager-Meyer, 2006, p. 9). Medicine has direct social effects, given that its aim is "to improve prophylactic, diagnostic and therapeutic procedures and the understanding of the aetiology and pathogenesis of disease" (World Medical Association, 2003). In view of the tremendous role of medical science in improving people's health and well-being, this research investigates rhythmical patterns in academic and popular medical titles. The academic and popular sub-corpora, along with the research method, are described in the following section.

4. Methodology

To explore the choices of rhythmical patterns, a sample of 59 AMTs and 50 PMTs is chosen, following convenience sampling. All the titles are selected,

building on their accessibility to the researcher, and their pertinence to the medical field. Because PMTs are longer than AMTs, the sub-corpora are equalized in the number of words to generate a more reliable comparative analysis. The corpus has a total of 1127 words. It includes medical titles published during the years 2021-2023. While PMTs are extracted from *Science Daily*[1], a website publishing novel scientific news, AMTs are taken from *The New England Journal of Medicine*[2], a peer-reviewed journal.

The corpus is annotated for rhythmical patterns at two levels using the computational software UAM CorpusTool (version 3.2). First, titles are assigned to their respective genres, i.e., whether academic or popular, and second instances of rhythmical patterns are identified (see Figure 2). The annotation of rhythmical features is carried out at two levels. First, the patterns are classified into four major categories, i.e., parallelism, alliteration, repetition and antithesis, following Griffin (2016). Second, since Griffin (2016) does not specify finer levels of delicacy, this research also relies on Quirk et al. (2005), Katamba (1989) and Brinton and Brinton (2010) to subcategorize higher level categories. For instance, the category of alliteration is divided into plosive, nasal, fricative, approximant and assonance (see Figure 2).

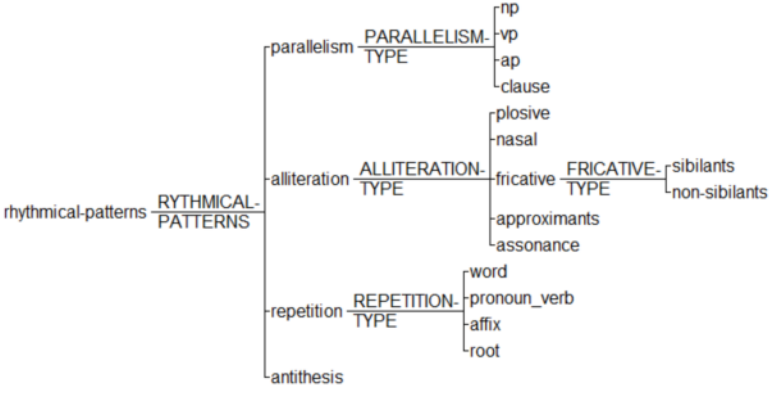

Figure 2. Annotation scheme for rhythmical patterns across AMTs and PMTs.

The raw frequencies are automatically generated by the UAM CorpusTool, and then the Mann Whitney U test is applied, using SPSS (Version 20), since normality assumptions are not met, with the values of Skweness and Kurtosis statistics lying beyond the range [-1, +1]. This test allows the

refutation of the null hypothesis claiming that there are no significant differences in the distribution of rhythmical patterns across AMTs and PMTs, and the assertion of the alternative hypothesis, postulating the existence of such differences. By means of SPSS, Spearman test of correlation is also carried out to check if there is a rank order relationship between lexical density and rhythmical patterns such as parallelism and repetition. Another version of the UAM CorpusTool (Version 6.2k) is also used to generate the lexical density of sub-corpora.

5. Results and discussion

This section analyses the general distribution of rhythm across AMTs and PMTs. At a more in-depth level of analysis, the rhythmical patterns, namely alliteration, parallelism, repetition and antithesis, are also explored.

5.1. Overall distribution of rhythm across AMTs and PMTs

A closer look at the general distribution of rhythm across sub-corpora reveals that PMTs include more rhythmical patterns (327) than AMTs (239) (Figure 3).

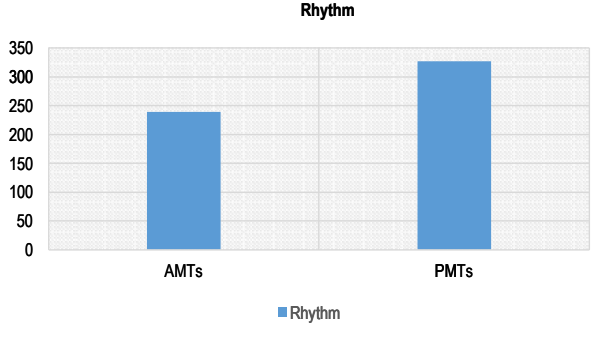

Figure 3. Overall distribution of rhythm across AMTs and PMTs.

The difference in the distribution of rhythm may be related to the identity of PMT writers and the target audience. In fact, PMTs, produced by journalists, are communicated to a large number of "non-specialists" (Myers, 1991, p. 1). Rhythmical patterns, characteristic of journalistic style, make the message "more commercial attractive and more catchy" (Jendrichovská, 2012, p .4). They also reveal the journalists' attempts to involve the audience

in "public debate" (Kyvik, 1994, p. 143), to act on them and to influence their perceptions of the message. That is, creating rhythmical messages makes the titles more memorable and easier to cognitively process, thus strengthening the addresser-addressee bond and increasing the number of faithful readers.

The more rhythmic nature of PMTs may also be associated with the lexical density of titles. Given that lexical density refers to "the proportion of content words (nouns, verbs, adjectives, and often also adverbs) to the total number of words" (Johansson, 2008, p. 65), the higher number of content words in PMTs (Table 2) produces "more attractive, interesting and as well as different" messages (Jendrichovská, 2012, p. 4). In fact, lexically dense titles in PMTs allow writers to employ content words in rhythmical patterns so as to enable the audience to construe the semantic mapping "of the specialized domain" to that "of their everyday life" (Myers, 1991, p. 1).

	AMTs	PMTs
Lexical words per segment	1.26	2.26

Table 2. Lexical density across AMTs and PMTs.

Compared with PMTs, AMTs are less rhythmic since they are developed by researchers, with a view to foregrounding their significant contribution to their community. In other words, authors of AMTs do not heed much attention, as writers of PMTs do, to rhythm, musicality and the resulting aesthetic effects in producing their titles. Rather, they show preference for more concise titles, involving fewer content words and, thus, having less rhythm, which reflects their attempts to highlight the originality of their study and to focus more on thematic prominence (Myers, 1991 p. 1).

5.2. Rhythmical patterns across AMTs and PMTs

At finer levels of delicacy, the study shows a greater preference for alliteration, parallelism and repetition in PMTs than in AMTs and a total absence of antithesis (see Figure 4).

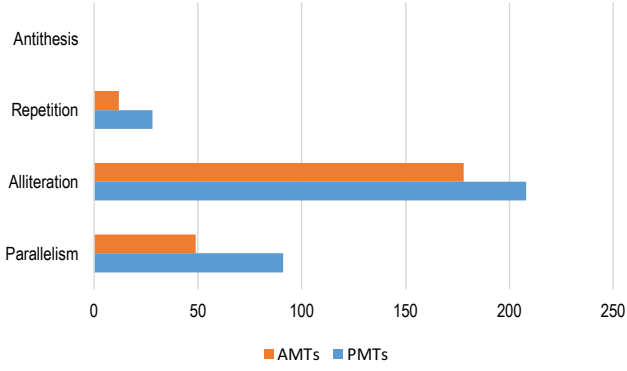

Figure 4. Rhythmical patterns across AMTs and PMTs.

Figure 4 indicates that alliteration is the most frequent rhythmical pattern, followed by parallelism. Repetition is rated third. As for antitheses, they are absent in AMTs and PMTs. which may be attributed to the generic conventions of titles. Given that they operate on contrasting ideas, placed in proximity, they do not serve the specificities of the title genre where a succinct space is left for authors to give prominence to the most important keywords which allow readers to get the gist of the article. To understand how alliteration, parallelism and repetition contribute to rhythm in titles, the distribution of each pattern is explained in the following subsections.

5.2.1. Alliteration

As is revealed in Table 3, alliteration is the most frequent rhythmical pattern in AMTs and PMTs. The Mann Whitney U test shows that there are significant differences in its distribution (N Alliteration in AMTs = 178, N Alliteration in PMTs = 208, U = 1129,000, z = -2,030, p = 0.042) (Table 3), with more preference for alliterative sounds in PMTs (208) than AMTs (178).

Rhythmical pattern	AMTs	PMTs	Mann Whitney U test
Alliteration	178	208	0.042

Table 3. Alliteration Across AMTs and PMTs.

Alliterative sounds can have different realizations, i.e., plosives, nasals, fricatives, approximants and assonance (see Figure 5), revealing the rhythmic architecture of each genre.

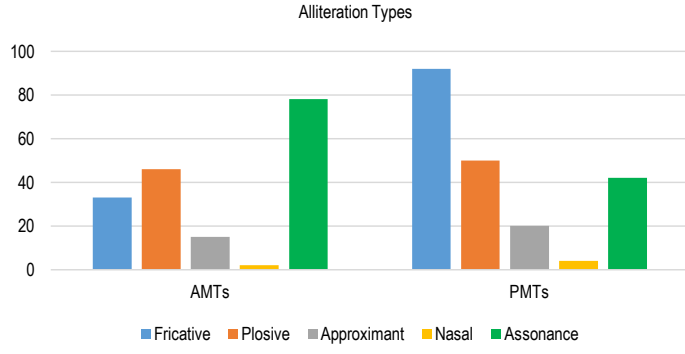

Figure 5. Distribution of alliterative sounds across AMTs and PMTs.

As is indicated in Figure 5, fricative alliteration is the most frequent in PMTs, yet it is rated third in AMTs. As for assonance, it is classified first in AMTs and third in PMTs. In both AMTs and PMTs, plosive alliteration is rated second, approximant alliteration fourth and nasal alliteration fifth. Each alliterative type is analyzed in the following subsections.

5.2.1.1. Fricative alliteration

Out of alliterative sounds, fricative alliteration is ranked first in PMTs (92 occurrences) and third in AMTs (33 occurrences) (see Figure 5). An example of fricative alliteration is provided:

> PMT1. Gum infection may be a risk **f**actor **f**or heart arrhythmia, researchers **f**ind.

In PMT1, the fricative /f/ is repeated three times, creating "audible friction" (Jones et al., 2003, p. 51). It is produced with a narrow stricture as the articulators come close enough to each other, yet without touching each other, "narrowing …the air passage at some point so that the air escapes making a kind of hissing sound" (Jones et al., 2003, p. 51). Therefore, the repetition of fricatives results in a turbulent recurrent tone. Fricatives consist of hissing sounds including /f/, /s/ and /ʃ/ and buzzing sounds such as /v/ and /ð/ known as euphonic sounds, the repetition of which yields a refined, melodious and aesthetically pleasing auditory experience (Pathak et al., 2020), thus contributing to the musicality of the message.

In PMTs, there are 47 sibilants out of a total of 92 fricatives in PMTs compared with 17 sibilants out of a total of 33 fricatives in AMTs (see Figure 6).

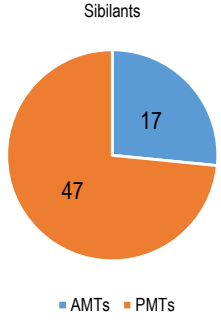

Figure 6. Distribution of sibilant alliterative fricative sounds.

The following examples illustrate the use of sibilants across AMTs and PMTs:

PMT2. People with **S**imilar Fa**c**es Likely Have **S**imilar DNA, **S**tudy Finds

AMT1. Polypill **S**trategy in **S**econdary Cardiovascular Prevention

In PMT2 and AMT1, there is an alliteration of the sibilant hissing sound /s/, creating a ringing tone, thus "signal[ling] that we speak the language in tones that grow increasingly charged" (Cleghom, 2019, p. 25). As illustrated in Figure 6, the difference in the distribution of sibilance alliteration across sub-corpora indicates that PMTs are more rhythmic than AMTs and may reveal how PMTs grasp readers' attention, with a rhythmic discourse involving "loud hissing sounds" (Brinton, 2000, p.31).

Overall, PMT writers' preference for fricatives producing rhythmic soft sounds may be attributed to their attempts to "inform and entertain the general public by reporting on new claims not yet endorsed as fact by the community" (Parkinson & Adendorff, 2004, p. 10). This is why PMT authors employ softening sounds in rhythmic patterns to emotionally appeal to the audience. Furthermore, "the flow of air of the repeated fricatives creates the perception of a delicate and muffled recurring sound in the reader's mind" (Autieri, 2019, p. 100), which may drive a larger number of readers to access the website. Therefore, the high frequency of fricatives in PMTs may be related to the advertising function of this genre. However, AMT writers use a

lower number of fricatives, which suggests that they appeal more to readers' reason and logic, given that their research is based on a sound methodology (Hyland, 2004, p. 33) and well-developed arguments (Barrass, 2002, p. 30).

5.2.1.2. Assonance alliteration

Figure 5 reveals that, in AMTs, assonance alliteration is rated first compared with PMTs where it is classified third. AMT authors' preference for assonance rather than fricative repetition of sounds may be attributed to their interest in creating a modulated airflow in the vocal tract rather than conferring musicality to their messages, as is explained in AMT2:

> AMT2. **D**uration **o**f Protection **a**gainst Mild and Severe **D**isease by Covid-19 Vaccines

AMT2 includes alliterative assonance as the phoneme /ə/ is repeated twice and stop alliteration through re-mentioning the phoneme /d/. The interplay between these two types of alliteration reveals writers' attempt to soothe the pace and make the message more energetic. In fact, stops are produced with "complete closure of the articulators, completely interrupting the flow of air from the mouth" (Butcher, 2015, p. 68). These sounds may, thus, slacken the information flow. To quicken the pace, AMT writers opt for assonance which is easier for the audience to pronounce since "vowels are phonemes that involve only phonation as the sound source, and are produced in different open configurations of the vocal tract" (Singh, 2019, p. 58). The repetition of these sounds results in neither obstruction in the airflow nor a narrow stricture. Accordingly, assonance and plosive alliteration speed up the message rather than create musical patterns in AMTs.

5.2.1.3. Alliteration of plosives

As is revealed in Figure 5, plosives show a slight difference across the two genres (46 instances in AMTs compared with 50 occurrences in PMTs). Plosives are pronounced with "a sudden damming up and sudden release of the stream of air from the lungs. Thus to the general bunching of consonants they add a particular texture of sound: a pervasive abruptness; a flinty, unyielding hardness" (Leech, 1969, p. 94) they do not result in greater rhythmical musicality. The almost equal distribution of plosive alliteration across AMTs and PMTs may be accounted for by the same function they share in both genres, as is explained through the following examples:

AMT3. Fractional Flow Reserve — Guided PCI as **C**ompared with **C**oronary Bypass Surgery

PMT3. SARS-CoV-2 Infects Fat Tissue, **C**reates Inflammatory Storm **C**loud, Study Finds

In AMT3 and PMT3, plosive alliteration is used for the same stylistic effects. Each example includes two instances of plosives. One occurrence is in a technical word which highlights the subject matter of the article (*Coronary* in AMT 3 and *Cloud* in PMT3). These technical words are informative, and they contribute to the designating function of titles (Busch-Lauer, 2000, p. 77). As for the other occurrence, it is used to drive the readers to a particular relationship (*Compared* in AMT 3) or to a new resulting course of action (*Creates* in PMT3). Therefore, the repetition of plosives in non-technical words creates a shift in information flow so as to draw the readers' attention to a particular chunk of discourse.

5.2.1.4. Alliteration of approximants and nasals

Figure 5 indicates that approximants and nasals are more frequent in PMTs than AMTs, a difference attributed to the smooth airflow these sonorants produce (Ahuja, 2025), as is explained in the following example:

PMT4. Adults **L**iving in Areas With High Air Pollution Are **M**ore **L**ikely to Have **M**ultiple **L**ong-Term Health Conditions.

PMT4 includes an alliteration of approximants and nasals. While approximants are pronounced with a relatively open stricture, nasals are articulated with obstruction in the oral tract, yet air release in the nasal tract and this is why they are sonorous (Brinton & Brinton, 2010, p. 25). Approximants and nasals are characterized by the absence of any turbulence during air passage, and they are rather marked by an ongoing and steady resonance and a higher level of acoustic energy (Peng, 2013, p. 203), thus creating a smooth information flow. The fluidity in rhythmic architecture may foster readers' cognitive processing of the message and help them process the message more smoothly. Therefore, through these sounds, authors get the audience involved in message construal and build a close addresser-addressee rapport, which is characteristic of popularization (Hyland, 2010, p. 125) since writers accommodate to "the needs of less informed groups of readers" (Varttala, 1999, p. 178) and get readers involved as discourse participants (Hyland, 2010, p. 125).

Compared with PMTs, AMTs have fewer occurrences of approximant and nasal alliteration. This finding reveals writers' awareness of the necessity of selecting the appropriate technical jargon relevant to the discipline they operate in (Hyland, 2004), without heeding much attention to developing a close emotional bond with the readership. This strategy of detachment in AMTs reflects writers' professionalism, as they rely more on logos than pathos.

5.2.2. Parallelism

Parallelism is more frequent in PMTs than AMTs, and it shows significant differences in its distribution across genres, as is revealed by the Mann Whitney U test (N Parallelism in PMTs = 91, N Parallelism in AMTs = 49, U = 1048,000, z = -2,717, p = 0.007) (Table 4).

Rhythmical pattern	AMTs	PMTs	Mann Whitney U test
Parallelism	49	91	0.007

Table 4. Parallelism across AMTs and PMTs.

The higher number of rhythmical patterns realized through parallelism in PMTs can be explained by the higher lexical density being 2.26 compared with 1.26 in AMTs (see Table 2). This association between lexical density and rhythm is confirmed through the Spearman test (Table 5).

		Correlations	Parallelism	Lexical density
Spearman's rho	Parallelism	Correlation Coefficient	1,000	,867**
		Sig. (2-tailed)	.	,000
		N	108	108
	Lexical density	Correlation Coefficient	,867**	1,000
		Sig. (2-tailed)	,000	.
		N	108	108

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5. SPSS output for correlation between lexical density and parallelism.

As indicated in Table 5, there is a significant correlation between the lexical density of the titles and parallelism, as is attested by the p value ($p < 0.05$). The Spearman coefficient shows a very strong positive correlation given that the value is more than 0.70 (Dancey & Reidy, 2004). This finding indicates that when the lexical density of the text gets higher, the number of parallel structures is likely to increase, and the text becomes more rhythmic.

Rated second in AMTs and PMTs, parallelism is realized through NPs, VPs, APs and clauses, with varying frequencies, as is shown in Figure 7.

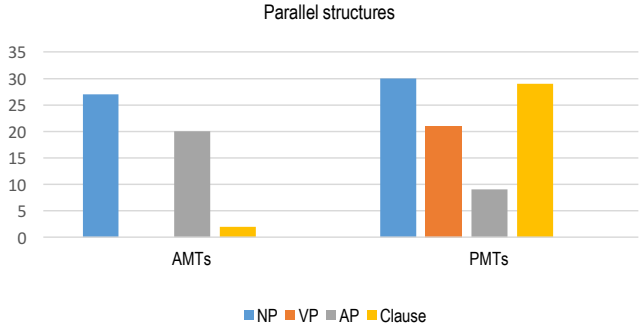

Figure 7. Distribution of parallel structures across AMTs and PMTs.

Figure 7 indicates that parallel NPs are the dominant realizations of parallelism, with a higher presence in AMTs and PMTs. However, APs are more frequent in AMTs, a finding in line with Caplan's (2019, p. 125) claim that "adjectives are more frequent in academic writing than any other discourse". As for parallel VPs and clausal structures, they are higher in PMTs than AMTs.

5.2.2.1. Parallelism: Noun phrases

Parallel NPs are more frequent in PMTs than AMTs and they are used to establish rhythmic technicality, as shown in PMT 5:

> PMT5. Cannabis Users had **Worse Bypass Outcomes**, **Increased Amputation** and **Opioid Use**, Study Shows.

PMT5 illustrates three parallel NPs including four grammatical metaphors, in three of which the process is construed as an NP, i.e., *Bypass*, *Amputation*, and *Use*. As for the fourth grammatical metaphor, i.e., *Increased*, it is a process construed as an adjective and it is embedded in the NP *Increased Amputation*. These experiential metaphors are perceived as "the metaphorical ways of meaning making where process (with a small p) is realized by a noun, and quality is realized by an adjective in lexicogrammar" (Devrim, 2015, p. 3). Writers, thus, use parallel NPs at repeated time intervals to reconstrue professional experiences as grammatical metaphors in a regular rhythmic symmetrical architecture, creating a rhythmical balance and resulting in a

higher level of technicality. This process of repeating parallel technical structures can be referred to as rhythmic technicality. Parallel NPs are slightly higher in PMTs than AMTs, a finding confirmed through academic word use showing a greater frequency in PMTs than AMTs (Table 6).

	AMTs	PMTs
Academic Word Use	2.36%	4.56%
Academic Rareness	5	3

Table 6. Academic word use across AMTs and PMTs (generated by the UAM CorpusTool Version 6.2k).

The higher frequency of rhythmic technicality in PMTs than AMTs runs contrary to Parkinson and Adendorff's claim (2004) that academic articles are characterized by a higher degree of specialism and technicality. These inconsistent findings may be explained by the fact that this research is limited to the analysis of titles and that PMT authors opt for more nominalization to foreground their allegiance to the medical community in this decisive and screening genre (Busch-Lauer, 2000, p. 77), their first encounter with the audience.

5.2.2.2. Parallelism: Adjective phrases

As for parallel APs, they are more frequent in AMTs than PMTs. Examples of APs and NPs are given below:

AMT4. Low-Dose **Subcutaneous** or **Intravenous** monoclonal Antibody to Prevent Malaria.

AMT5. Reliever-Triggered Inhaled Glucocorticoid in **Black** and **Latinx** Adults with Asthma.

In AMT4 and AMT5, adjectives are used as classificatory resources by means of which writers identify different groups of antibodies (AMT 4) or patients (AMT 5). These APs create a descriptive discourse, enabling writers to provide readers with "a more complete picture of the people, places and things they want to describe" (Savage & Shafiei, 2012, p. 43). Since APs joined via a coordinator create rhythmic patterns at regular intervals, their higher frequency in AMTs than PMTs may be explained by the "vitality" they result in (Johnson, 2016, p. 35) and precision in this genre, mirroring the scientific rigor of academic articles (Sellami-Baklouti, 2013).

5.2.2.3. Parallelism: Verb phrases and clauses

Authors of PMTs opt more for parallel verb phrases and clauses, illustrated through the following examples:

PMT6. Eating Late **Increases Hunger**, **Decreases Calories Burned**, and **Changes Fat Tissue**.

PMT7. People **Who Are 'Night Owls**' Could Have Greater Risk of Type 2 Diabetes and Heart Disease Than Those **Who Are 'Early Birds'**, Study Finds.

PMT7 includes two parallel relative clauses resulting in echoes whereby similar signals are repeated throughout time to create not only rhythmic but also familiar discourse which can be easily processed by the readership. In PMT6, writers use three consecutive VPs, thus creating a rhythmic pattern. These ensuing dynamic processes "describe an action" (Hinterholzer, 2007, p. 3) and pack activities in a linear succession, producing motion in discourse. Given that this dynamic rhythmic architecture appeals to readers and gets them involved in an energetic flow of discourse, parallel VPs may serve more PMT authors who get readers engaged in a moving rhythmic flow.

5.2.3. Repetition

Compared with alliteration and parallelism, repetition is less frequent. As Table 7 indicates, there are significant differences in its distribution across AMTs and PMTs (N Repetition in PMTs = 28, N Repetition in AMTs = 12, U = 1169,000, z = -2,625, p= 0.009).

Rhythmical pattern	AMTs	PMTs	Mann Whitney U test
Repetition	12	28	0.009

Table 7. Repetition across AMTs and PMTs.

The presence of rhythmical patterns realized through repetition may be related to the lexical density of titles, as is shown in Table 8.

		Correlations	Lexical density	Repetition
Spearman's rho	Lexical density	Correlation Coefficient	1,000	,245*
		Sig. (2-tailed)	.	,010
		N	108	108
	Repetition	Correlation Coefficient	,245*	1,000
		Sig. (2-tailed)	,010	.
		N	108	108

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

Table 8. SPSS output for correlation between lexical density and repetition

As is shown in Table 8, there is a significant correlation between lexical density and repetition ($p < 0.05$). The Spearman coefficient shows a weak positive correlation since rs (0.245) falls between 0.20 and 0.29. Thus, the more lexically dense the message becomes, the higher the number of repeated items is. Given that PMTs are more lexically dense than AMTs (see Table 2), they are more likely to include a higher frequency of repetition, which results in a more eloquent rhythmical architecture in PMTs.

Repetition is by far higher in PMTs than AMTs and is realized by lexical words, pronoun-verb structures, affixes and roots (Figure 8).

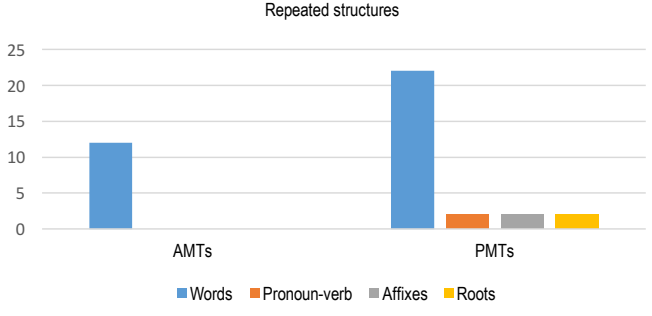

Figure 8. Repeated linguistic features across AMTs and PMTs.

As is revealed in Figure 8, the repetition of single words is the most frequent, with a higher presence in PMTs than AMTs. As for affixes, roots and pronoun-verb structures, they are barely repeated in PMTs and totally absent in AMTs.

5.2.3.1. Distribution of repeated words

Figure 8 reveals that repeated words are nearly as twice in PMTs than AMTs. Re-mentioning the lexical item reveals writers' attempt to emphasize a particular chunk of discourse, as is revealed in the following example:

> AMT6. Relatlimab and **Nivolumab** versus **Nivolumab** in Untreated Advanced Melanoma

Through repeating the word twice in AMT6, writers create a rhythmic flow and foreground the contrast between two immunotherapies, i.e., *Relatlimab and Nivolumab* as compared with *Nivolumab*. The repetition of words results

not only in rhythm but also highlights a particular piece of information so that it can be better memorized. Rhythmic repetition in discourse evokes the same patterned recurrences that structure perceptual experience in architecture through the repetition of spatial or formal designs. In both discourse and architecture, rhythmic repetition serves as a medium to communicate ideas and functions as "a persuasive strategy used to affect or coordinate attitudes" (Chan, 2012, p. 254). It can also be perceived as "a cognitive process", by which "a small set of items" is maintained "in short-term memory, and any information in short-term memory is transferred to long-term storage to some degree throughout its stay in short-term memory" (Chan, 2012, p. 254). Therefore, through the rhythmic repetition of words, authors of PMTs craft engaging titles designed to emotionally appeal to the readership and attract their attention. This may be accounted for by the fact that popular medical discourse is often the product of preliminary or pilot studies for which enough scientific data is not provided (Parkinson & Adendorff, 2004).

5.2.3.2. Distribution of repeated affixes and roots

For the affixes and roots, they are absent in AMTs, and barely present in PMTs. Repeating the affix or the root while adding derivational and inflectional morphemes also reflects an attempt to create melody and to act on readers' cognitive processing of the message, as is revealed in examples PMT8 and PMT9:

PMT8. Eating Late In**crease**s Hunger, De**crease**s Calories Burned, and Changes Fat Tissue.

PMT9. Check**ing** Blood Pressure in a Heartbeat, Us**ing** Artificial Intelligence and a Camera.

In PMT8, the bound root *crease* is repeated twice, but with semantically different prefixes, i.e., *In* and *De*, which produces rhythm while inviting readers to discern the semantic contrast between actions. In PMT9, the inflectional suffix *-ing* is repeated twice, each time with a different verb, i.e., *check* and *use*. These occurrences of the suffix impart a sense of motion and dynamism to the title, thereby producing an intermittent, symmetrical and rhythmical pattern of movement.

5.2.3.3. Distribution of repeated pronoun+verb structure

The two instances of pronoun + verb structure realized through *who are* are embedded within parallel clausal patterns (PMT7), and result in a recurrent alternation of words and clauses, which marks the movement of the airflow, creates a ringing tone and strengthens the rhythmic architecture of the message in PMTs. Compared with other types of repetition, the structure composed of a relative pronoun and the verb to be is less frequent, which may be attributed to its length and the limited space offered to authors in titles.

6. Conclusion

The study has investigated rhythm across AMTs and PMTs and shown that PMTs are more rhythmic than AMTs, which may be attributed to the higher lexical density of PMTs, the identity of the authors and the expected readership. When it comes to rhythmical patterns, the study has revealed that antithesis is absent in AMTs and PMTs, a finding likely due to the conciseness of titles and the larger space required to balance contrasting ideas in antitheses. As for alliteration, parallelism, and repetition, the study has uncovered that there are significant differences in their distribution across AMTs and PMTs, which testifies to the vital role of context in determining choices, whether at the level of phonology or lexico-grammar. In fact, PMTs have a higher frequency of alliteration, repetition and parallelism compared with AMTs, which results in a higher number of rhythmical patterns and a greater level of musicality. The study has also pointed out the close nexus between rhythm and lexical density, especially when it comes to parallelism and repetition. The more lexically dense the title is, the more likely it is to include parallel and repeated structures and to have more rhythmic architecture.

At lower levels of delicacy, the study has uncovered that fricative alliteration is the most frequent in PMTs, creating a turbulent hissing tone that appeals to readers' minds and ears. Compared with other types of alliteration, fricative alliteration is characterized by acoustic salience as the continuous stream of turbulent air is more noticeable. In addition, the sharp percussive effect of fricatives generates a beat-like quality. Concerning parallelism, the study has shown that nominal parallelism is the most prevalent among adjectival, verbal and clausal parallelism in PMTs, resulting in a flow of rhythmic technicality. In addition, parallel noun phrases produce clearer rhythmic beats as nouns are more stable in form, allowing only the plural

inflection, compared with verbs which change for aspect, tense or person. They have their semantic weight as well, giving rhythm more strength and memorability. As for repetition, the study has indicated that the repetition of single words is the most recurrent, a finding which may be attributed to the fact that re-mentioning the same linguistic unit establishes a steady beat reminiscent of musical pulses. Restating the same word also contributes to the intensification of its meaning and produces a chant-like message.

The different selections of rhythmical patterns reveal how each scientific community construes scientific knowledge, with authors in PMTs having a closer addresser-addressee relationship than their peers in AMTs, as they attempt to appeal to the readership. Rather than foregrounding the accuracy or credibility of scientific claims, PMT authors write titles characterized by a resonant stricture, sonority and rhythmical architecture to make the message more memorable (Atkinson & Shiffrin, 1968) and to garner the audience's support. In this way, they rely more on pathos rather than logos to disseminate their claims.

Theoretically, the study has highlighted the role of genres and has provided an account of the phonological and lexico-grammatical choices in titles, a genre which has an important screening role for the audience yet has not received much attention in the literature. It has also shown that rhythmic architecture is best expressed at the level of phonology rather than lexico-grammar. Methodologically, it has testified to the importance of a combined phono-grammar approach to the analysis of rhythm in written discourse. Pedagogically, the study has offered insights into the rhythmical architecture of academic and popular medical titles, which may help medical scholars and journalists to enhance their writing skills and to get accepted in their respective communities.

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NOTES

[1] https://www.sciencedaily.com/

[2] https://www.nejm.org/