

УНИВЕРЗИТЕТ „ГОЦЕ ДЕЛЧЕВ“ - ШТИП  
ФИЛОЛОШКИ ФАКУЛТЕТ

UDC 81  
UDC 82  
UDC 008



ISSN: 2545-3998  
DOI: 10.46763/palim

# ПАЛИМПСЕСТ

МЕЃУНАРОДНО СПИСАНИЕ ЗА ЛИНГВИСТИЧКИ,  
КНИЖЕВНИ И КУЛТУРОЛОШКИ ИСТРАЖУВАЊА

# PALIMPSEST

INTERNATIONAL JOURNAL FOR LINGUISTIC,  
LITERARY AND CULTURAL RESEARCH

PALMK, VOL X, NO 19, STIP, 2025

ГОД. 10, БР. 19  
ШТИП, 2025

VOL. X, NO 19  
STIP, 2025



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Меѓународно списание за лингвистички, книжевни  
и културолошки истражувања

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International Journal for Linguistic, Literary  
and Cultural Research

Год. 10, Бр. 19  
Штип, 2025

Vol. 10, No 19  
Stip, 2025

PALMK, VOL 10, NO 19, STIP, 2025

DOI: <https://doi.org/10.46763/PALIM251019>

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International Journal for Linguistic, Literary  
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The International Scientific Journal “Palimpsest” is issued twice a year in printed form and online at the following website of the web portal of Goce Delcev University in Stip: <http://js.ugd.edu.mk/index.php/PAL>  
Papers can be submitted and published in the following languages: Macedonian, English, German, French, Russian, Turkish and Italian language.  
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FOR THE INTERNATIONAL SCIENTIFIC JOURNAL “PALIMPSEST”

## SENTENCE STRUCTURE IN HUMAN AND AI-GENERATED TEXTS: A COMPARATIVE STUDY

**Elena Shalevska**

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**Abstract:** This mixed-method study analyzes the syntactic differences between human and AI-generated text. To this end, the study includes a corpus of 20 essays (10 human, 10 ChatGPT-generated) across 10 topics, with each sentence in those essays manually coded for structure (simple, compound, complex, compound-complex). Sentence length, total word count, and number of sentences are also measured to gain further insights. Preliminary results indicate that 1. Humans' sentences are longer, on average; 2. Both human-written and AI-generated texts rarely include compound-complex sentences; 3. 60% of AI-generated text have no compound-complex sentences whatsoever, and 4. Both AI and human texts consistently rely heavily on simple sentences, though human-authored pieces of writing display more variation in their use of simple sentences across different essays.

**Keywords:** *Syntactic features; Syntax; Artificial Intelligence; Academic Writing; Comparative analysis.*

### 1. Introduction

The introduction and widespread use of Large Language Models (LLMs) has revolutionized natural language processing (NLP), enabling machines i.e. Artificial Intelligence (AI) to easily generate text that closely mirrors human writing (Kaplan, 2024). AI-based models, such as OpenAI's GPT series have taken the world by storm and have, since their introduction, found their use in different domains, including textual content creation. The now increasing prevalence of such AI-generated text, however, raises questions about the linguistic characteristics of these texts, compared to human-authored pieces of writing. And in an era where AI texts are getting more and more difficult to detect, understanding these differences can be crucial for better authorship attribution, plagiarism detection, and, of course, the development of future, improved AI systems that produce text that resembles human writing even more closely.

Recognizing this, this study aims to compare the syntactic features of human and AI-generated essays, focusing on sentence structure in particular. By analyzing the frequency and distribution of simple, compound, complex, and compound-complex sentences, and the average sentence length, the study sets out to identify patterns that possibly distinguish human writing from AI-generated text.

### **1.1. Sentence Structure: Basic Notions**

Analyzing sentence structure provides valuable insights into how meaning is conveyed in English. According to Radford (2009), the basic sentence types in English are simple, compound, complex, and compound-complex. A simple sentence consists of a single independent clause; a compound sentence contains two or more independent clauses joined by a coordinating conjunction; a complex sentence includes one independent clause and at least one dependent clause; a compound-complex sentence combines multiple independent clauses with at least one dependent clause. Understanding these structures is crucial for syntactic analysis, as the structures themselves reveal the relationships between different sentence elements (Radford, 2009).

### **1.2. Literature Review**

LLMs have significantly advanced the field of text generation. Models like GPT-2 and GPT-3 utilize transformer architectures to produce coherent and contextually relevant text across various applications (Ijibadejo Oluwasegun & Altamimi, 2023). And they are getting more and more advanced. These models now excel at summarization, translation, and content creation (Kaplan, 2024). However, the quality of the text they generate is influenced both by the user and their prompt and the decoding strategies that the model uses during generation, with methods like greedy search, beam search, and top-k sampling affecting the fluency and diversity of the output (Singh et al., 2023).

AI-generated texts, as the most popular area of computer-generated content, have thus been gaining momentum in the research community. Research into the linguistic features of AI-generated text, in particular, has identified distinct patterns that differentiate it from human writing. Goom (2023) explores the differences between AI-generated and human-written text focusing on two key metrics: perplexity and burstiness. Perplexity measures how well a language model predicts the next word in a sequence, with lower scores indicating better predictability. Human-written text typically has higher perplexity due to the complexity of human thought. Burstiness refers to the variation in sentence length and structure, with human writing often showing greater diversity and creativity.

Other studies have shown that AI-generated texts, particularly news articles, often exhibit differences in sentence length distribution, use of dependency and constituent types, and emotional tone compared to human-authored articles (Muñoz-Ortiz et al., 2023). Zhou et al. (2023) also studied news articles and compared AI-generated and human-created misinformation about COVID-19. Using a dataset of human-written misinformation, they prompted GPT-3 to produce synthetic fake news. Their analysis showed that AI-generated misinformation was more emotionally charged and used more attention-grabbing language.

AI-writings were also studied by Shah et al. (2023). They suggest that AI-generated content may lack the sentence variety and complexity characteristic of human writing, potentially due to the models' training on large but generalized datasets. Studying a corpus of AI and human texts, Shalevska (2024) found that AI writings include no boosters, and rely heavily on hedges such as “may”. These



linguistic discrepancies have the potential to help us better detect AI-generated text, with various methods still being developed to identify this kind of content based on stylistic and structural features (Alamleh et al., 2023). This study builds upon these findings by contrasting human essays and AI-produced ones. The outlined differences can be further understood through the lens of syntactic complexity theory. This theory posits that the ability to produce varied and intricate sentence structures is a hallmark of advanced language proficiency and cognitive engagement (Ortega, 2003).

Furthermore, it is important to note that AI writing has also become part of academic writing in various educational and non-educational settings and has sparked discussions regarding its benefits and challenges. Some research shows that AI tools can assist non-native English speakers in improving their writing by providing suggestions for grammar and style (Warschauer et al., 2023). However, concerns have been raised about the potential for AI-generated text to undermine academic integrity, particularly in cases where students may use AI to produce essays or assignments (Woo et al., 2023). Furthermore, the use of AI in academic writing calls for taking a closer look at how we discuss ethics, academic misconduct and the ethical implications of AI misuse as well as the urgent need for improved guidelines that stress responsible use (Warschauer et al., 2023).

In terms of human writing and academic writing in particular, some studies have shown that both male and female authors predominantly use simple sentences (around 50%), followed by complex sentences (37-41%), with compound and compound-complex sentences being less frequent (Saragih & Hutajulu, 2020). This suggests that gender does not significantly influence sentence type usage in academic writing (Saragih & Hutajulu, 2020). Other research has shown that human essays typically include all four sentence types with simple and compound sentences being most common, while compound-complex sentences – least frequent (Qonitatu, 2016). As for sentence length, traditionally, researchers have examined the statistical properties of sentence length distribution to resolve questions of disputed authorship. This approach dates back to studies by Mendenhall in 1887 and Yule in 1939. All of these stylistic features can be the cornerstone for distinguishing AI-generated texts from human-authored ones. And this, in turn, provides the foundation for this study's comparative analysis of sentence complexity and length in essays produced by both sources.

## **2. Research Methodology**

The aim of this study is to uncover patterns in sentence structure usage across four syntactic categories: simple, compound, complex, and compound-complex sentences, as well as average sentence length, as a separate feature. To achieve this, this study employs a mixed-method research design (Brewer & Hunter, 1989; Ackroyd & Hughes, 1992), using both qualitative and quantitative analyses to compare the syntactic features of human-authored and AI-generated texts. The obtained results, thus, are both objective and subjective (Cohen & Manion, 1994).

As for the sample that serves as the cornerstone of this research, the study includes a self-made corpus (Sinclair, 1991) that offers an opportunity to study

authentic texts with greater objectivity (Svartvik, 1992). The corpus includes 20 essays—10 written by human authors and 10 generated by ChatGPT. The AI-generated essays were generated by the author, during the month of January, 2025 using OpenAI's free ChatGPT-3.5 model, prompted to produce an essay on the same topics as the human-written one, using a simple, standardized prompt of: *"Write an essay on \_\_\_\_"*. Thus, essays on 10 different topics were generated, with two essays (one human-written and one AI-generated) per topic in the corpus, to ensure consistency and comparability. Human-written essays were collected from publicly-available essays written for the TOEFL exam. It is important to note that while AI-generated texts can be tailored (using the prompt) to specific stylistic and syntactic instructions, human writers—such as students preparing for exams like the TOEFL—often operate under instructional constraints, including expected word counts and stylistic conventions taught in class. This distinction may influence the nature of the outputs and should be considered. Still, it does not undermine the validity of the study; rather, it underscores the importance of contextual awareness when evaluating such comparisons.

To quantitatively compare the syntactic features between human-written and AI-generated essays, the Mann-Whitney U Test, a non-parametric statistical test, was employed (Mann & Whitney, 1947). This test was selected due to its suitability for small sample sizes ( $n = 10$  per group) and its lack of assumption regarding normality of the data, which could not be guaranteed given the limited corpus size and potential non-normal distribution of variables.

### 2.1. Coding and Classification

Each sentence in the essays was manually coded (Maxwell, 2005 & Flick, 2014) to identify its structure and categorized into one of four syntactic types:

1. **Simple sentences** – containing one independent clause.
2. **Compound sentences** – containing two or more independent clauses.
3. **Complex sentences** – containing one independent clause and at least one dependent clause.
4. **Compound-complex sentences** – containing two or more independent clauses and one or more dependent clauses.

The following metrics were also analyzed for each essay:

- Total number of sentences per essay;
- Frequency of each sentence type;
- Total word count;
- Average sentence length (calculated automatically in MO Excel, as the total number of words divided by the total number of sentences)

Quantitative data were analyzed using MO Excel, while the qualitative analysis, relied on interpretative-inductive methods of Khalke (2014) and aimed to interpret the stylistic patterns and syntactic choices in the texts. The data obtained, in full, is available in Appendix 1.

### 2.2. Limitations

Before proceeding with the results, it is important to acknowledge some

limitations. Firstly, the study is limited to a small sample size of essays, which may constrain the generalizability of findings. Additionally, the AI-generated texts were produced using a single model (the model of ChatGPT-3.5), which may not fully represent the diversity of AI models. Despite these limitations, it is believed that the study offers valuable insights into the stylistic features of AI-generated texts that could be expanded on in the future.

### 3. Results and Discussion

The analysis conducted for the purpose of this study primarily compared the sentence structures of AI-generated and human-written essays across four categories: simple, compound, complex, and compound-complex sentences. All the sentences in the corpus were manually coded by the author. A total of 357 sentences were analyzed and coded across the two corpora, with 120 of them being generated by ChatGPT and 237 written by humans. The obtained data, in full, is as follows:

| Essay  | Simple      | Compound   | Complex    | Compound-Complex | Total Sentences | Total no. of Words | Avg. no. of words in a sentence |
|--|-------------|------------|------------|------------------|-----------------|--------------------|---------------------------------|
| 1. Why People Attend College/ University -- AI | 5 (41.6%)   | 3 (25%)    | 3 (25%)    | 1 (8.33%)        | 12              | 148                | 12.33                           |
| Why People Attend College/ University -- Human | 12 (50.00%) | 3 (12.50%) | 7 (29.17%) | 2 (8.33%)        | 24              | 428                | 17.83                           |
| 2. Parents Are the Best Teachers -- AI         | 5 (41.6%)   | 3 (25%)    | 3 (25%)    | 1 (8.33%)        | 12              | 151                | 12.58                           |
| Parents Are the Best Teachers -- Human         | 10 (45.45%) | 5 (22.73%) | 6 (27.27%) | 1 (4.55%)        | 22              | 491                | 22.32                           |
| 3. Not Everything Learned in Books -- AI       | 6 (50%)     | 2 (16.6%)  | 4 (33.3%)  | 0                | 12              | 148                | 12.33                           |
| Not Everything Learned in Books -- Human       | 11 (52.38%) | 3 (14.29%) | 6 (28.57%) | 1 (4.76%)        | 21              | 329                | 15.67                           |
| 4. Factory Near Community -- AI                | 5 (41.6%)   | 2 (16.6%)  | 5 (41.6%)  | 0                | 12              | 148                | 12.33                           |
| Factory Near Community -- Human                | 12 (50.00%) | 4 (16.67%) | 7 (29.17%) | 1 (4.17%)        | 24              | 390                | 16.25                           |
| 5. One Change in Hometown -- AI                | 5 (41.6%)   | 3 (25%)    | 3 (25%)    | 1 (8.33%)        | 12              | 148                | 12.33                           |
| One Change in Hometown -- Human                | 10 (55.56%) | 2 (11.11%) | 6 (33.33%) | 0                | 18              | 290                | 16.11                           |
| 6. Media Influence on Behavior                 | 5 (45.4%)   | 2 (18.1%)  | 4 (36.3%)  | 0                | 11              | 194                | 17.64                           |
| Media Influence on Behavior -- Human           | 8 (40.00%)  | 5 (25.00%) | 6 (30.00%) | 1 (5.00%)        | 20              | 512                | 25.60                           |

|   |             |            |             |           |    |     |       |
|---|-------------|------------|-------------|-----------|----|-----|-------|
| 7. Television and Communication -- AI           | 4 (36.3%)   | 3 (27.2%)  | 4 (36.3%)   | 0         | 11 | 191 | 17.36 |
| Television and Communication -- Human           | 10 (35.71%) | 7 (25.00%) | 10 (35.71%) | 1 (3.57%) | 28 | 654 | 23.36 |
| 8. Hard Work vs. Luck -- AI                     | 5 (41.6%)   | 3 (25%)    | 4 (33.3%)   | 0         | 12 | 194 | 16.17 |
| Hard Work vs. Luck -- Human                     | 9 (37.50%)  | 5 (20.83%) | 9 (37.50%)  | 1 (4.17%) | 24 | 502 | 20.92 |
| 9. Equal Funding for Sports and Libraries -- AI | 6 (46.1%)   | 3 (23.08%) | 3 (23.08%)  | 1 (7.69%) | 13 | 195 | 15.00 |
| Equal Funding for Sports and Libraries -- Human | 8 (30.77%)  | 6 (23.08%) | 10 (38.46%) | 2 (7.69%) | 26 | 458 | 17.62 |
| 10. Eating at Food Stands vs. at home -- AI     | 7 (53.8%)   | 2 (15.3%)  | 4 (30.7%)   | 0         | 13 | 204 | 15.69 |
| Eating at Food Stands vs. at home -- Human      | 11 (36.67%) | 8 (26.67%) | 10 (33.33%) | 1 (3.33%) | 30 | 513 | 17.10 |

Table 1: Sentence type frequency in the essays in the corpus

Additional metrics, including total number of sentences (calculated by the author using MS Excel), total number of words, and average number of words per sentence (all machine-calculated) were also evaluated to better understand how humans write and how machines try to imitate them.

In terms of the four sentence categories, the following trends were observed:

3.1. Simple Sentences

The obtained data shows that AI-generated texts consistently rely heavily on simple sentences, making up approximately 36.36% to 53.85% of all sentences. Humans also seem to use simple sentences significantly but less dominantly, with numbers ranging from 35-55%. Thus, it is clear that both AI and human essays rely heavily on simple sentences, with AI texts having a greater uniformity in their proportion across all essays.

Human writers, on the other hand, display more variation in their use of simple sentences across different essays. This supports the findings of Shah et al. (2023), who argue that AI lacks the sentence variety seen in human writing.

One might argue that simple sentences dominate in AI-generated texts due to their emphasis on clarity and straightforwardness. Human writers also seem to use simple sentences effectively but balance them with more complex structures, enhancing expressiveness. This balance suggests that human writers instinctively vary sentence structures for impact, while AI models tend toward uniformity.

3.2. Compound Sentences

Data shows that both AI and human texts have a similar range of compound sentences, and that compound sentences, in general, are used less frequently across

the corpus. In AI texts, these sentences make up about 15-27% of all sentences, while in human texts, their prominence ranges between 11-27%.

Though similar in a general overview sense, AI's percentages are more clustered around 20-25%, while human writing fluctuates more. This suggests that AI-generated texts might be less dynamic in sentence structure, which reinforces Goom (2023)'s claims that human writing exhibits greater burstiness.

### **3.3. Complex Sentences**

Complex sentences are consistently used by both AI and human writers, but human texts generally show a higher proportion (28-38%) of them compared to AI texts (23-41%). AI, on the other hand, has a slightly wider range of complex sentences use.

The use of complex sentences in AI-generated texts indicates some ability of the model to handle dependent clauses, but the lower overall percentage compared to human texts suggests limited syntactic sophistication. Human writers use complex sentences to convey more complex arguments and layered ideas, and this, in turn, improves the depth of their writing. The higher frequency in human texts may reflect people's ability to articulate relationships between ideas more effectively – a skill that ChatGPT can currently only partially emulate.

### **3.4. Compound-Complex Sentences**

Compound-complex sentences allow for the simultaneous presentation of multiple ideas and their interrelationships – something that can be seen as a hallmark of advanced writing. However both AI and human texts rarely include these sentences, with percentages ranging from 0-8% in both groups.

The obtained data shows that AI-generated texts include very few compound-complex sentences, and in many essays, they are avoided altogether. In fact, only 4 of the 10 AI-produced essays include such type of sentence. Humans also seem to steer away from compound-complex sentences, but still, the overall distribution of such sentences in the human-authored corpus is more varied. 9 out of the 10 human-authored essays include at least one compound-complex sentence. This suggests that human texts have a more natural balance of complexity. This fits with the insights of Muñoz-Ortiz et al. (2023) who noted that AI-generated texts often differ in their use of syntactic structures and Qonitaton (2016) who noted that human essays typically include all four types of sentences.

### **3.5. Sentence Length**

To gain further insights into the syntactic and stylistic features of AI generated texts, the average sentence length of the texts in both corpora was also considered. The data shows that AI-generated sentences include anywhere from 12.33 to 17.64 words per sentence, while human-written sentences include 15.67 to 25.60.

On average, human-written essays have longer sentences (averaging at approximately 19.28 words per sentence) than AI-generated essays (with approximately 14.38 words per sentence) (Graph 1), supporting the observation that AI tends to produce more concise and uniformly structured text compared



to the more varied and elaborate sentence construction typically found in human writing. This also supports the findings of Muñoz-Ortiz et al. (2023), who found that AI and human texts differ in sentence length distribution. Thus, AI essays tend to be more concise, keeping sentences within a narrow range of lengths, while human writers produce longer, more varied sentences, which may lead to greater burstiness, as indicated by previous research (Goom, 2023). To quantitatively assess the difference in average sentence length between human-written and AI-generated essays, a Mann-Whitney U Test was also conducted using the data from Table 1. The test yielded a U statistic of 11 and a p-value of 0.006 (two-tailed), indicating a statistically significant difference ( $p < 0.05$ ) between the two groups. This result confirms that human-written essays feature significantly longer sentences on average (approximately 19.28 words) compared to AI-generated essays (approximately 14.38 words), aligning with observations of greater syntactic variation and elaboration in human writing, as noted by other authors.

### 3.6. Additional Insights

If one takes a closer look at the essays and their content, beyond the coding, one can speculate that humans bring experiential knowledge, cultural understanding, and emotional resonance to writing. This is something that AI models only try to imitate. It is the author's impression that AI models bring algorithmic knowledge and vast (yet still limited) training data that comes with a plethora of constraints. These factors contribute to the ability of humans to better “infuse” their writing with a personal voice, and variation in style, which, in turn, makes their writing more relatable and engaging.

In contrast, AI models like ChatGPT excel in producing grammatically accurate and semantically coherent texts. The AI-generated texts include no grammatical or spelling errors, which is not the case with the human-authored ones. Additionally, unless prompted to maintain a certain word count – something that was not done in this study, AI-generated essays tend to be shorter and more uniform in length. Thus, 6 out of the 10 essays in the AI corpus include 12 sentences with the 4 remaining being essays of 11 or 13 sentences in length. The texts average 12 sentences in length. In contrast, human essays tend to be longer, almost double that, averaging 23,7 sentences in length. This reflects the organic nature of human thought processes, where ideas are explored in depth, often leading to longer and more complex texts. This also suggests a potential tendency for humans to elaborate, digress, or provide additional context – something that enriches the narrative but may also result in inconsistencies or errors.

The strengths and limitations of both human and AI writing suggest their complementary roles. So, AI can assist with writing tasks requiring precision, efficiency, or large-scale content generation, while humans can focus on the creative, emotional, and culturally-charged aspects of writing. This further shows the unique value that human writers bring to the table. While AI models excel in technical accuracy and efficiency, they still remain *a tool* that complements rather than replaces human creativity.

#### 4. Conclusion

Humans and AI models produce texts that differ. And while they each have their strengths, it is important to acknowledge these differences. While both humans and AI use simple sentences frequently, AI exhibits a higher degree of uniformity in their proportion. Human writing demonstrates more variation in simple sentence use. Similarly, while both use compound sentences, AI's usage is less dynamic than human writing. Humans also employ complex sentences more frequently, suggesting a greater capacity for conveying layered ideas and complex arguments. Compound-complex sentences, though rare in both, appear slightly more often and with greater distribution in human-written text, indicating a more natural balance of complexity.

Beyond syntax, it is also worth reflecting on qualities often attributed to human writing, such as experiential knowledge, cultural understanding, and emotional resonance—things that AI, despite its algorithmic sophistication and access to vast training data, may only approximate at a superficial level. While AI excels at producing grammatically flawless and semantically coherent texts, which tend to be shorter and more uniform in length, human writing is frequently more varied and exploratory, reflecting the non-linear nature of thought. Although this paper does not present direct qualitative evidence of these traits, such reflections highlight potential areas of distinction that may inform future research. Because as AI continues to evolve, further research will be needed to explore how these syntactic differences influence reader perception, engagement, and trust. By deepening our understanding of the linguistic features of AI-generated text, we can better detect AI generated content and navigate the opportunities and challenges posed by the integration of artificial intelligence in writing. It may be safe to say that as AI continues to improve, the boundary between human and machine-generated writing may blur, but creativity and original thought will never stop being inherently human.

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VOL. X  
NO 19