

A computer-aided study of the ideational metafunction in “The Penelopiad” by Margaret Atwood

Marianna Dilai¹, Iryna Dilai^{2,*}, Iryna Khomytska¹ and Olesya Tatarovska²

¹ Lviv Polytechnic National University, Stepan Bandera Street, 12, Lviv, 79013, Ukraine

² Ivan Franko National University of Lviv, Universytetska Street, 1, Lviv, 79000, Ukraine

Abstract

The paper seeks to explore computer-aided techniques aimed at informing and facilitating literary text analysis. The text is being analyzed in terms of the realization of the ideational metafunction, defined within the framework of Systemic Functional Grammar (SFG) as the one aimed at construing human experience through the deployment of six types of processes: material, verbal, mental, behavioral, existential, and relational. Such an experience construal is based on the functional grammatical category of transitivity, which transfers the process from the subject to the object and has different degrees depending on the semantics of the process. The ideational metafunction is best manifested in narratives, which generally have linear structure and presuppose consecutive alternation of processes. The computer-aided analysis is conducted on the material of the novel “The Penelopiad” by M. Atwood with the use of the Voyant Corpus Tools. The Pearson correlation coefficient and data clustering are applied to establish inner semantic and structural relations within the narrative. The conducted statistical text analysis revealed the peculiarities of the distribution of different types of processes throughout the text.

Keywords

Systemic Functional Grammar (SFG), ideational metafunction, process, narrative, statistical text analysis, clustering

1. Introduction

The application of computational techniques to the production and processing of natural language is the key task of AI. Computer-aided text analysis has been rapidly developing due to the implementation of more and more sophisticated algorithms and the elaboration of more advanced software. The automated analysis of texts is, on the one hand, a prerequisite of an objective discourse analysis capable of revealing latent language dimensions; on the other hand, it serves as the indispensable basis for the emergence of AI

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* Corresponding author

✉ marianna.p.dilai@lpnu.ua (M. Dilai); iryna.dilay@lnu.edu.ua (I. Dilai); iryna.y.khomytska@lpnu.ua (I. Khomytska); olesya.tatarovska@lnu.edu.ua (O. Tatarovska)

ORCID 0000-0001-5182-9220 (M. Dilai); 0000-0001-9626-290X (I. Dilai); 0000-0003-3470-7191 (I. Khomytska); 0000-0001-9175-2774 (O. Tatarovska)



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text-generating applications. In this respect, the relevance of computer-aided literary text analysis cannot be underestimated.

The goal of this study is to investigate how meanings are construed in the narrative by conducting the computer-aided analysis of the ideational metafunction realization exemplified by the novel “The Penelopiad” by Margaret Atwood.

The ideational language metafunction is one of the three main language metafunctions discerned by the founding father of Systemic Functional Linguistics (SFL), Michael A. K. Halliday. It is associated with the perception of text as a reflection of human experience.

We attempt to trace the ideational metafunction in the construal of a narrator's experience and convey the ideas presented through language in the novel under study. According to the tenets of SFG, the linguistic manifestation of the ideational metafunction is ensured by different alternating types of processes (clauses) in the text and the functional grammatic category, which reflects the unfolding of the process through time, its transference from the subject to the object is transitivity [1].

The tasks of the attempted computer-aided ideational metafunctional analysis of the narrative are as follows:

- To elaborate and test a transferrable computer-aided methodology of the analysis of different process types in the text based on verbs as their language manifestations.
- To conduct the statistical analysis of the distribution of the verbs in the narrative under study.
- To account for the quantitative findings, making conclusions and generalizations regarding the realization of the ideational metafunction in “The Penelopiad” by M. Atwood.
- To assess the advantages and shortcomings of the methodology applied and suggest the ways of its upgrading.

2. Related works

The related works for this study have been mostly written within the scope of the Systemic Functional Grammar approach by M. A. K. Halliday. In “An Introduction to Functional Grammar,” he holds that “The aim of Systemic Functional Grammar has been to construct a grammar for the purpose of text analysis: one that would make it possible to say sensible and useful things about any text, spoken or written, in modern English” [2]. The theory appears to be consistent and robust, applicable for computational text processing, and that is why experiencing a surge of interest in modern computational linguistics [2-7]. Within the SFG framework, a text is viewed as the basic unit of semantics, language use in context, and the process of construing meaning in context [1].

M. A. K. Halliday proposes three main language metafunctions representing functional grammatical categories used for the linguistic descriptions in SFL: the ideational, the interpersonal, and the textual [1, 8]. The ideational metafunction is ensured by the functional grammatical category of transitivity, which transfers the action to the object. It reflects the construal of human experience through the alternation of different types of

processes (clauses) in text. M. A. K. Halliday claimed that the prototypical form of the 'outer' experience is that of actions and events [1]. The process is understood as a way of reflecting on experience, of imposing a linguistic order on the experience of infinite variations in the flow of events. Processes of different types indicate the variability of experience construal in the text and, accordingly, the specifics of the realization of the ideational metafunction of language [8]. The system of transitivity provides lexicogrammatical resources for construing the mental representation of the process as a configuration of all the related elements.

The mental representation of the process in SFG is a figure ('configuration frame'), defined as "a quantum of change in the flow of events that construe human experience" [1]. The figure consists of the process that unfolds through time (realized by a predicate verb) and participants directly involved in this process (verb arguments); in addition, there may be attendant circumstances of time, place, cause, manner of action, etc.

The significance of the predicate-argument structure has been emphasized by other scholars in terms of verb semantics study resulting in its representation as a frame (Ch. Fillmore) [9]. Moreover, its implications go beyond the level of a sentence (clause): the predicate-actant model was proposed by A. J. Greimas to study the structure of the narrative [10].

From the semiotic standpoint, the nature of the process and the narrative is alike. In fact, the narrative is a process. C. Bremond holds that the narrative is regulated by the same rules as those which control human thought and action [11]. Modern cognitive linguist R. Langacker defines a process as a consecutive mental scanning of states changing over time [12]. It echoes the definition of the narrative as a temporal structure containing the change of the situation or state [13]. According to L. Polanyi-Bovditch, the narrative is built of two structures: a temporal structure that outlines the progression of the narrative in time, representing a series of events that occur in sequence, and a durational, descriptive structure that represents the spatial, characterization, and durational context for which the temporal structure marks time and changes of state [14]. Events have been defined by M. Bal as "the transition from one state to another state caused or experienced by actors," where "the word 'transition' stresses the fact that the event is a process, an alteration" [15].

In Systemic Functional Linguistics, the category of transitivity forms a continuum rather than binary oppositions, as in traditional grammar. The transitivity continuum is based on semantics which determines to what extent an action affects its object. Therefore, some verbs, such as *see*, have low transitivity, and some, such as *kill*, have high transitivity. Hopper and Thompson (1980) proposed semantic and formal features that determine the degree of transitivity [16]. According to them, actions are transferred, but states are not: in *I hugged Sally* something happened to Sally, in *I like Sally*, Sally was not affected [16]. A characteristic discourse function of transitivity is that high transitivity indicates foregrounding, while low transitivity indicates backgrounding [16].

Transitivity patterns represent the encoding of experiential meanings: meaning about the world and about experience [17]. The transitivity analysis is deemed significant for exploring themes and character construction in a narrative discourse by analyzing language choices used by the authors [18].

The first study of transitivity in literary text was conducted by M. A. K. Halliday himself in 1981: he investigated the novel “The Inheritors” by William Golding [19]. Nowadays, more and more research is being done into the study of transitivity and the ideational metafunction in discourse. For example, researchers have identified ideational metafunctional patterns found in the lexicogrammar of Joseph Conrad’s “Heart of Darkness” and have noted the author’s use of foregrounding [17].

The transitivity analysis has also been used in media studies to show how language is used in media to construct social reality [20]. Some studies also highlighted the variation in ideational functions in different languages [21].

Since the advent of the twenty-first century, the use of computational tools to study linguistic features of text has grown exponentially. A number of computer-aided text analysis tools have proved to be quite efficient in terms of fast and objective literary text feature analysis. Bhatti et al. (2019) examined frequent transitivity elements in Samuel Beckett’s “Waiting for Godot” with the application of the UAM Corpus Tool [22].

The narrative fiction “Kew Gardens” by Virginia Woolf was also analyzed with the use of the UAM Corpus Tool by Ammara et al. (2019), outlining different types of processes (clauses) in the novel and providing the statistics of their types, subtypes as well as participants, circumstances, configurations [23]. Another study by Ammara et al. (2019) on the transitivity analysis of “To the Lighthouse” by Virginia Woolf made use of the concordances and corpus frequencies based on the AntConc corpus toolkit [24].

A variety of statistical measures have been used to analyze texts. An instance of the efficient application of the Pearson correlation coefficient in studying relations between the words that contribute to the overall meaning of a literary text exemplified by A. Byatt’s novels “Children’s Book” and “Possession” is the paper by Melnychuk et al. (2023) [25]. The authors acknowledge the pivotal role of verbs in building a narrative and apply the Voyant Tools to conduct the computer-based discourse analysis.

Despite the vivid interest in the study of the ideational metafunction in the narrative and the transitivity analysis, the previous research has not addressed the way the narrative unfolds: the sequence, alternation, overlap of different process types and their uneven distribution across the body of the text, especially with the aid of modern computational technologies.

3. Methods and material

The methodology of this study is based on the theoretical foundations of the Systemic Functional Grammar, namely on the typology (or rather topology) of processes in a closed semantic space proposed by M. A. K. Halliday, who identified six types of processes, the boundaries of which are blurred [1]:

1. Material processes construct “a quantum of change in the flow of events that occurs through the input of energy” [1]. The source of energy is the Actor, an active subject. There are transitive material processes (doings) and intransitive material processes (happenings). The transitive material processes involve another participant, the Goal (the Patient), towards which the input is applied.

2. Mental processes describe the experience of human consciousness. As a result, the subject of a mental process is always a conscious being, the Senser. The following subtypes of mental processes are distinguished: emotional, cognitive, perceptual, and desiderative. Mental processes have been studied in detail in linguistics as psychological (psych) predicates where the main argument is the Experiencer, which can take the position of both the subject and object.
3. Relational processes serve to characterize or identify entities and are realized by the verb *be* in the simple present or past tense. There are three types of relations: intensive (*x is a*), possessive (*x has a*), and circumstantial (*x is at a*). Each type has two modes of being: attributive and identifying, which function within the category of transitivity. The identifying mode is reversible, *x* and *a* can be swapped: for example, *Sarah is the leader/ the leader is Sarah*. The attributive mode, on the other hand, is not reversible: *Sarah is wise* [1]. In the attributive mode, the following roles of subjects are distinguished: the Attribute and the Carrier. In the identifying mode, the roles of the Identifier and the Identified are distinguished.
4. Existential processes represent the existence of something or someone, introduce participants into the narrative: *be* (in the structures *There is/are/was/were...*), *exist*, etc. The role of the subject is called the Existant.
5. Behavioral processes describe physiological and psychological behavior, normally typical of people: *breathe, cough, smile, dream, stare*, etc. The role of the subject is called the Behaver.
6. Verbal processes are speech processes whose function is to build a narrative through the introduction of dialogues. They always have a speaker as a participant (the Sayer) and may have an addressee participant (the Receiver) [1].

The process types will change as the narrative unfolds. As a rule, existential and relational processes will prevail at the beginning of the narrative, while the plot is built from material processes [1]. An interiorized narrative is mainly built with the help of mental processes [26], while an exteriorized narrative is built with the help of verbal processes. The processes are mainly represented by verbs belonging to the respective lexicosemantic groups.

Having considered the theoretical and methodological prerequisites for studying the structure of the narrative through the employment of different types of process as quanta of change in its texture, we attempt to study the realization of the ideational metafunction (the construal of the narrator's experience) exemplified by M. Atwood's novel "The Penelopiad" [27].

"The Penelopiad" (2005) is a postmodern feminist novel by the famous contemporary Canadian author Margaret Atwood, written as a modern interpretation of the Odyssey myth. The story is told in the first person (the heterodiegetic narrator in an extra-diegetic situation, according to G. Gennett [28]). Odysseus' wife, Penelope, describes in detail the events and her experiences before, during, and after Odysseus' departure for the Trojan War. Although the narrative is retrospective, the deceased Penelope consistently tells the story of her life. The linear structure of the narrative reflects the gradual construal of the

narrator's experience and thus ensures the realization of the ideational language metafunction [8].

Given that texts are ergodic (transitive) dynamic systems in which the positions of linguistic units are not chaotic but subject to certain regularities, it stands to reason to use statistical measures of correlation to describe them. We apply the Voyant Tools [29] to create and process the corpus of "The Penelopiad" by M. Atwood as a preliminary stage of the discourse analysis.

The experimental study consists of several stages:

1. Establishing the frequency of use of verb lemmas in the work, identifying the most frequent verbs, and pointing out the peculiarities of the author's choice/use of atypically frequent words by comparing the findings with the ones obtained from the general corpus of Canadian Fiction.
2. Categorizing the verbs based on the prototypical processes described above, and identifying the respective six lexicosemantic groups of verbs according to the Hallidayan process typology.
3. Using the Voyant Tools to segment the text of the novel into equal parts and determine the distribution of verb word forms across the text segments.
4. Using unsupervised machine learning methods and techniques to establish differences and similarities in data distribution and identify their correlation, clustering, and trends.
5. Interpreting the results of the analysis, assessing strengths and weaknesses of the implemented computer-aided approach to the literary text analysis.

We take verb forms as a basic unit of the study since they have different values and functions in text whereby manifesting the instability of a lemma in context.

Obviously, individual verb forms/groups of verbs testifying to the realization of different process types will be mutually related: they will occur close or far in the text, precede or follow other verbs, forming clusters and collocations testifying to paradigmatic and syntagmatic relations of different types. We apply density-based clustering, trying to identify the verbs grouped in the areas of their high concentrations in the text. On the successful completion of the computer-aided experiment, conclusions can be drawn regarding the prevalence and variation of different types of processes and, as a result, the realization of the ideational language metafunction in the narrative under study.

4. Experiment

In accordance with the procedure described above, we follow all the stages of the experimental study. The statistical text analysis relies on normalized frequencies of occurrences.

Table 1 shows the 25 most frequent verbs in M. Atwood's novel "The Penelopiad" compared to the most frequent verbs in the section "Fiction" of the Strathy Corpus of the Canadian variety of the English language identified previously [30].

Table 1

Top-frequency Verbs in “The Penelopiad” by M. Atwood vs Strathy’s Fiction Corpus

| Rank | Verbs in “The Penelopiad” | Absolute Frequency | Normalized Frequency | Verbs in Strathy’s Fiction | Normalized Frequency |
|------|---------------------------------|-----------------------|-------------------------|----------------------------------|-------------------------|
| 1 | BE | 1,426 | 40,220.00 | BE | 36,843.85 |
| 2 | HAVE | 644 | 18,163.87 | HAVE | 6,983.50 |
| 3 | DO | 258 | 7,276.83 | DO | 6,185.85 |
| 4 | SAY | 188 | 5,302.50 | SAY | 5,424.42 |
| 5 | MAKE | 84 | 2,369.20 | GO | 3,813.84 |
| 6 | TELL | 81 | 2,284.59 | WOULD | 3,472.30 |
| 7 | KNOW | 75 | 2,115.36 | WILL | 3,237.54 |
| 8 | GO | 73 | 2,058.99 | COULD | 2,899.21 |
| 9 | GET | 72 | 2,030.74 | GET | 2,881.51 |
| 10 | TAKE | 62 | 1,748.70 | COME | 2,611.60 |
| 11 | WANT | 58 | 1,635.88 | SEE | 2,391.33 |
| 12 | COME | 52 | 1,466.64 | LOOK | 2,139.94 |
| 13 | THINK | 50 | 1,410.24 | MAKE | 1,963.93 |
| 14 | SEE | 48 | 1,353.83 | THINK | 1,936.03 |
| 15 | KEEP | 39 | 1,099.99 | KNOW | 1,923.69 |
| 16 | LOOK | 38 | 1,071.78 | TAKE | 1,877.81 |
| 17 | GIVE | 35 | 987.17 | CAN | 1,577.58 |
| 18 | TRY | 27 | 761.52 | WANT | 1,330.22 |
| 19 | USE | 26 | 733.32 | ASK | 1,152.07 |
| 20 | EAT | 26 | 733.32 | GIVE | 1,118.80 |
| 21 | FIND | 26 | 733.32 | FIND | 1,023.02 |
| 22 | BRING | 25 | 705.12 | TURN | 871.16 |
| 23 | LET | 25 | 705.12 | LIKE | 603.13 |
| 24 | HEAR | 24 | 676.91 | MAY | 393.32 |
| 25 | SLEEP | 23 | 648.71 | WORK | 180.83 |

In general, the frequency distribution of the top-ranked verbs corresponds to Zipf’s Law, and the verbs themselves coincide in rank with the verbs in the general frequency list formed on the basis of the Strathy corpus of Fiction. Thus, the most frequent verb, apart from the basic verbs *be*, *have*, *do*, is the lexical verb *say*. Down the list, the verbs exhibit a more vivid variability and digression from the general use. The verbs that stand out in terms of normalized frequency in the novel “The Penelopiad” are *make*, *tell*, *know*, *want*, *keep*, *look*, *try*, *use*, *eat*, *bring*, *let*, *hear*, *sleep*, etc. These verbs can be considered the key verbs in the novel. It is noticeable that the top 25 list of verbs in “The Penelopiad” does not contain any modals in comparison with the general Strathy’s Fiction list. Modals do not contribute to the ideational metafunction realization, they are associated with the other language metafunction – interpersonal, and that is why they are not typical of the narrative and not found on the top of this list.

The identified verbs are subject to the classification in accordance with M. A. K. Halliday's taxonomy of processes. As a result, six lexicosemantic groups of verbs (provided in descending order according to their normalized frequencies) are identified, which denote:

1. Material processes: *make, go, get, take, come, give, try, use, eat, bring, call, kill, weave, throw, sail, play, rape, send, carry, hang, etc.*
2. Mental processes: *know, think, want, see, hear, suppose, believe, learn, consider, mean, understand, need, remember, etc.*, which correspond to four types of perception: perceptual (*see, hear*), cognitive (*know, think*), emotional (*love*) and desiderative (*want, need*) [5].
3. Relational processes: *be, have, marry, etc.*
4. Existential processes: *be* (in the structures *There is/are/was/were...*), *exist, etc.*
5. Behavioral processes: *look, sleep, die, laugh, weep, wait, listen, stand, enjoy, watch, pretend, sit, etc.*
6. Verbal processes: *say, tell, speak, claim, order, etc.*

Some verbs are difficult to categorize (e.g., *be*) and can belong to different groups. We focus on the prototypical verbs of the groups that have the highest frequency ranks in the text. In addition, we take into account the frequency distribution of verb forms, which is uneven, e.g., *say* and *said* (see Figure 1).

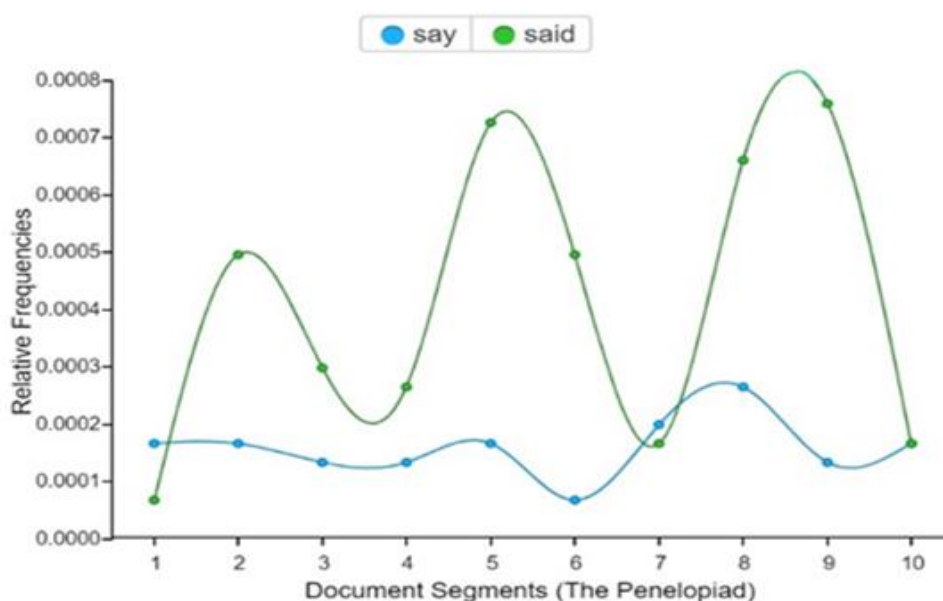


Figure 1: The distribution of *say* and *said* in “The Penelopiad” by M. Atwood.

The identified verbs (verb forms) denoting different process types in the narrative point to the peculiarities of the author's choice determined by the genre, theme, and idiosyncrasy (see Figure 2).

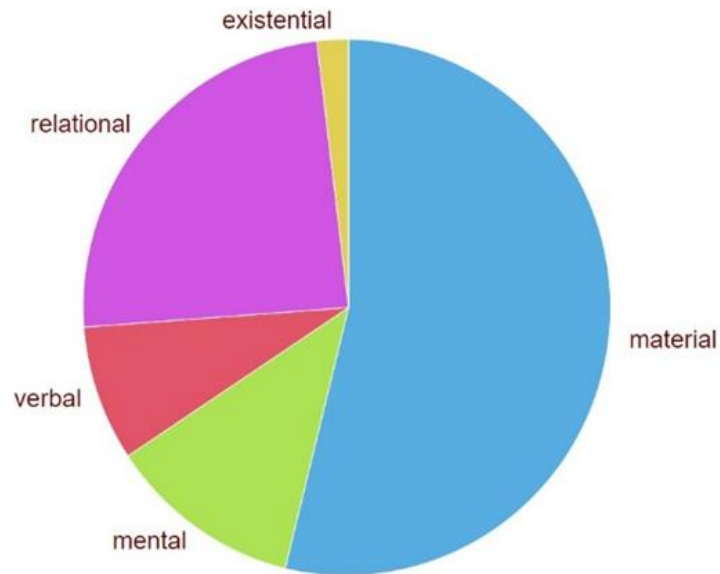


Figure 2: Process types in "The Penelopiad" by M. Atwood.

5. Results

With the help of the Voyant Corpus Tools, we have identified the linear distribution of all the identified lexicosemantic verb groups corresponding to six process types across 10 text segments. Figure 3 presents the visualization of the distribution of the mental processes in the text of "The Penelopiad" by means of bubblelines. The visualization shows the verb clustering and alternation as the narrative unfolds.



Figure 3: The distribution of the mental processes in "The Penelopiad" by M. Atwood.

On the whole, the mental processes have an even distribution across the text segments. The verbs *know* and *remember* prevail at the beginning of the novel, whereas the verbs *blame* and *want* have more occurrences towards the end.

Figure 4 illustrates the distribution of the verbal processes in "The Penelopiad". The forms of the most frequent verb *say* occur throughout the central part of the text and noticeably cluster at its end. Their function is to introduce direct and reported speech in the narrative.

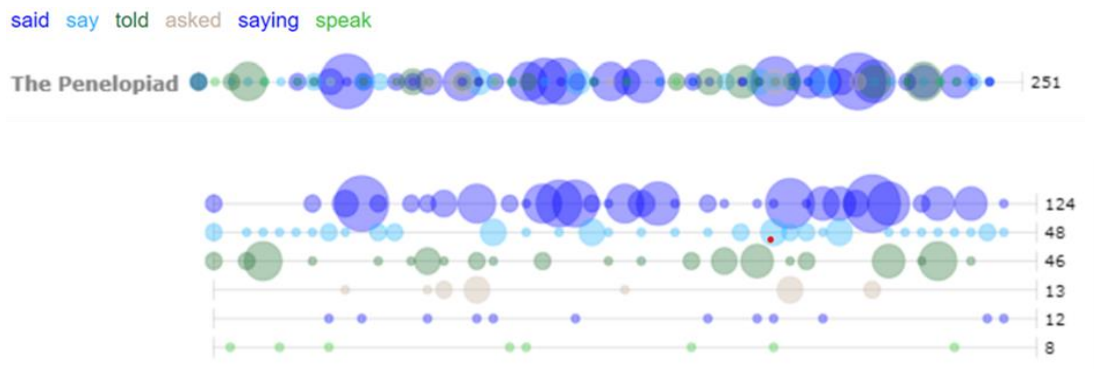


Figure 4: The distribution of the verbal processes in “The Penelopiad” by M. Atwood.

One can assume mutual exclusiveness of mental and verbal verbs. If we compare the distribution of the most frequent mental and verbal verb forms across the text segments, we will see some correlation (Figure 5). The Pearson correlation coefficient was obtained for *said* and *know*, amounting to -0.359, which indicates a moderate inverse proportional relationship in the use of these verb forms.

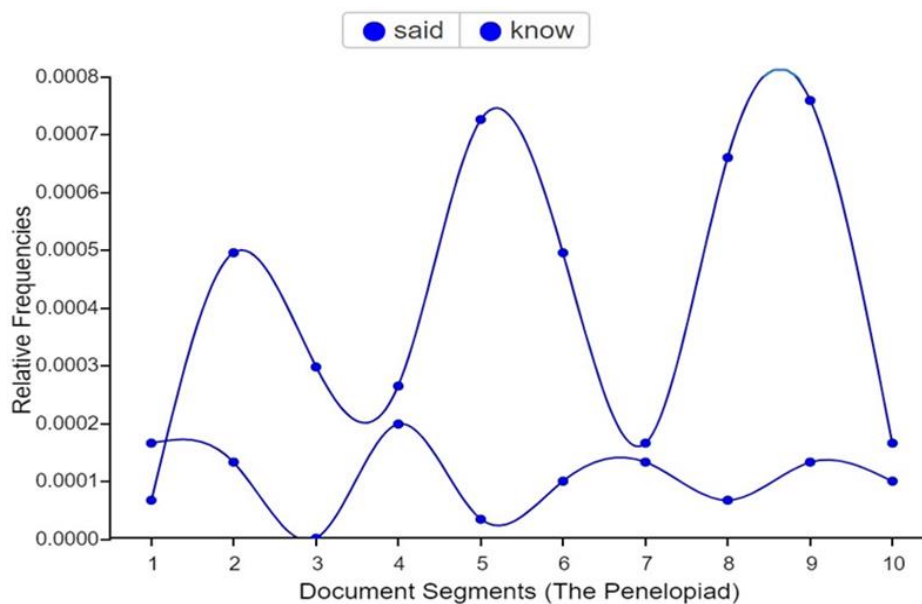


Figure 5: The distribution of *said* and *know* in “The Penelopiad” by M. Atwood.

To discover transitivity patterns of the most frequent verbs, we have identified their typical collocations with the subjects and objects in the text under study. Thus, the most frequent collocations with the verbs are with the subjects: *I know*, *he said* (see Figure 6). On the whole, the transitivity of the mental and verbal processes is rather low since no action transference on the object occurs.



Figure 6: The collocations of *said* and *know* in “The Penelopiad” by M. Atwood.

One can observe the dominance of the verbal processes over the mental ones, which may indicate a certain degree of exteriorization in the narrative, but comparing the frequency of use of these verbs in the section “Fiction” established on the basis of the general corpus (check Table 1), we do not find any significant deviations. The narrator does not directly express her thoughts and feelings but rather tells a story.

The distribution of the existential processes in the novel expressed in the structures *There is/are/was/were* is shown in Figure 7. The findings correspond to the above-mentioned observations by M. A. K. Halliday: their frequency prevails at the beginning of the novel.

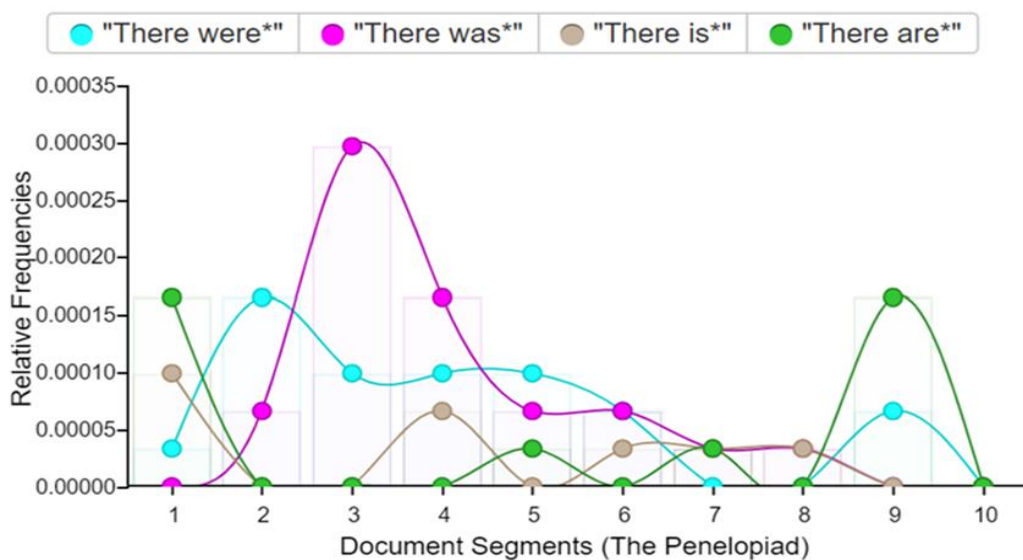


Figure 7: The distribution of the existential processes in “The Penelopiad” by M. Atwood.

The distribution of the behavioral processes across the 10 text segments of “The Penelopiad” by M. Atwood is presented in Figure 8.

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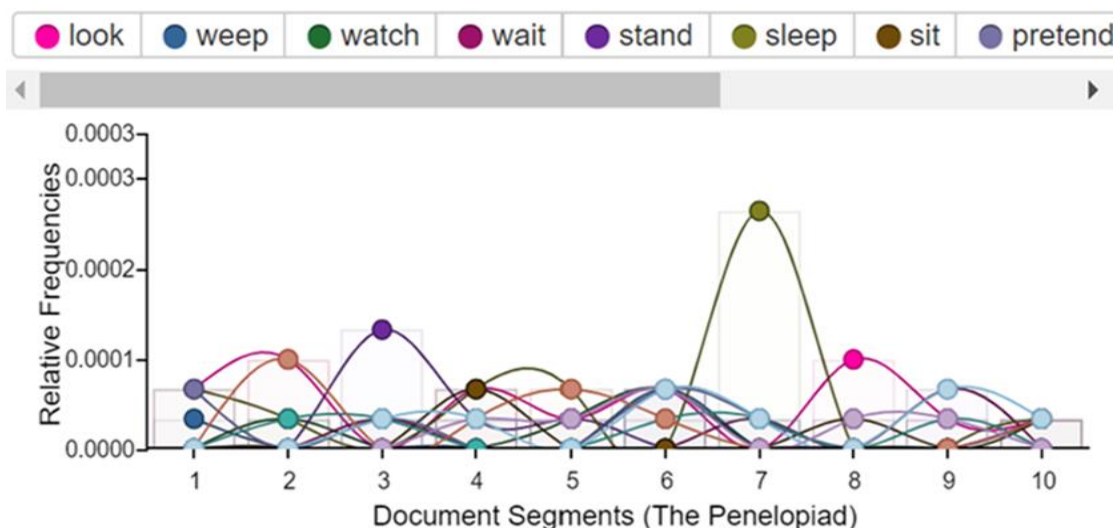


Figure 8: The distribution of the behavioral processes in “The Penelopiad” by M. Atwood.

The distribution of the behavioral processes in the novel is mostly uniform, with a few exceptions. For instance, in segments 6-8, we observe an increased frequency of the verb *sleep*. In general, behavioral processes have a lower level of transitivity, describing the background of the main action, conveying a reaction to the action, for example: *When things get too dismal, and after I've done as much weeping as possible without turning myself into a pond, I have always - fortunately - been able to go to sleep. And when I sleep, I dream* [27].

The distribution of the relational processes is even in all the segments of the text, but their identification is difficult due to the polysemy of the prototypical lexemes *be* and *have*, which can denote other types of processes.

The distribution of the material processes is also even, with the prevalence of some verbs in certain segments, e.g., *take* at the end of the novel. Although the frequency of individual verbs denoting material processes is relatively low, their variability is higher, as the list of these verbs is wider. An important feature of these verbs is their higher degree of transitivity, manifested by the variety of objects in the role of the Goal.

6. Discussion

The applied computer-aided methodology to identify the realization of the ideational metafunction reflecting the construal of the narrator’s experience is only a preliminary stage of the qualitative discourse analysis.

The top-frequency verbs representing different process types identified in accordance with the classification by M. A. K. Halliday and subject to the correlation analysis mostly comply with the expectations:

1. The existential verbs prevail at the beginning of the text.
2. The material verbs are the most diverse and distributed evenly throughout the text, featuring the highest degree of transitivity.
3. The verbal and mental verbs show a tendency towards inverse correlation.
4. The behavioral verbs are used as a means of backgrounding.
5. The relational verbs need either further manual research or more sophisticated techniques for their automated sense disambiguation.

The proposed methodology of the computer-aided narrative analysis appears to have the following advantages:

1. It provides an objective, statistically verified text analysis.
2. Data clustering reveals latent patterning of linguistic features in the text, which requires further attention on the part of discourse analysts.
3. The study of collocations of the verbs with their arguments is indispensable for the identification of the transitivity patterns and the roles of the arguments (actants) in the structure of the narrative, as well as in structuring the contextual meaning of verbs.
4. Due to the affinity of the structure of the narrative and the structure of the process from the standpoint adopted in this paper, the methodology applied here and the findings can be of use both for the study of English grammar and text, shedding light on the underlying mental representations.
5. The conducted analysis reveals the advantages of the Voyant Tools in conducting the analysis of the language data distribution across the text, making use of a variety of visualization tools.
6. The understanding of the alternation and mutual correlation of the processes in the literary text can feed future text generation applications.

Nonetheless, the proposed method is not devoid of the shortcomings and caveats that need to be addressed in the future. Here, we only specify some of them:

1. The identified distribution of the verbs and alternating process types does not fully reflect the aspectual semantics of the verbs. Some processes have a longer duration and can overlap with others, and some verbs denote repeated actions, so their representation as separate points on a graph or visualization by bubbles is not entirely correct, for example:
 - (1) *She kept saying that I was certainly very young* [27].
 - (2) *I did a lot of secluded weeping in those early days* [27].
 - (3) *I had not been attempting to catch men like flies: on the contrary, I'd merely been trying to avoid entanglement myself* [27].

2. The study of the linear distribution of the text data does not take into consideration Heaps' Law, according to which the rate of the count of distinct words available in text gradually slows down, and the size of the vocabulary increases exponentially. The implications of this principle are that since the majority of the words are encountered at the beginning of the text, the words added at the end of the text have a higher functional value, even though their frequencies can be lower. For instance, in the novel under study, the verb blame appears in the final segments, conveying the message of the narrator – blaming violence and restoring justice. Though the model easily identifies verb forms and their functioning, it still fails to handle the issue of verb polysemy and word sense disambiguation. Polysemous verbs can belong to different lexicosemantic groups and represent different context-sensitive process types, which needs further research and more robust techniques of automated lexical analysis.

7. Conclusions

The realization of the ideational metafunction, i.e., the construal of the narrator's experience, in the novel "The Penelopiad" by M. Atwood is manifested by the functional grammatical category of transitivity, which is realized through the transfer of an action to the object and the identification of different process types. The temporal structure of the narrative as a series of consecutive linear events is mainly conveyed by material processes profiled by the corresponding verbs. The descriptive structure denoting the context in which the events in the story take place is normally expressed by means of other process types characterized by lower transitivity: existential, relational, and behavioral.

The conducted statistical analysis and the application of the Voyant Tools proved to be effective in studying the linear assembly of different types of processes in the narrative. In general, we can observe the tendency that all types of processes are represented in all the segments of the text more or less evenly, but with different frequencies of individual verbs (verb forms).

The analysis of the data correlation revealed their interdependencies and intricate semantic and structural relations within the text, oftentimes subliminal.

The clustering of the data appears to show the prominence of certain units performing the function of foregrounding.

The prospects for further research lie in a deeper analysis of transitivity as a functional grammatical category relevant to discourse studies and narratology, and in a more fine-grained identification of different types of processes and their interaction within the narrative. The elaborated computer-aided methodology of narrative/text analysis can be applied to other literary and non-literary works and yield promising results in terms of comparative text analysis.

In terms of computer-aided narrative/text analysis, we can pinpoint the need for applying more sophisticated machine learning methods and techniques, such as neural networks and transformer-based models, for word sense disambiguation.

References

- [1] M. A. K. Halliday, C. Matthiessen, *Halliday's Introduction to Functional Grammar*, 4th ed., Routledge, London, 2014.
- [2] M. A. K. Halliday, *Computational Linguistics and Quantitative Studies*, Continuum, London and New York, 2005.
- [3] M. O'Donnell, J. Bateman, SFL in computational contexts: A contemporary history, in: R. Hasan, C. M. I. M. Matthiessen, J. J. Webster (Eds.), *Continuing Discourse on Language: A Functional Perspective*, volume 1, Equinox, London, 2005. pp. 343–382.
- [4] C. M. Matthiessen, B. Wang, Y. Ma, I. N. Mwinlaaru, *Computational Linguistics*, in: *Systemic Functional Insights on Language and Linguistics*, The M. A. K. Halliday Library Functional Linguistics Series, Springer, Singapore, 2022, pp. 125–145. doi:10.1007/978-981-16-8713-6_5
- [5] J. Bateman, M. O'Donnell, *Computational linguistics: the Halliday connection*, in: J. J. Webster (Ed.), *The Bloomsbury Companion to M. A. K. Halliday*, Bloomsbury, London and New York, 2015, pp. 453–467.
- [6] J. Bateman, D. McDonald, T. Hiippala, D. Couto-Vale, E. Costetchi, *Systemic Functional Linguistics and computation: new directions, new challenges*, in: G. Thompson, W. L. Bowcher, L. Fontaine, D. Schönthal (Eds.), *The Cambridge Handbook of Systemic Functional Linguistics*, Cambridge Handbooks in Language and Linguistics, Cambridge University Press, Cambridge, 2019, pp. 561–586.
- [7] J. J. Webster, *Text processing using the Functional Grammar Processor (FGP)*, in: M. Ghadessy (Ed.), *Register Analysis: Theory and Practice*, Pinter, London and New York, 1993, pp. 181–195.
- [8] M. A. K. Halliday, C. Matthiessen, *Construing Experience through Meaning: A Language-Based Approach to Cognition*. Open Linguistics Series, Continuum, London, 1999.
- [9] Ch. Fillmore, *Frame semantics and the nature of language*, in: *Annals of the New York Academy of Sciences: Conference on the Origin and Development of Language and Speech*, volume 280, 1976, pp. 20–32.
- [10] A. J. Greimas, *Structural Semantics. An Attempt at a Method*, University of Nebraska Press, 1983.
- [11] C. Bremond, *Logiqlle dll recit*, Editions du Seui, Paris, 1973.
- [12] R. Langacker, *Concept, Image, and Symbol: The Cognitive Basis of Grammar*, Walter de Gruyter, 2002.
- [13] W. Schmid, *Naration*, Walter de Gruyter, 2010.
- [14] L. Polanyi-Bowditch, *Why the whats are when: mutually contextualizing realms of narrative*, in: *Proceedings of the 2nd Annual Meeting of the Berkeley Linguistics Society*, 1976, pp. 59–77.
- [15] M. Bal, *Narratology: Introduction to the Theory of Narrative*, 2nd ed., University of Toronto Press Incorporated, Toronto, 1999.
- [16] P. J. Hopper, S. A. Thompson, *Transitivity in grammar and discourse*, *Language*. 56/2 (1980) 251–299. doi:10.2307/413757. JSTOR 413757.

- [17] A. Mahya, S. Ahangari, A study of ideational metafunction in Joseph Conrad's "Heart of Darkness": a critical discourse analysis, *English Language Teaching*, 9/4 (2016) 203–213. doi: 10.5539/elt.v9n4p203.
- [18] S. Opara, Transitivity systems in selected narrative discourse, *International Journal of Arts and Commerce*, 1/7 (2012) 109–121.
- [19] M. A. K. Halliday, Linguistic function and literary style: an inquiry into the language of William Golding's "The Inheritors", in: R. Carter, P. Stockwell (Eds.), *The Language and Literature Reader*, Routledge, London, 2008, pp. 19–28. doi: 10.4324/9781003060789
- [20] M. Mushtaq, T. Saleem, S. Afzal, A. Saleem, K.-W. Tong, A corpus-based ideational meta-functional analysis of Pakistan Prime Minister Imran Khan's speech at United Nations General Assembly, *Cogent Social Sciences*, 7/1 (2021) 1–17. doi:10.1080/23311886.2020.1856999.
- [21] F. Ghani, T. Saleem, S. Majeed, R. Batool, M. Aslam, A corpus-based comparative ideational meta-functional analysis of Pakistani English and UK English newspaper editorials on COVID-19, *Cogent Arts & Humanities*, 9/1 (2022). doi:10.1080/23311983.2022.2114619.
- [22] I. A. Bhatti, M. Azher, S. Abbas, Syntactic deconstruction of Beckett's dramatic text: a transitivity analysis of "Waiting for Godot", *International Journal of English Linguistics*, 9/4 (2019) 93–106. doi: 10.5539/ijel.v9n4p93.
- [23] U. Ammara, R. Y. Anjum, The transitivity analysis of Woolf's "Kew Gardens": a corpus-based study, *Corporum: Journal of Corpus Linguistics*, 2/2 (2019) 16–37.
- [24] U. Ammara, R. Y. Anjum, M. Javed, A corpus-based Halliday's transitivity analysis of "To the Lighthouse", *Linguistics and Literature Review*, 5/2 (2019) 139–162. doi:10.32350/llr.52.05
- [25] O. Melnychuk, I. Bekhta, M. Tkachivska, Pearson correlation coefficient in studying the meaning of a literary text, in: *Proceedings of the 7th International Conference on Computational Linguistics and Intelligent Systems*, volume II: Computational Linguistics Workshop, April 20–21, 2023, Kharkiv, Ukraine, pp. 460–477.
- [26] I. Bekhta, Computer processing of verba sentiendi in Doris Lessing's fiction (using R), in: *Proceedings of the IEEE 18th International Conference on Computer Science and Information Technologies (CSIT)*, Lviv, Ukraine, 2023, pp. 1–4. doi:10.1109/CSIT61576.2023.10324104.
- [27] M. Atwood, *The Penelopiad*, Canongate Books Ltd, Edinburgh, UK, 2005.
- [28] G. Genette, *Figures of Literary Discourse*, Columbia University Press, New York, NY, 1982.
- [29] Voyant Tools. URL: <https://voyant-tools.org/>
- [30] The Strathy Corpus of Canadian English. URL: <https://www.english-corpora.org/strathy/>