

# NLP-based analysis of verb semantic cohesion in L2 writing: Interaction of genre and proficiency on verb networks

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## ABSTRACT

Natural language processing (NLP) is a computer-based approach to linguistic analysis that applies algorithmic techniques to textual data, enabling the extraction of complex patterns and the examination of language structures. In second language (L2) writing research, NLP techniques have facilitated increasingly sophisticated analyses of semantic features, extending beyond traditional structural measures to capture deeper mechanisms of meaning construction. While previous studies have explored various dimensions of L2 writing through NLP-based approaches, less attention has been given to how genre influences semantic cohesion, particularly in verb usage. This study investigates genre effects on verb semantic cohesion in L2 writing, using an NLP-based semantic network analysis of narrative and argumentative essays written by higher- and lower-proficiency L2 learners. The semantic network analysis identifies how verbs function as semantic anchors within constructions, illuminating cohesion patterns that reflect writers' conceptual organization. Results indicated that higher-proficiency writers demonstrated stronger semantic cohesion and more sophisticated verb usage in argumentative essays, characterized by denser and more interconnected verb networks. In contrast, their narrative essays showed less complex networks with concrete action verbs. Lower-proficiency writers exhibited less pronounced differentiation between genres, relying on a restricted range of verbs across both types of writing. These findings suggest that advanced L2 writing proficiency is marked by the ability to adapt verb usage to genre-specific demands, aligning with usage-based approaches to language learning. These findings are discussed in light of their potential implications for L2 writing instruction and assessment, emphasizing the importance of considering semantic cohesion and genre-appropriate verb usage.

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## 1. Introduction

In recent decades, the emergence of advanced computational techniques has enabled rapid and precise analysis of extensive learner corpus data, particularly in the assessment of linguistic structures as indicators of second language (L2) writing quality. This process has been pronounced in research examining the syntactic complexity of L2 writing. Studies in this area have developed and validated a wide range of indices that reliably capture the diversity and sophistication of structural units, including clauses, phrases, and argument structure constructions (e.g., [Biber et al., 2016](#); [Bulté & Housen, 2012](#); [Kyle & Crossley, 2018](#); [Lu, 2011, 2017](#); [Norris & Ortega, 2009](#); [Wolf-Quintero et al., 1998](#)). In addition, several studies have identified the interactive roles of learner-internal and learner-external

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factors, such as text genre, task complexity, modality, the writer's familiarity with the topic, motivation, and collaborative planning (e.g., Abdi Tabari & Wang, 2022; Casal & Kessler, 2020; Huang & Li, 2023; Kang & Lee, 2019; Li & Yu, 2024; Mostafa & Crossley, 2020; Kim & Ro, 2024; Pu et al., 2022; Yoon, 2017; Yoon & Polio, 2017; Zhang & Lu, 2022).

However, previous research has predominantly focused on structural features in learner essays, leaving the semantic dimensions of L2 writing relatively underexplored. This imbalance in research focus potentially limits our understanding of how learners develop their ability to convey meaning effectively in L2 writing, calling for the need to devote equal attention to both form and meaning (Crossley & McNamara, 2012). Exploring semantic features not only helps clarify how L2 learners' conceptual understanding of phrasal and clausal units influences their written production but also provides additional predictive power in assessing L2 writing quality and development (O'Donnell et al., 2013). To address these gaps, the current study investigates how L2 learners employ semantically cohesive verbs within specific argument structure constructions in written production, while also testing the potential effects of genre and L2 writing proficiency.

This study expands the scope of previous research in two major ways. First, our investigation into verb semantics in writing is firmly grounded in usage-based approaches to language learning (Bybee, 2008; Goldberg, 1995, 2006, 2019), which posit that language acquisition involves recognizing and internalizing conventionalized patterns in the combination of verbs and argument structure constructions (i.e., clause-level units of form-meaning pairings; Goldberg, 1995, 2006). According to this perspective, language learners gradually acquire knowledge of the distributional properties of verb-construction pairings, facilitating the induction of statistical regularities in their co-occurrence (Ellis et al., 2016; Goldberg, 1995, 2006, 2019; Robinson & Ellis, 2008; Tomasello, 2003).

One critical component of this statistical learning is the semantic coherence of verbs within constructions. Verb semantic cohesion refers to the degree to which verbs used within specific constructions are semantically related to one another (Ellis & Larsen-Freeman, 2009; Ellis et al., 2016). According to Ellis et al. (2016), verb semantic cohesion serves as a key indicator of constructional knowledge development, along with the frequency and contingency of verb-construction pairings, reflecting learners' ability to employ semantically consistent verbs that align with the core meanings of the constructions. Building on this theoretical framework, our study extends these insights to the context of L2 writing by employing verb semantic network analysis (e.g. Gries & Ellis, 2015; Wulff et al., 2007).

Additionally, this study seeks to examine the potential influence of text genre and writing proficiency on the semantic cohesion of verbs in L2 writing. A substantial body of research has explored genre effects in L2 writing, with a primary focus on the relationship between genre-specific cognitive complexity and linguistic complexity (e.g., Goh & Burns, 2012; Kim & Ro, 2024; Qin & Uccelli, 2016; Renandya & Nguyen, 2023; Yoon, 2017, 2021; Yoon & Polio, 2017; Zhang & Lu, 2022). Findings from these studies indicate that L2 learners tend to employ more complex linguistic structures in non-narrative genres, such as argumentative writing, than in narrative genres. Based on Robinson's Cognition Hypothesis (2001, 2003), this tendency is attributed to the greater cognitive demands of non-narrative genres, which necessitate higher levels of linguistic complexity.

However, it remains unclear whether this genre effect applies to the semantic aspects of L2 writing, particularly regarding verb semantic cohesion, and how it interacts with L2 writing proficiency. Among many linguistic elements, verbs play a central role in structuring discourse, encoding event relations, argument structure, and information flow (Gentner, 1982; Levin, 1993). Given their fundamental role in establishing coherence within a text (Gries & Ellis, 2015), it is plausible that genre effects influence the semantic cohesion of verbs as well. Moreover, since the ability to construct cohesive texts often requires greater attentional resources and proficiency (Kormos, 2011), the genre effect on verb semantic cohesion is likely to be more pronounced among higher-proficiency writers, who tend to possess a broader repertoire of linguistic resources and greater genre awareness.

To test these hypotheses, we employed natural language processing (NLP) techniques to analyze verb semantics within individual constructions in narrative and argumentative essays produced by 919 college-level L2 learners with beginner and upper-intermediate proficiency levels. This study investigates whether the previously observed genre effect extends to the semantic cohesion of verbs within individual constructions. Furthermore, it explores whether these genre effects manifest differently across L2 writers with different proficiency levels. Based on usage-based perspectives, we specifically aim to determine whether advanced L2 writers exhibit greater flexibility in their verb choices and semantic relationships across different genres compared to less proficient writers.

## 2. Literature review

### 2.1. Usage-based approaches to verb and construction acquisition

Through cumulative language experience, learners acquire knowledge about both the form and meaning of various linguistic units. In usage-based constructionist approaches, these form-meaning correspondences are referred to as *constructions*, which serve as fundamental building blocks that scaffold language development (Bybee, 2008; Goldberg, 1995, 2006, 2019; Goldberg & Casenhiser, 2008; Sethuraman & Goodman, 2004; Tomasello, 2003). Among the diverse types of constructions, this study specifically focuses on argument structure constructions (or simply constructions), which represent clausal units that denote the core meanings of events via consistent syntactic configurations (Goldberg, 1995, 2006, 2019).

The development of constructional knowledge is well-documented in research on monolingual children, who demonstrate the ability to abstract schematic grammatical categories of constructions from specific exemplars of usage, driven by cognitive processes and linguistic input (Ellis, 2006, 2008; Goldberg et al., 2004; Ninio, 1999; Tomasello, 2003). For example, children show conventionalized patterns in their use of constructions to convey a variety of meanings, such as intransitive actions performed by agents (intransitive construction), movement (intransitive motion construction), actions affecting objects (transitive construction), passive states (passive construction), actions causing a change of location (caused-motion construction), and transfer of possession

(ditransitive construction), as illustrated in (1).

(1)

- a. The ball bounced. (*intransitive*)
- b. The ball rolled into the hole. (*intransitive motion*)
- c. Peter rolled the ball. (*transitive*)
- d. The ball was rolled (by Peter). (*passive*)
- e. Peter rolled the ball into the hole. (*caused motion*)
- f. Peter gave Nancy the ball. (*ditransitive*)

As children acquire constructional knowledge, they also develop sensitivity to the statistical regularities underlying the link between verbs and the constructions in which they appear. Within the rich linguistic input, certain verb cues become distinctively associated with particular constructional categories, rendering their co-occurrence highly contingent and thereby facilitating the learning of these associations (Ellis, 2006; Ellis et al., 2013; Gries & Ellis, 2015). This form-meaning contingency between verbs and constructions is primarily determined by both the probability of their co-occurrence in the input and their semantic compatibility (Ellis & Ferreira-Junior, 2012; Gries & Ellis, 2015). For instance, the verb *disappear* is frequently attested in intransitive (e.g., *The rabbit disappeared*) and intransitive motion constructions (e.g., *The rabbit disappeared into the forest*), but is rarely, if ever, found in transitive (e.g., \**The magician disappeared the rabbit*) or caused-motion constructions (e.g., \**The magician disappeared the rabbit into the hat*). Furthermore, the inherent intransitivity of the verb *disappear* aligns it more closely with intransitive constructions, enhancing its semantic compatibility with these structures. The knowledge of these form-meaning contingencies of verbs and constructions allows speakers to produce grammatically correct and semantically appropriate utterances while effectively avoiding overgeneralizations (e.g., Ambridge, 2013; Ambridge et al., 2015; Ellis, 2002; Goldberg, 2006; Perek & Goldberg, 2017; Robenalt & Goldberg, 2015).

## 2.2. Contingency of verb-construction mapping in L2 acquisition

The statistical learning mechanisms underlying L1 acquisition are similarly applicable to L2 acquisition. As L2 learners advance in proficiency, they continually refine and update their knowledge of form-meaning contingencies, resulting in increasingly sophisticated use of verbs and constructions. A growing body of empirical research supports this pattern, particularly in L2 writing contexts, where higher-proficiency writers tend to use more conventionalized, native-like associations between verbs and constructions (e.g., Ellis & Ferreira-Junior, 2012; Ellis & Larsen-Freeman, 2009; Kim & Hwang, 2022; Kyle & Crossley, 2017; Li & Yu, 2024; Mostafa & Crossley, 2020; Römer et al., 2020).

While these findings demonstrate the strong relationship between L2 writing proficiency and the sophisticated use of verb-construction associations, it is important to note that these analyses predominantly relied on probabilistic measures derived from native speaker usage, such as frequency and association strength. Considering that the acquisition of verb-construction contingencies is also influenced by semantic compatibility, it is hypothesized that L2 learners' sensitivity to the semantic aspects of verb-construction combinations also plays a crucial role in their writing development.

Addressing this gap, recent studies have utilized advanced NLP techniques to capture more subtle aspects of semantic compatibility between verbs and constructions. A pivotal study in this regard is Gries and Ellis (2015), which proposed the use of semantic network analysis as a measure of semantic cohesion of verbs within particular constructions (see also Wulff et al., 2007). This method assesses the degree of semantic relatedness among verbs within a given construction, providing insights into how verb semantic clusters are organized around the core meanings of particular constructions in speakers' mental lexicon (see the Method section for further details).

Extending this technique to the assessment of L2 writing, the current study explores the semantic characteristics of verbs within individual constructions, aiming to offer a more comprehensive view of the verb-construction mappings that L2 writers develop. Importantly, we investigate verb semantic cohesion across different genres, specifically narrative and argumentative texts, driven by the observation that genre significantly influences linguistic complexity in L2 writing. We hypothesize that while this genre effect will similarly extend to verb semantic cohesion in L2 writing, it will also interact with L2 writing proficiency. In the following section, we provide a brief overview of genre effects in L2 writing and discuss their implications for the use of verbs and constructions.

## 2.3. Theoretical perspectives on genre effects in L2 writing

As a socio-cognitive construct, genre plays an instrumental role in determining linguistic choices and discourse organization (Hyland, 2007; Swales, 1981, 1990). Language users are expected to adopt genre-specific, conventionalized linguistic features that are attuned to particular discourse contexts. In the context of L2 writing, the influence of genre manifests in various linguistic domains, including lexical diversity, syntactic complexity, and rhetorical organization (Biber & Conrad, 2009; Tardy, 2011; Yoon, 2017).

Central to the current study is the distinction between narrative and non-narrative genres, each fulfilling distinct communicative functions and imposing unique cognitive and linguistic demands on L2 writers (Beers & Nagy, 2009; Berman, 2008; Berman & Nir-Sagiv, 2009; Berman & Slobin, 2013; Ravid & Berman, 2010). Narratives, which recount events or actions in chronological order, often require the use of past tense constructions, action verbs, and temporal sequencing devices (Berman & Nir-Sagiv, 2009; Berman & Slobin, 2013). In contrast, non-narrative genres, such as argumentation, focus on conveying concepts, ideas, or arguments, necessitating the use of more abstract verbs, longer syntactic structures, and logical connectives to maintain cohesion (Uccelli et al., 2013).

These requirements can significantly influence the linguistic complexity within texts. A key theoretical framework for understanding such genre-specific linguistic variations is Robinson's Cognition Hypothesis (2001, 2003). This hypothesis posits that increased cognitive demands lead to greater linguistic complexity. Since non-narrative genres are generally perceived as more

cognitively demanding than narrative genres (Weigle, 2002), the Cognition Hypothesis predicts that non-narrative texts will exhibit higher levels of linguistic complexity.

#### 2.4. Empirical research on genre effects in L2 writing

Empirical studies on L2 writing have demonstrated that writers display greater syntactic complexity, sophistication, and use of abstract language in argumentative essays compared to narrative essays (e.g., Kim & Ro, 2024; Lu, 2011; Qin & Uccelli, 2016; Renandya & Nguyen, 2023; Yoon & Polio, 2017; Zhang & Lu, 2022). For instance, Lu (2011) compared syntactic complexity between narrative and argumentative essays written by L1-Chinese L2-English learners. He found that argumentative texts contained longer clauses, a higher frequency of complex nominals, and more coordinate phrases than narrative essays. Similarly, in analyses of narrative and argumentative essays produced by L1-Korean L2-English learners, Kim and Ro (2024) observed that argumentative essays exhibited less frequent verbs and constructions, less frequent verb-construction combinations, stronger associations between verbs and constructions, and a greater variety of construction types.

The previously observed genre effects on syntactic complexity and sophistication suggest that genre-specific requirements might also extend to the semantic aspects of L2 writing, particularly regarding the semantic cohesion of verbs within constructions. Specifically, the functional demands inherent in each genre could influence the selection and distribution of verbs, potentially leading to greater semantic cohesion in argumentative compared to narrative texts. In narrative texts, individual constructions might exhibit lower semantic cohesion due to the variety of verbs used to describe diverse events and character actions. Conversely, argumentative texts might exhibit higher semantic cohesion, with abstract or cognitive verbs clustering more tightly within constructions, reflecting the genre's emphasis on logical reasoning, evaluation, and stance-taking (Uccelli et al., 2013). Consequently, verbs used in argumentative texts may form denser semantic networks, sharing more semantic features associated with reasoning, evaluation, or persuasion.

This hypothesized genre effect may further interact with L2 proficiency to influence the patterns of verb semantic cohesion. More proficient L2 writers are likely to demonstrate greater flexibility in adapting their verb choices to genre-specific constraints, potentially resulting in more pronounced differences in semantic cohesion between narrative and argumentative texts (e.g., Crossley et al., 2016). In contrast, less-proficient writers, with a limited repertoire of verbs and constructions at their disposal and a less developed understanding of genre conventions, are expected to rely more heavily on a limited set of high-frequency verbs across both genres, leading to less distinct patterns of verb semantic cohesion between narrative and argumentative texts.

### 3. The current study

Building on previous research on genre effects in L2 writing and the theoretical frameworks of usage-based approaches and the Cognition Hypothesis, this study investigates how genre and proficiency influence verb semantic cohesion in L2 writing. Given the fundamental role of verbs in structuring discourse (Gentner, 1982; Levin, 1993) and establishing coherence within a text (Gries & Ellis, 2015), we hypothesize that the previously observed genre effects on syntactic complexity will extend to verb semantic cohesion. Specifically, we expect argumentative essays to exhibit higher levels of semantic cohesion than narrative essays, due to the increased cognitive demands typically associated with argumentative writing (Robinson, 2001, 2003). Furthermore, we predict that these genre effects will be more pronounced among higher-proficiency writers. This expectation is grounded in usage-based approaches to language learning, which propose that as learners gain more experience with the target language, they develop a more sophisticated understanding of how verbs and constructions function within various communicative contexts (Ellis et al., 2016; Tomasello, 2003).

To test these hypotheses, the study poses the following research questions:

1. To what extent does the semantic cohesion of verbs within individual constructions differ between narrative and argumentative essays?
2. How does L2 proficiency influence the semantic cohesion of verbs within constructions across genres?

**Table 1**  
Overview of the YELC data.

Genre	Proficiency group	Number of words		Number of clauses	
		Mean	SD	Mean	SD
Narrative	Higher ( <i>n</i> = 459)	102.8	15.5	15.5	3.5
	Lower ( <i>n</i> = 460)	80.7	32.5	12.9	5.7
Argumentative	Higher ( <i>n</i> = 459)	288.2	39.6	44.1	8.1
	Lower ( <i>n</i> = 460)	156.5	92.3	25.7	15.4

## 4. Method

### 4.1. Corpus data

#### 4.1.1. Corpus description

We retrieved writing samples from the Yonsei English Learner Corpus (YELC; [Rhee & Jung, 2012](#)), which comprised narrative and argumentative essays written by Korean-speaking students at Yonsei University. Each participant supplied one narrative and one argumentative essay, resulting in a total dataset of 1838 writing samples. [Table 1](#) provides a summary of the samples used in the current study, categorized by genre and proficiency group.

#### 4.1.2. Data collection procedure

According to the corpus compilers, the data collection process was designed to closely mirror the test administration format of the TOEFL iBT. During data collection, each participant completed computer-based writing tasks within a 1-h session, which included both narrative and argumentative writing tasks. The narrative prompt required students to share personal experiences on familiar topics, such as their favorite high school extracurricular activity or recent travel experiences. On the other hand, the argumentative task required them to engage in academic discourse on specific issues, such as the debate over banning smoking in public places. A complete list of essay topics for each genre is available in [Appendix A](#) in the supplementary materials.

#### 4.1.3. Essay evaluation

Following the collection of the essays, trained raters, comprising both native English speakers and highly proficient English learners, evaluated each essay using the Common European Framework of Reference (CEFR, [Council of Europe, 2011](#)) rubric. Each essay was subsequently stratified into one of the nine proficiency levels: A1, A1+, A2, B1, B1+, B2, B2+, C1, C2. To ensure clear distinctions between proficiency levels, we selected 460 participants from the A1, A1+, and A2 levels and categorized them as the lower-proficiency group, and 459 participants from the B2 and B2+ levels to form the higher-proficiency group.<sup>1</sup> According to the CEFR level descriptors, the lower-proficiency group consists of basic or beginner writers who can produce simple sentences on personal topics using basic connectors, express likes and dislikes, and write brief notes about immediate needs. In contrast, the higher-proficiency group consists of independent or upper-intermediate learners who are capable of writing clear, detailed texts on various subjects within their area of expertise, synthesizing information from multiple sources, and effectively expressing opinions while engaging with the views of others.

#### 4.1.4. Data preparation

Since our primary focus was on learners' use of verb types within particular constructions, we corrected spelling errors in the essays, which helped improve verb lemmatization and ensure the accuracy of our automatic analysis (e.g., [Zhang & Lu, 2022](#)).

### 4.2. Construction identification and verb semantic network analysis

Before conducting the verb semantic network analysis, we first identified key constructions within the written samples, employing a construction classification algorithm outlined by [Hwang et al. \(2020\)](#). This initial step involved the application of several Python-based NLP tools to analyze and classify construction types in the text samples. The analysis began with sentence segmentation, conducted using the Natural Language Toolkit (NLTK; [Bird et al., 2009](#)), an open-source Python library widely used for NLP tasks, available at <https://www.nltk.org/>. Using NLTK, we decomposed each sample text into individual sentences. Following segmentation, we extracted syntactic features from each sentence using spaCy ([Honnibal & Montani, 2019](#)). This extraction process involved a series of tasks: tokenization, which divided sentences into clauses<sup>2</sup>; lemmatization, which reduced words within each clause to their base or lemma forms; part-of-speech tagging, where each token was labeled with its corresponding syntactic category; and dependency parsing, which identified the syntactic relationships among tokens, capturing the underlying argument structures of each clause.

Based on the syntactic dependency information obtained from these processes, each clause was classified into one of eleven primary construction types. To ensure a robust and meaningful analysis, we further narrowed our focus to six specific constructions that exhibited high frequency and contained an adequate number of verb instances within the samples, making them suitable for comprehensive network analysis. The classification algorithms for these six constructions are illustrated in (2).

(2)

- a. Intransitive: [Subject] + [Verb] + (Optional Adverbial Phrase)
  - b. Intransitive motion: [Subject] + [Verb] + [Path/Location Prepositional Phrase]
- (continued on next page)*

<sup>1</sup> While our dataset included essays from C1 and C2 levels, we chose to exclude them from our higher-proficiency group due to the limited number of samples (37 essays at C1 and 2 essays at C2). Including these levels could have introduced unnecessary heterogeneity into our analysis, potentially skewing the results. By focusing on the B2 and B2+ levels in the higher-proficiency group, we ensured a balanced comparison between proficiency groups while maintaining a substantial sample size for statistical analysis.

<sup>2</sup> In this study, we define clauses following the approach used in [Kyle \(2016\)](#), which includes both finite and non-finite clauses. This definition was chosen to capture the characteristics of argument structure constructions, which can manifest in both finite and non-finite forms.

(continued)

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- c. Transitive: [Subject] + [Verb] + [Direct Object] + (Optional Adverbial Phrase)  
d. Passive: [Subject] + [Auxiliary Verb] + [Past Participle]  
e. Caused-motion: [Subject] + [Verb] + [Direct Object] + [Path/Location Prepositional Phrase]  
f. Ditransitive: [Subject] + [Verb] + [Indirect Object] + [Direct Object].
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The validity of this classification algorithm was confirmed through a comparison with human-annotated classifications, as reported in Hwang et al. (2020).<sup>3</sup> This comparison demonstrated high efficacy, achieving a recall of 0.82, precision of 0.86, and an F1 value of 0.82. Detailed information about the construction classification algorithms and their applications in research can be found at <https://haerimhwang.github.io/tools/English-constructional-diversity-analyzer>.

For each of the identified constructions, we conducted a semantic network analysis of the verbs used within them, following a structured approach based on Gries and Ellis (2015). We began with verb tokenization using the NLTK package, ensuring a precise identification of verbs across the dataset. For an accurate comparison of semantic properties of verbs, we lemmatized verb forms using the *WordNetLemmatizer*, which draws on the WordNet lexical database (Pedersen et al., 2004). Subsequently, to explore and quantify the semantic relationships between the lemmatized verbs, we utilized the WordNet Path Similarity measure, which assesses the semantic similarity between verb synsets on a scale from 0 (no similarity) to 1 (identical synset). Using this similarity data, we constructed undirected graphs for each construction, using the *networkx* package (Hagberg et al., 2008). In these graphs, nodes represented individual verbs, while edges reflected strong semantic similarities, as determined by the Path Similarity measure. To further elucidate the internal structure of these networks, we applied the Louvain algorithm (Blondel et al., 2008), identifying communities of semantically related verbs and color-coding them for clarity. These visualizations provided a detailed illustration of the overall network structure, highlighting prominent semantic clusters and thus allowing for assessing the semantic cohesion among verbs within each construction (Gries & Ellis, 2015).

To quantitatively assess verb semantic cohesion within the constructions, we calculated betweenness centrality for each construction across our sample data. We specifically chose this metric for its distinctive utility among various measures of verb semantic cohesion, including network density, average clustering, closeness centrality, Katz centrality, and degree centrality (Baronchelli et al., 2013; de Nooy et al., 2018). Betweenness centrality, grounded in network theory, evaluates the extent to which a particular node (i.e., verb) functions as a crucial bridge within the network, facilitating connections along the shortest paths between other nodes (Freeman, 1977; Newman, 2010). This measure is particularly useful for understanding how learners expand constructional knowledge, as verbs with high betweenness centrality facilitate integrating new verbs into existing patterns. Moreover, focusing on this metric allows for meaningful comparisons with previous studies that have employed it (e.g., Ellis et al., 2013; Ellis & Ferreira-Junior, 2009; Gries & Ellis, 2015).

A verb network exhibiting high betweenness centrality values indicates that certain verbs play a pivotal role as semantic anchors, linking disparate parts of the network. This connectivity enhances the overall coherence and cohesion of the semantic structure within the text (Gries & Ellis, 2015). The betweenness centrality of a node  $v$  is calculated using the following formula:

$$C_{B(v)} = \sum_{\{s \neq v \neq t\}} \frac{\sigma_{st}(v)}{\sigma_{st}}$$

- $s$  and  $t$  are different nodes in the graph, distinct from  $v$
- $\sigma_{st}$  represents the total number of shortest paths from node  $s$  to node  $t$
- $\sigma_{st}(v)$  represents the number of those shortest paths that pass through node  $v$

#### 4.3. Statistical analysis

To investigate the potential effects of genre and proficiency on verb semantic cohesion, we employed a linear mixed-effects regression model (Bates et al., 2015) to estimate betweenness centrality values conditioned by the interaction of two fixed effects: genre (argumentative, narrative) and proficiency group (higher, lower). Each fixed factor was deviation-coded, with -0.5 assigned to argumentative essays and the higher group, and 0.5 assigned to narrative essays and the lower group. The model also included participants and constructions as random effects to account for individual variability and construction-specific influences. We initially constructed the maximal random effects structure, including by-participant and by-construction random slopes and intercepts for genre and proficiency group. However, due to issues with non-convergence, we simplified the model by removing the by-construction random slope. P-values were derived using the *lmerTest* package (Kuznetsova et al., 2016). In case

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<sup>3</sup> Since Hwang et al. (2020) validated their classification accuracy using the American National Corpus, which contains native English writing, their results may not directly apply to our learner data. To address this concern, we extracted a random sample of 100 sentences from our dataset and compared the automatic analysis results with human annotations. This analysis yielded high accuracy rates, with a recall of 0.96, a precision of 0.97, and an F1 value of 0.96. These results indicate that the automatic analysis tool performs well on our L2 learner corpus as well.

of a significant interaction between genre and proficiency, we further conducted pairwise comparisons using the *emmeans* package (Lenth, 2018). Tukey adjustments were applied to account for multiple comparisons. All statistical modeling was performed using R version 4.3.3 (R Core Team, 2024).

## 5. Results

**Table 2** provides the descriptive statistics for the betweenness centrality values across the different genre and proficiency groups, followed by a jitter plot in **Fig. 1**.

The descriptive statistics revealed an opposite trend between the two proficiency groups. Specifically, for the higher-proficiency group, betweenness centrality values were notably higher in the argumentative compared to the narrative genre, whereas the lower-proficiency group exhibited higher values in the narrative genre.

To scrutinize these patterns in detail, we turned to the results of the mixed-effects model, which are summarized in **Table 3**.

The results showed significant effects of both genre and proficiency on betweenness centrality values. The genre effect was driven by generally higher betweenness centrality values in argumentative compared to narrative genres. The proficiency effect was due to higher values among the higher-proficiency group compared to the lower-proficiency group. Crucially, there was a significant interaction between genre and proficiency. Pairwise comparisons showed distinct patterns across the proficiency groups. The higher-proficiency group exhibited significantly higher betweenness centrality values in argumentative than narrative genres ( $b = 0.000003$ ,  $SE = 0.000005$ ,  $p < .001$ ), indicating increased verb semantic cohesion in their argumentative essays. In contrast, for the lower-proficiency group, there was no significant difference between argumentative and narrative genres ( $b = -0.00001$ ,  $SE = 0.00005$ ,  $p = .101$ ), suggesting that this group maintained similar degrees of verb semantic cohesion across both genres.

Consistent with these statistical findings, the semantic networks for each construction show distinct patterns between argumentative and narrative essays across proficiency levels. A comprehensive overview of the semantic networks for all constructions is provided in **Appendix B**. To illustrate these patterns in detail, we present specific examples from the passive construction, which generally features a high level of linguistic sophistication and thus serves as an effective indicator of writing proficiency.

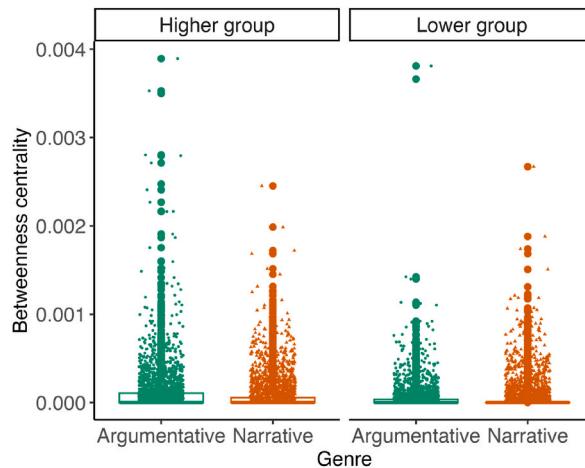
**Figs. 2 and 3** illustrate the verb semantic networks for passive sentences in argumentative essays produced by the higher-proficiency group, presenting both the complete and reduced versions. The intricate interconnections of verbs within the argumentative network (**Fig. 2**) suggest that higher-proficiency writers utilized a complex set of semantically related verbs when constructing arguments in the passive voice. This network, characterized by high semantic density and cohesion, reflects the specific demands of argumentative writing, which requires the articulation, support, and refutation of various stances. In the reduced version of this network (**Fig. 3**), which includes only three nodes from each community, verbs such as “allow,” “permit,” “protect,” “restrict,” and “support” further highlight the analytical and often confrontational nature of argumentation.

In contrast, the semantic network for narrative essays produced by this group features a more streamlined array of verbs, characterized by lower semantic density and reduced cohesion, as shown in **Fig. 4**. Unlike the argumentative network, where clear clusters of related verbs emerge, the narrative network exhibits a simpler structure, with semantic relationships centered around more basic and concrete actions. This linear organization reflects the sequential and event-driven nature of storytelling, where the narrative unfolds through the progression of events and the depiction of specific actions and experiences. For example, this network is dominated by semantically light verbs such as “get,” “take,” “call,” and “move,” emphasizing the focus on personal experiences and actions that are central to narrative discourse. As a result, this network demonstrates less density, indicating the genre-specific differences in verb usage and semantic cohesion among the higher-proficiency group.

The higher-proficiency group’s ability to differentiate their verb usage in the passive construction depending on genre is clearly illustrated in the sample writing provided in **Table 4**. In this writer’s argumentative essay, the passive constructions include verbs such as “eclipsed,” “notified,” “protected,” and “used,” which are examples of more sophisticated and abstract verbs typically associated with argumentative discourse. The use of these verbs indicates the writer’s effort to present and critically analyze different viewpoints, a hallmark of the complex and analytic nature of argumentative writing. In the narrative sample, in contrast, the same writer produced passive sentences involving verbs such as “permitted,” “called,” and “told” to describe personal experiences and situations focusing on the writer. This choice reflects a common rhetorical strategy in narrative writing, where the focus shifts to personal storytelling. Beyond verb selection, this writer also exhibited an understanding of the different functions of passive sentences across genres. In the argumentative essay, passives were strategically used to depersonalize statements, potentially enhancing the persuasiveness of the argument. Conversely, in the narrative sample, passives were utilized to highlight experiences and emotions, which could increase the reader’s empathy and engagement with the personal story being conveyed. These distinctions suggest the writer’s ability to adapt the use of passive voice according to the genre, adjusting their linguistic choices to align with the specific communicative goals of

**Table 2**  
Descriptive statistics.

Genre	Proficiency group	Betweenness centrality	
		Mean	SD
Narrative	Higher ( $n = 459$ )	0.000077	0.000187
	Lower ( $n = 460$ )	0.000060	0.000174
Argumentative	Higher ( $n = 459$ )	0.000109	0.000261
	Lower ( $n = 460$ )	0.000049	0.000156



**Fig. 1.** Betweenness centrality values across genre and proficiency groups.

**Table 3**  
Results of mixed-effects regression.

	B	SE	t	p
(Intercept)	0.00007	0.00003	2.314	0.069
Genre	-0.00001	0.000004	-2.780	0.005 <sup>a</sup>
Proficiency	-0.00004	0.000004	-10.447	<0.001 <sup>b</sup>
Genre × Proficiency	0.00004	0.000007	6.019	<0.001 <sup>b</sup>

<sup>a</sup>  $p < .01$ .

<sup>b</sup>  $p < .001$ .

argumentation and narration.

Turning to the lower-proficiency group, the semantic networks for passive verbs are shown in Fig. 5 for argumentative essays and Fig. 6 for narrative essays. Compared to the higher-proficiency group, the difference in both the size and complexity of the networks between argumentative and narrative essays is less pronounced. While the argumentative network is still larger than the narrative network, both networks contain a more limited range of verbs compared to those of the higher-proficiency group. In particular, the argumentative network does not exhibit the same level of verb density and semantic clustering observed in the higher-proficiency group. This reduced distinction between verbs used in argumentative and narrative contexts reflects the lower-proficiency group's tendency to rely on a more limited and generalized set of verbs across both genres. For instance, basic verbs such as "give," "use," "go," and "take" appear frequently in both networks, indicating a more uniform approach to verb usage in passive constructions, regardless of the writing genre. This observation suggests that the lower-proficiency group may not have fully developed the ability to differentiate and adapt their verb usage according to the specific rhetorical demands of argumentative versus narrative writing.

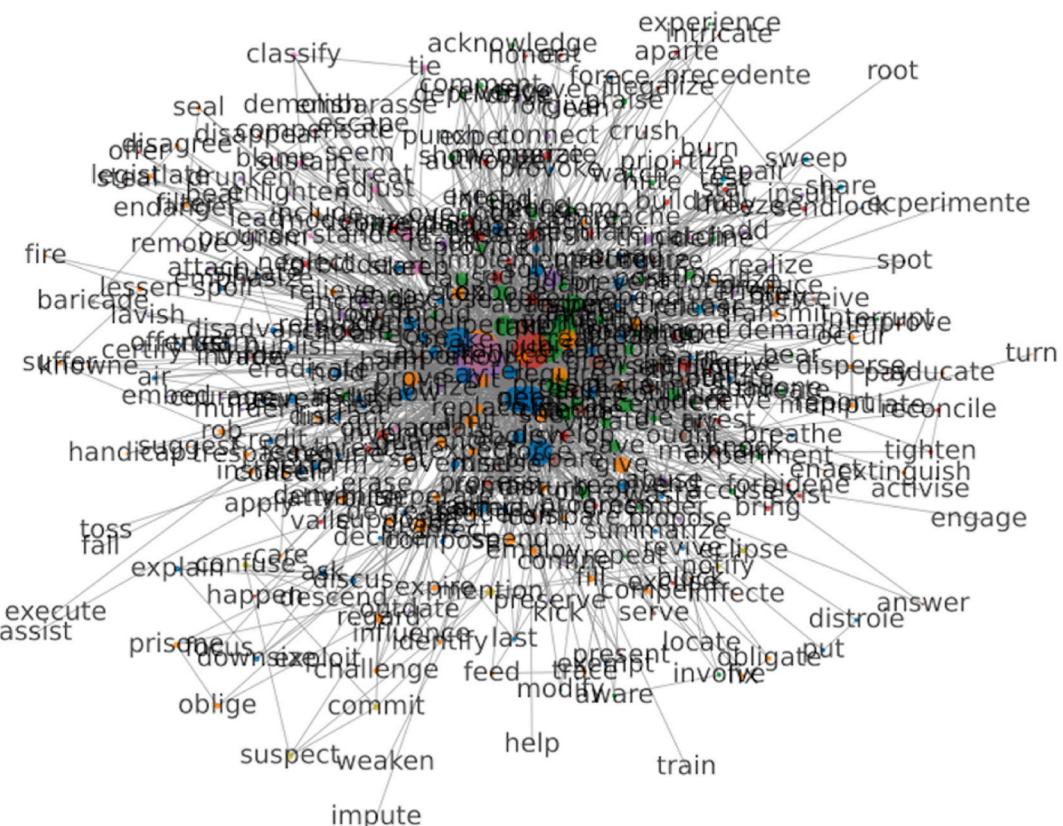
To illustrate the less pronounced distinction between the two genres in the lower-proficiency group, we analyzed sample passive sentences from a writer in this group, as presented in Table 5. Unlike the higher-proficiency learners, this writer does not demonstrate a significant differentiation in the use of passive voice between argumentative and narrative genres. The range of verbs employed in passive constructions is notably limited, and there are noticeable grammatical errors in both the formation of passives and the overall sentence structure, which are typical of lower-proficiency learners. Moreover, the strategic use of passive constructions to enhance rhetorical effect in argumentation or to emphasize an experiential focus in narration is less evident, falling short of increasing the persuasiveness of arguments or the vividness of narrative descriptions.

## 6. Discussion

The primary objective of the current study was to investigate the effect of genre on the semantic cohesion of verbs within constructions in L2 writing, along with its potential interaction with L2 writing proficiency. By employing a semantic network analysis that focused on verbs within various constructions across argumentative and narrative genres, we found that each proficiency group exhibited distinct patterns in verb semantic networks across genres.

### 6.1. Summary of findings

In the higher proficiency group, there was a marked contrast between argumentative and narrative essays. Argumentative essays exhibited stronger semantic cohesion, characterized by denser and more interconnected verb networks. These networks included a



**Fig. 2.** Semantic network for passive sentences in argumentative essays by the higher-proficiency group.

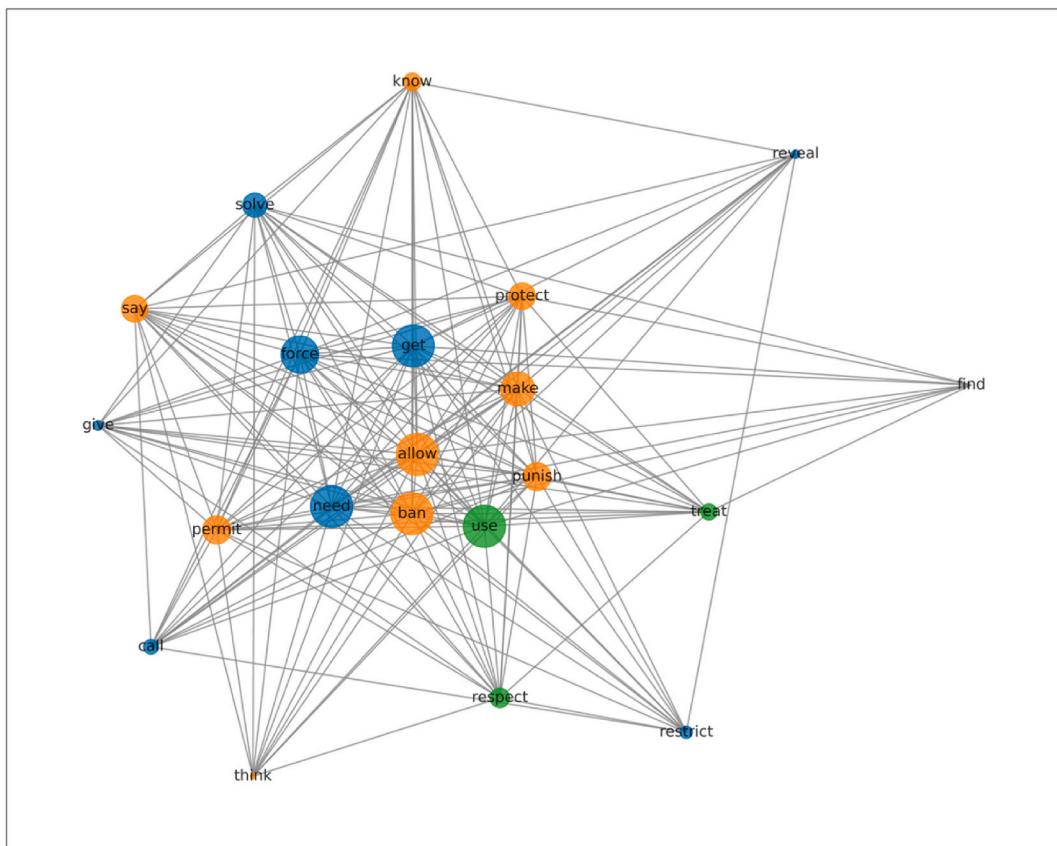
wide range of sophisticated verbs associated with analysis, judgment, and persuasion, reflecting the analytic characteristics of argumentative discourse. In contrast, narrative essays demonstrated lower semantic cohesion, with more streamlined networks featuring concrete actions and experiential verbs, consistent with the more straightforward and event-driven nature of storytelling.

Unlike the higher-proficiency group, the lower-proficiency group showed less pronounced differentiation between genres, relying on a more restricted range of verbs in both argumentative and narrative writing. Their verb semantic networks were simpler and less distinct between genres, suggesting a diminished ability to adapt verb usage to the specific rhetorical demands and objectives of each genre.

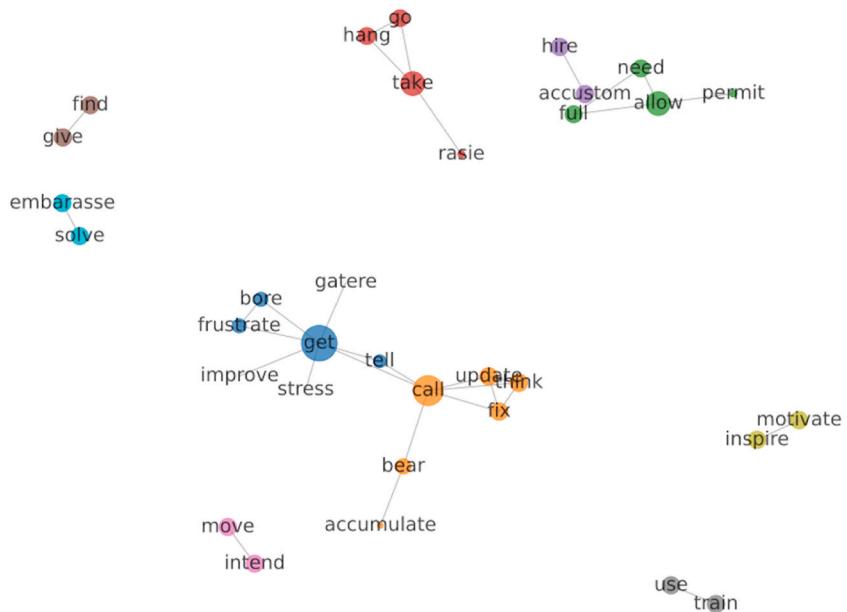
## **6.2. Theoretical implications**

The distinct verb usage patterns across genres in the higher-proficiency group align with previous research on genre effects in L2 writing (e.g., Lu, 2011; Qin & Uccelli, 2016; Renandya & Nguyen, 2023; Yoon, 2017; Yoon & Polio, 2017; Zhang & Lu, 2022). For example, Yoon and Polio (2017) found that L2 learners at a U.S. university used more complex syntactic structures in argumentative essays compared to narrative ones, particularly in terms of clause length, coordinate phrases, complex nominals, and verb phrases. The current study adds a new dimension to this line of research by extending the investigation of genre effects to verb semantic cohesion in writing. While previous studies have predominantly focused on syntactic and lexical complexity, relatively less attention has been paid to the semantic aspects of writing. In this regard, our study contributes to the field by highlighting the importance of semantic considerations, particularly in relation to verb usage and semantic cohesion, thus offering a more comprehensive understanding of genre effects in L2 writing.

The differences in verb semantic cohesion between the two genres among the higher-proficiency group can be interpreted within the framework of Robinson's Cognition Hypothesis (Robinson, 2001, 2005). According to this hypothesis, increased task complexity leads to greater linguistic complexity and accuracy in language production. In line with this view, the higher-proficiency writers exhibited greater verb semantic cohesion in argumentative writing, which imposes greater task complexity compared to narrative writing. Specifically, argumentative writing requires multifaceted analytic processes, including logical reasoning, evidence evaluation, and persuasive rhetoric, rendering it a more cognitively complex task than narrative writing (Swales, 1990; Uccelli et al., 2013). Our findings of denser and more interconnected verb networks in the argumentative essays of higher-proficiency writers suggest that these learners effectively adjusted their writing style to meet the increased cognitive demands of the genre by employing more sophisticated language. This pattern also reflects their strategic use of verbs to enhance rhetorical effect and maintain an objective tone in



**Fig. 3.** Reduced semantic network for passive sentences in argumentative essays by the higher-proficiency group, including only three nodes from each community.

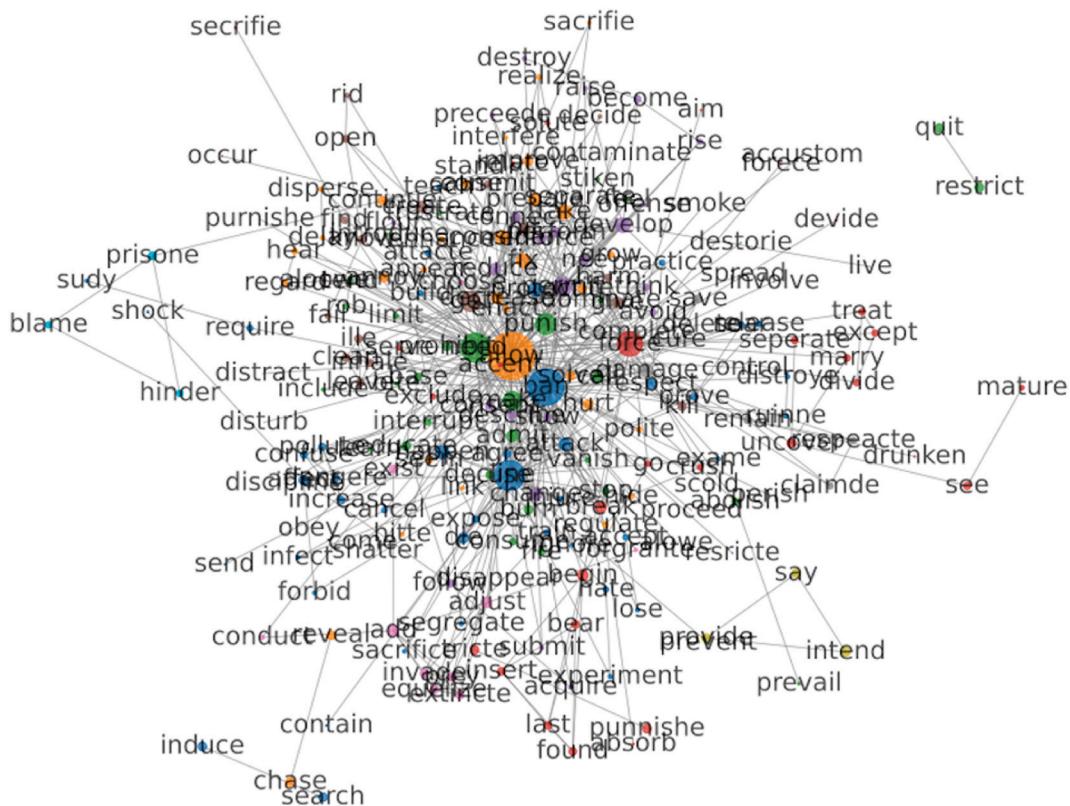


**Fig. 4.** Semantic network for passive sentences in narrative essays by the higher-proficiency group.

Table 4

Examples of passive sentences produced by a higher-proficiency writer (grammatical and spelling errors uncorrected).

Participant ID (proficiency level)	Argumentative	Narrative
#2611 (B2+)	<ul style="list-style-type: none"> <li>- But their statement <u>is eclipsed</u> by the following reasons I would mention below.</li> <li>-Then, critics say that if we engage people into experiment who agreed to be a part of the experiment after they <u>were fully notified</u> about the dangers of the experiment, there would be no problem.</li> <li>-These reality renders the fact that the argument of maintaining that animal <u>should be protected</u> from <u>being used</u> in medical experiment is unreasonable and my statement that it is proper to practice animal experiment truly convincing.</li> </ul>	<ul style="list-style-type: none"> <li>-I thankfully could <u>get permitted</u> in Yonsei University majoring in Medicine.</li> <li>-And I'm quite positive that this story would be surely enough to <u>be called</u> a miracle.</li> <li>-However, when I <u>was told</u> that I should take an English Certification Test, I became really afraid.</li> </ul>

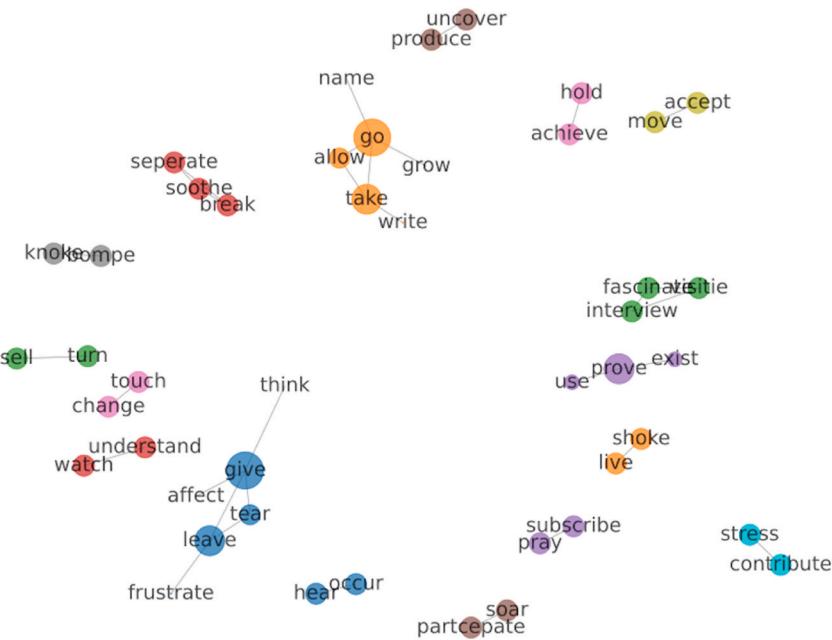


**Fig. 5.** Semantic network for passive sentences in argumentative essays by the lower-proficiency group.

argumentation. These results indicate that higher-proficiency writers were not only capable of handling the cognitive complexity of argumentative writing but also demonstrated an awareness of the distinct linguistic features required for different communicative purposes in each genre, aligning with insights from genre-based studies (Biber & Conrad, 2009; Tardy, 2011).

Moreover, the modulation of proficiency is consistent with a usage-based perspective on language learning (Ellis, 2006, 2008; Goldberg, 1995, 1999; Tomasello, 2003). The more pronounced genre differentiation observed among higher proficiency writers likely reflects their greater exposure to and practice with a variety of text types. This finding aligns with the usage-based principle that language learning is fundamentally driven by the frequency and variability of input. Higher proficiency writers, having encountered a wider array of verbs and constructions across diverse examples of argumentative and narrative texts, have developed more distinct and sophisticated verb usage patterns appropriate for each genre. This genre-specific adaptation suggests their robust understanding of how verbs and constructions co-occur and function in different communicative contexts, reflecting a higher degree of entrenchment and abstraction of these linguistic patterns (Bybee, 2006).

In contrast, the less differentiated verb usage among the lower-proficiency group can be attributed to their less developed sensitivity to verb-construction contingencies, presumably due to their more limited language experience. Furthermore, the less distinct semantic cohesion across genres indicates that these writers have not yet fully internalized the genre-specific conventions that guide the effective utilization of verbs and constructions in each genre. From a usage-based perspective, this finding aligns with the view that sensitivity to such contingencies develops gradually through repeated exposure and use in varied contexts (Tomasello, 2003). As these



**Fig. 6.** Semantic network for passive sentences in narrative essays by the lower-proficiency group.

**Table 5**

Examples of passive sentences produced by a lower-proficiency writer (grammatical and spelling errors uncorrected).

Participant ID (proficiency level)	Argumentative	Narrative
#2998 (A2)	<p>-So that could make us to <u>be called</u> 'polite eastern nation' from another countries.</p> <p>-About 300–400 years ago, when 'Josun Kingdom' was in this land, our ancestors <u>were punished</u> by a physical punishment from the elders in 'seodang'.</p> <p>-And that will give them a perception that the action should not <u>be done</u> again.</p>	<p>-The best interesting thing that happened in last summer vacation <u>was occurred</u> in my highschool.</p> <p>-Suddenly very loud sound <u>was heard</u> continually.</p>

writers gain more language experience, it is expected that they will develop a keener awareness of how verbs and constructions work together to convey meaning and achieve communicative goals in different genres. This progression should lead to more differentiated and complex verb semantic networks as their proficiency increases.

### 6.3. Pedagogical implications

The current findings have several implications for L2 writing instruction and assessment practices, particularly in evaluating the semantic aspects of writing. First, our results indicate that verb semantic analysis can supplement traditional assessment measures that focus on syntactic complexity and sophistication. By incorporating measures of semantic cohesion—specifically related to verb usage within constructions—educators can provide a more comprehensive and refined evaluation of a learner's writing proficiency. Notably, our study introduces useful resources for the automatic analysis of verb semantic cohesion using NLP techniques, implemented through a Python script. This automated process allows for a fast and accurate assessment of students' verb usage across different writing contexts, offering an efficient tool for educators to evaluate and monitor students' writing progress in greater detail.

Second, the study highlights the importance of genre-specific evaluation in writing assessments (e.g., Yoon, 2017). We propose that writing assessments should explicitly measure a learner's ability to adapt their verb usage to meet the distinct demands of various genres. For example, in argumentative essays, evaluators should assess the use of sophisticated verbs that convey analysis, judgment, and persuasion, ensuring these verbs are effectively embedded within relevant constructions to strengthen the arguments. In contrast, narrative writing should be assessed based on the effective use of action and experiential verbs that clearly describe events and experiences.

Third, the observed differences between proficiency groups suggest that genre-specific sensitivity to verb-construction contingencies develops gradually along a continuum. This finding highlights the need for differentiated teaching approaches that align with students' proficiency levels. For lower-proficiency students, for instance, instruction may begin by focusing on basic verbs that express the core meanings of the constructions in which they are used. As students become more comfortable with these prototypical patterns,

they can gradually be introduced to more complex verb-construction pairings and their appropriate use within specific genres. For advanced learners, instruction should incorporate exercises that challenge them to adjust their verb usage to meet the rhetorical demands of different genres. These activities can help foster a more sophisticated understanding of how verbs function within diverse communicative contexts. Such tailored instruction, which considers students' current abilities, may ultimately enable them to make deliberate, genre-appropriate choices in their verb usage.

Alongside instruction, assessment practices should be refined to better capture this developmental progression. Educators could develop detailed rubrics that describe different levels of sensitivity to verb-construction contingencies, from basic use of common verbs to more sophisticated, genre-appropriate applications of a broad range of verbs within varied constructions. By implementing regular assessments that track students' progress in developing these skills, teachers can more effectively guide learners through their long-term development. This approach will allow students to build a more contextually appropriate understanding of verb usage, gradually refining their ability to apply verbs strategically across different genres.

#### 6.4. Limitations and suggestions for further research

We note several limitations that require further attention in future studies. First, a potential limitation stems from the presence of underdeveloped essays and grammatical errors in our corpus data. As is common in L2 writing research, we encountered several essays containing incomplete sentences and various linguistic inaccuracies. Given the lack of established conventions for handling such errors in semantic cohesion analysis, we chose to maintain the integrity of the original data, making only minor corrections for spelling errors in verbs. However, as noted by a reviewer, the inclusion of underdeveloped essays may have influenced our findings. This limitation points to the need for future research to develop standardized protocols for addressing incomplete or grammatically incorrect texts in semantic analyses of L2 writing.

Moreover, further studies should implement rigorous inter-rater reliability measures to ensure the consistency and validity of proficiency ratings. Although the essays in our dataset were evaluated by trained raters using CEFR rubrics as part of the corpus compilation process, no inter-rater agreement information was provided by the compilers. Incorporating multiple independent ratings for each essay would strengthen the reliability of these assessments, allowing for a more accurate and comprehensive evaluation of proficiency.

Another limitation of our study is its limited scope. By focusing on only two genres and exclusively examining Korean L2 learners of English, the generalizability of our findings is somewhat restricted. To address this limitation, future research should consider a wider range of genres and include a more diverse sample of L2 learners from different L1 backgrounds, using a more fine-grained proficiency scale. These expansions would enhance the validity and generalizability of the results, offering deeper insights into how verb semantic cohesion manifests across different linguistic and cultural contexts in L2 writing.

### 7. Conclusion

This study investigated how genre and proficiency influence verb semantic cohesion in L2 writing, using NLP-based semantic network analysis of essays by Korean learners. Our findings have important implications for L2 writing instruction and assessment, suggesting that writing instruction should incorporate a focus on verb-construction contingencies, particularly within genre-based approaches. Additionally, the findings point to the need for more refined evaluation criteria in writing assessment that capture the complexity of verb usage and semantic cohesion across genres. To further generalize our findings, future research should examine whether the observed patterns apply to L2 production across various genres and learners with different L1 backgrounds.

#### CRediT authorship contribution statement

**Hyunwoo Kim:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Woonhyung Chung:** Writing – review & editing, Validation, Methodology, Investigation. **Heechung Nam:** Writing – review & editing, Validation, Software, Methodology, Investigation.

#### Declaration of interest

The authors declare no conflict of interest.

#### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.system.2025.103657>.

#### References

- Abdi Tabari, M., & Wang, Y. (2022). Assessing linguistic complexity features in L2 writing: Understanding effects of topic familiarity and strategic planning within the realm of task readiness. *Assessing Writing*, 52, Article 100605.

- Ambridge, B. (2013). How do children restrict their linguistic generalizations? An (un-)grammaticality judgment study. *Cognitive Science*, 37, 508–543.
- Ambridge, B., Bidgood, A., Twomey, K. E., Pine, J. M., Rowland, C. F., & Freudenthal, D. (2015). Preemption versus entrenchment: Towards a construction-general solution to the problem of the retreat from verb argument structure overgeneralization. *PLoS One*, 10, Article e0123723.
- Baronchelli, A., Ferrer-i-Cancho, R., Pastor-Satorras, R., Chater, N., & Christiansen, M. H. (2013). Networks in cognitive science. *Trends in Cognitive Sciences*, 17, 348–360.
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67, 1–48.
- Beers, S. F., & Nagy, W. E. (2009). Syntactic complexity as a predictor of adolescent writing quality: Which measures? Which genre? *Reading and Writing*, 22, 185–200.
- Berman, R. A. (2008). The psycholinguistics of developing text construction. *Journal of Child Language*, 35, 735–771.
- Berman, R. A., & Nir-Sagiv, B. (2009). Clause-packaging in narratives: A crosslinguistic developmental study. In D. I. Slobin, J. Guo, E. Lieven, S. Ervin-Tripp, N. Budwig, S. Özçalışkan, & K. Nakamura (Eds.), *Crosslinguistic approaches to the psychology of language: Research in the tradition* (pp. 149–162). Mahwah, NJ: Lawrence Erlbaum.
- Berman, R. A., & Slobin, D. I. (2013). *Relating events in narrative: A crosslinguistic developmental study*. New York: Psychology Press.
- Biber, D., & Conrad, S. (2009). *Register, genre, and style*. Cambridge, UK: Cambridge University Press.
- Biber, D., Gray, B., & Staples, S. (2016). Predicting patterns of grammatical complexity across language exam task types and proficiency levels. *Applied Linguistics*, 37, 639–668.
- Bird, S., Klein, E., & Loper, E. (2009). *Natural Language processing with Python: Analyzing text with the Natural Language Toolkit*. O'Reilly.
- Blondel, V. D., Guillaume, J.-L., Lambiotte, R., & Lefebvre, E. (2008). Fast unfolding of communities in large networks. *Journal of Statistical Mechanics*, Article P10008.
- Bulté, B., & Housen, A. (2012). Defining and operationalising L2 complexity. In A. Housen, F. Kuiken, & F. Vedder (Eds.), *Dimensions of L2 performance and proficiency: Complexity, accuracy and fluency in SLA* (pp. 21–46). Amsterdam: John Benjamins.
- Bybee, J. (2008). Usage-based grammar and second language acquisition. In P. Robinson, & N. C. Ellis (Eds.), *Handbook of cognitive linguistics and second language acquisition* (pp. 216–236). New York: Routledge.
- Casal, J. E., & Kessler, M. (2020). Form and rhetorical function of phrase-frames in promotional writing: A corpus-and genre-based analysis. *System*, 95, Article 102370.
- Council of Europe. (2011). Common European framework of reference for languages. *Learning, teaching, assessment*. Council of Europe.
- Crossley, S. A., & McNamara, D. S. (2012). Predicting second language writing proficiency: The roles of cohesion and linguistic sophistication. *Journal of Research in Reading*, 35, 115–135.
- de Nooy, W., Mrvar, A., & Batagelj, V. (2018). *Exploratory social network analysis with Pajek: Revised and expanded edition for updated software*. Cambridge, UK: Cambridge University Press.
- Ellis, N. C. (2002). Frequency effects in language processing: A review with implications for theories of implicit and explicit language acquisition. *Studies in Second Language Acquisition*, 24, 143–188.
- Ellis, N. C. (2006). Selective attention and transfer phenomena in SLA: Contingency, cue competition, salience, interference, overshadowing, blocking, and perceptual learning. *Applied Linguistics*, 27, 1–31.
- Ellis, N. C. (2008). The dynamics of language use, language change, and first and second language acquisition. *The Modern Language Journal*, 91, 232–249.
- Ellis, N. C., & Ferreira-Junior, F. (2009). Constructions and their acquisition: Islands and the distinctiveness of their occupancy. *Annual Review of Cognitive Linguistics*, 7, 188–221.
- Ellis, N. C., & Larsen-Freeman, D. (2009). Constructing a second language: Analyses and computational simulations of the emergence of linguistic constructions from usage. *Language Learning*, 59, 90–125.
- Ellis, N. C., O'Donnell, M. B., & Römer, U. (2013). Usage-based language: Investigating the latent structures that underpin acquisition. *Language Learning*, 63, 25–51.
- Freeman, L. C. (1977). A set of measures of centrality based on betweenness. *Sociometry*, 40, 35–41.
- Gentner, D. (1982). Why nouns are learned before verbs: Linguistic relativity versus natural partitioning. In S. A. Kuczaj (Ed.), *Language development: Vol. 2. Language, thought, and culture* (pp. 301–334). Lawrence Erlbaum Associates.
- Goh, C., & Burns, A. (2012). *Teaching speaking: A holistic approach*. New York, NY: Cambridge University Press.
- Goldberg, A. E. (1995). *Constructions: A construction grammar approach to argument structure*. London: University of Chicago Press.
- Goldberg, A. (1999). The emergence of the semantics of argument structure construction. In B. MacWhinney (Ed.), *The emergence of language* (pp. 197–212). Hillsdale, NJ: Lawrence Erlbaum.
- Goldberg, A. E. (2006). *Constructions at work: The nature of generalization in language*. Oxford: University Press.
- Goldberg, A. E. (2019). *Explain me this: Creativity, competition and the partial productivity of constructions*. Princeton, NJ: Princeton University Press.
- Goldberg, A. E., Caseniser, D. M., & Sethuraman, N. (2004). Learning generalizations. *Cognitive Linguistics*, 15, 289–316.
- Gries, S. T., & Ellis, N. C. (2015). Statistical measures for usage-based linguistics. *Language Learning*, 65, 228–255.
- Hagberg, A. A., Schult, D. A., & Swart, P. J. (2008). Exploring network structure, dynamics, and function using NetworkX. In G. Varoquaux, T. Vaught, & K. J. Millman (Eds.), *Proceedings of the 7th Python in science conference* (pp. 11–15).
- Honnibal, M., & Montani, I. (2019). spaCy 2: Natural language understanding with bloom embeddings, convolutional neural networks and incremental parsing Version 2.0.18. <https://spacy.io>. January 2021.
- Huang, L., & Li, Y. (2023). Revisiting the relationships of n-gram measures to L2 writing proficiency: Comparisons between genres and connections to vocabulary levels. *System*, 118, Article 103136.
- Hwang, H., Choe, A., & Zenker, F. (2020). Construction counter: A tool to measure (nonnative) language development. *Brown Bag Series*. University of Hawai'i at Mānoa.
- Hyland, K. (2007). Genre pedagogy: Language, literacy and L2 writing instruction. *Journal of Second Language Writing*, 16, 148–164.
- Kang, S., & Lee, J. H. (2019). Are two heads always better than one? The effects of collaborative planning on L2 writing in relation to task complexity. *Journal of Second Language Writing*, 45, 61–72.
- Kim, H., & Hwang, H. (2022). Assessing verb-construction integration in young learners of English as a foreign language: Analyses of written and spoken production. *Language Learning*, 72, 497–533.
- Kim, H., & Ro, E. (2024). Usage-based approaches to assessing syntactic sophistication in second language writing: Interaction of genre and proficiency. *Journal of Second Language Writing*, 65, 101131.
- Kormos, J. (2011). Task complexity and linguistic and discourse features of narrative writing performance. *Journal of Second Language Writing*, 20, 148–161.
- Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2016). *lmerTest: Tests in linear mixed effects models*.
- Kyle, K. (2016). *Measuring syntactic development in L2 writing: Fine grained indices of syntactic complexity and usage-based indices of syntactic sophistication*. Georgia State University. Unpublished doctoral dissertation.
- Kyle, K., & Crossley, S. (2017). Assessing syntactic sophistication in L2 writing: A usage-based approach. *Language Testing*, 34, 513–535.
- Lenth, R. (2018). emmeans: Estimated marginal means, aka least-square means: R package [computer software]. Available at: version 1.2.4. <https://cran.r-project.org/package=emmeans>.
- Levin, B. (1993). *English verb classes and alternations: A preliminary investigation*. University of Chicago Press.
- Li, H., & Yu, X. (2024). Verb argument constructions in argumentative essays by college-level Asian learners of English: Exploring the effects of English proficiency, acquisition context, and topic. *Journal of Second Language Writing*, 65, Article 101127.
- Lu, X. (2011). A corpus-based evaluation of syntactic complexity measures as indices of college-level ESL writers' language development. *Tesol Quarterly*, 45, 36–62.
- Lu, X. (2017). Automated measurement of syntactic complexity in corpus-based L2 writing research and implications for writing assessment. *Language Testing*, 34, 493–511.
- Mostafa, T., & Crossley, S. A. (2020). Verb argument construction complexity indices and L2 writing quality: Effects of writing tasks and prompts. *Journal of Second Language Writing*, 49, Article 100730.

- Newman, M. E. J. (2010). *Networks: An introduction*. Oxford, UK: Oxford University Press.
- Ninio, A. (1999). Pathbreaking verbs in syntactic development and the question of prototypical transitivity. *Journal of Child Language*, 26, 619–653.
- Norris, J. M., & Ortega, L. (2009). Towards an organic approach to investigating CAF in SLA: The case of complexity. *Applied Linguistics*, 30, 555–578.
- O'Donnell, M. B., Römer, U., & Ellis, N. C. (2013). The development of formulaic sequences in first and second language writing: Investigating effects of frequency, association, and native norm. *International Journal of Corpus Linguistics*, 18, 83–108.
- Pedersen, T., Patwardhan, S., & Michelizzi, J. (2004). WordNet:Similarity—Measuring the relatedness of concepts. *Paper presented at the proceedings of fifth annual meeting of the north American chapter of the association of computational linguistics (NAACL 2004)*.
- Perek, F., & Goldberg, A. E. (2017). Linguistic generalization on the basis of function and constraints on the basis of statistical preemption. *Cognition*, 168, 276–293.
- Pu, L., Heng, R., & Cao, C. (2022). The effects of genre on the syntactic complexity of argumentative and expository writing by Chinese EFL learners. *Frontiers in Psychology*, 13, Article 1047117.
- Qin, W., & Uccelli, P. (2016). Same language, different functions: A cross-genre analysis of Chinese efl learners' writing performance. *Journal of Second Language Writing*, 33, 3–17.
- R Core Team. (2024). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. <http://www.R-project.org/>.
- Ravid, D., & Berman, R. A. (2010). Developing noun phrase complexity at school age: A text-embedded cross-linguistic analysis. *First Language*, 30, 3–26.
- Renandya, W. A., & Nguyen, M. T. T. (2023). Teaching speaking in L2 contexts. In E. Hinkel (Ed.), *Handbook of practical second language teaching and learning* (pp. 269–280). New York, NY: Routledge.
- Rhee, S. C., & Jung, C. K. (2012). Yonsei English learner corpus (YELC). *Paper presented at the first Yonsei English corpus symposium*. March.
- Robenalt, C., & Goldberg, A. E. (2015). Judgement evidence for statistical preemption: It is relatively better to vanish than to disappear a rabbit, but a lifeguard can equally well backstroke or swim children to shore. *Cognitive Linguistics*, 26, 467–503.
- Robinson, P. (2001). Task complexity, task difficulty, and task production: Exploring interactions in a componential framework. *Applied Linguistics*, 22, 27–57.
- Robinson, P. (2003). The cognition hypothesis, task design, and adult task-based language learning. *Second Language Studies*, 21, 45–105.
- Robinson, P., & Ellis, N. (2008). An introduction to cognitive linguistics, second language acquisition, and language instruction. In P. Robinson, & N. Ellis (Eds.), *Handbook of cognitive linguistics and second language acquisition* (pp. 3–24). New York: Routledge.
- Römer, U., Skalicky, S. C., & Ellis, N. C. (2020). Verb-argument constructions in advanced L2 English learner production: Insights from corpora and verbal fluency tasks. *Corpus Linguistics and Linguistic Theory*, 16, 303–331.
- Swales, J. M. (1981). *Aspects of article introductions: Language studies unit*. Birmingham: University of Aston.
- Swales, J. (1990). *Genre analysis: English in academic and research settings*. New York: Cambridge University Press.
- Tardy, C. M. (2011). The history and future of genre in second language writing. *Journal of Second Language Writing*, 20, 1–5.
- Tomasello, M. (2003). *Constructing a language: A usage-based theory of language acquisition*. Cambridge, MA: Harvard University Press.
- Uccelli, P., Dobbs, C. L., & Scott, J. (2013). Mastering academic language: Organization and stance in the persuasive writing of high school students. *Written Communication*, 30, 36–62.
- Weigle, S. C. (2002). *Assessing writing*. Cambridge, UK: Cambridge University Press.
- Wolff-Quintero, K., Inagaki, S., & Kim, H. Y. (1998). *Second language development in writing: Measures of fluency, accuracy, & complexity*. Honolulu: University of Hawaii Press.
- Wulff, S., Stefanowitsch, A., & Gries, S. T. (2007). Brutal Brits and persuasive Americans: Variety-specific meaning construction in the into-causative. In G. Radden, K.-M. Kopcke, T. Berg, & P. Siemund (Eds.), *Aspects of meaning construction* (pp. 265–281). Amsterdam: John Benjamins.
- Yoon, H. J. (2017). *Investigating the interactions among genre, task complexity, and proficiency in L2 writing: A comprehensive text analysis and study of learner perceptions*. Michigan State University. Unpublished doctoral dissertation.
- Yoon, H. J., & Polio, C. (2017). The linguistic development of students of English as a second language in two written genres. *Tesol Quarterly*, 51, 275–301.
- Zhang, X., & Lu, X. (2022). Revisiting the predictive power of traditional vs. fine-grained syntactic complexity indices for L2 writing quality: The case of two genres. *Assessing Writing*, 51, Article 100597.