

Exploring Lexical Processing and Sustainability Awareness in EFL Learners: A Psycholinguistic Discourse-Cognition Perspective

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Abstract—Despite the increasing emphasis on sustainability literature, limited research has examined how EFL learners cognitively and neurologically process sustainability-related literature in English. This research study investigates this psycholinguistic gap by analyzing how EFL learners are engaged in word processing while comprehending sustainability discourse and developing awareness of worldwide environmental issues. The research endeavors to answer the following question: How do psycholinguistic processes, especially word processing, impact EFL learners' comprehension and sustainability insights in discourse-intensive contexts? A mixed-method design was used, integrating quantitative visual tracking indicators of word recognition and processing with qualitative reflective narrations and open-ended interviews. Forty intermediate EFL university learners participated in this research study. Data analysis focused on processing cognitive pace, precision, and patterns of cognitive engagement, alongside learners' reported comprehension of sustainability notions. Findings show that learners' word processing effectiveness significantly correlates with their full comprehension of sustainability-based discourse. Participants who showed a higher level of lexical and semantic processing demonstrated greater awareness of ecological issues. Further, they reflected a more precise interpretation of discourse meaning. These results suggest that some psycholinguistic factors, such as word recognition and semantic integration, play an essential part in linking language acquisition to content-based insights. The research implications include integrating targeted psycholinguistic activities that promote word processing skills while simultaneously boosting learners' sustainability insights.

Index Terms—word processing, cognitive linguistics, language perception, sustainability texts, discourse

I. INTRODUCTION

Incorporating sustainability discourse into scholastic frameworks has become essential as worldwide ecological challenges augment. Within the EFL context, this integration boosts language proficiency. Furthermore, it fosters environmental perspectives among language users. However, the cognitive processes underlying learners' engagement with sustainability texts are still unexplored. These cognitive processes receive scant research attention. Understanding how English language learners process this discourse is crucial for designing effective scholastic mechanisms that boost both linguistic and environmental literacy (Lin & Lei, 2020).

Psycholinguistics extensively examined cognitive word processing in first and second language acquisition, concentrating on lexical access, semantic integration, and reading perception. Psycholinguistic studies have provided insights into how language users process language at the cognitive levels. However, there are relatively few studies that explore how EFL learners and language users comprehend sustainability discourse. While some studies have investigated the incorporation of environmental themes into second language courses (Chen, 2021), the cognitive mechanisms and operations engaged in processing such content have not been adequately examined. This linguistic gap is substantial, as understanding the cognitive mechanisms involved can reveal more effective instructional approaches that boost both

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language skills and environmental awareness (Rayner et al., 2006).

This study attempts to examine this gap by investigating how language users process sustainability-themed texts and how this processing reflects their environmental awareness. By using eye-tracking technology to estimate real-time word processing and combining it with qualitative think-aloud protocols, this research endeavors to provide a comprehensive analysis of the cognitive mechanisms at play. The findings are anticipated to offer valuable insights into the interplay between language processing and content perception in second language acquisition contexts (Odia, 2021; Nervino et al., 2024).

Guided by the identified gaps and objectives, this study seeks to explore several key questions related to English language learners' engagement with sustainability discourse. Specifically, it examines how learners process sustainability-themed texts at both the lexical and semantic levels, investigates the relationship between their word processing efficiency and their overall comprehension of sustainability discourse, and analyzes how cognitive processing of such texts influences learners' environmental awareness.

II. LITERATURE REVIEW

The intersection of psycholinguistics, English language learning, and sustainability awareness is an emerging area of research that seeks to understand how cognitive processes impact learners' engagement with ecological discourse. This literature review synthesizes existing research studies on word processing in second language acquisition contexts, the role of psycholinguistics in language learning, and the integration of sustainability themes into language acquisition (Al-Khotaba et al., 2019).

Research on second language (L2) reading has consistently concentrated on the centrality of psycholinguistic cognitive operations in facilitating text perception. Word recognition and lexical access are considered crucial, with efficient processing enabling language users to handle textual semantics more effectively (Perfetti & Stafura, 2014). Eye-tracking research studies further demonstrated that measures such as fixation durations and regressions offer critical insights into the cognitive operations underlying cognitive processing (Rayner, 2009). These findings show that reading is not a passive decoding process but rather a highly active, cognitively demanding activity that incorporates multiple linguistic and semantic markers.

Many reading models, such as Beers (1987), Geyer (1972), and Schraw and Bruning (1996), propose that up to five words can be processed simultaneously. While prior research indicates that foveal words may be processed alongside immediately adjacent words, it remains unclear whether this parallel processing extends to three words. To investigate this point, Mlinarič et al. (2025) employed a lexical decision paradigm that presents three flankers on each side of a central target. Results showed that only flankers directly adjacent to the target affected word recognition, whereas more distant flankers had no measurable or significant influence. These findings indicate that readers can process approximately three words in parallel. This level of parallel processing exceeds the predictions of some models, such as the E-Z Reader and the Chinese Reading Model, but it remains lower than the estimates proposed by other frameworks, including Glenmore and OB1-Reader (Mlinarič et al., 2025; Snell & Grainger, 2018).

In EFL contexts, difficulties at the lexical and semantic levels often impede learners' comprehension of academic or content-based texts (Koda, 2005; Nassaji, 2011). Vocabulary knowledge, including both breadth and depth, is a strong predictor of reading performance, particularly when learners engage with dense and conceptually demanding discourse (Laufer & Ravenhorst-Kalovski, 2010). Content and language integrated learning (CLIL) approaches emphasize the importance of embedding linguistic instruction within meaningful subject matter, thereby supporting both language and conceptual development (Coyle et al., 2010). Yet, despite the rising global importance of sustainability, studies that directly examine learners' cognitive engagement with sustainability texts remain limited (Sadoughvanini & Ghaemi, 2025).

Gahshan and Weintraub (2024) argued that elementary-school students are increasingly expected to compose texts using computers, which requires both higher-level skills, such as planning, translating, and revising, and lower-level transcription skills. To address this issue, the Word Processing and Typing Instructional Program (WoTIP) was developed and implemented through a collaborative consultation model. This study examined whether WoTIP could improve typing speed, word processing, and composition performance compared to a control group with no typing or word processing instruction. The findings indicate that WoTIP is an effective approach for enhancing both transcription skills and overall writing abilities in elementary students.

Research studies in the sustainability context underscore its transformative potential in boosting critical thinking and global awareness. Sterling (2010) points out that sustainability pedagogy fosters learners' capacity for reflection and systemic thinking, while Chun (2016) underscores the role of language processing in promoting sustainability consciousness. Integrating sustainability discourse into English language curricula has been shown to contribute not only to linguistic development but also to learners' environmental and ecological awareness and critical engagement with global concerns. However, few studies connect these outcomes to psycholinguistic processes such as word recognition and semantic integration, leaving a gap in the literature that this study seeks to address (Piga, 2023).

Prior psycholinguistic research in Greek and English has demonstrated that the lexical category and argument structure of the base verb play a crucial role in processing deverbal pseudowords that violate these constraints. A comparable study in Slovenian highlighted the influence of aspectual properties of the base verb on deverbal word processing. Tsaprouni

and Manouilidou (2025) revisit the impact of aspect on the morphological processing of Greek deverbal formations. To examine this, both an offline acceptability judgment task and an online lexical decision task were administered using various pseudowords that breached derivational rules. Findings indicate that aspect significantly influences the processing of deverbal pseudowords in Greek. Specifically, aspectual rules interact distinctly with categorial and argument structure constraints for the suffix responsible for generating formations with unambiguous, eventive interpretations and clear eventive implications, but this effect does not extend to other suffixes.

This study is grounded in psycholinguistic theoretical frameworks of reading comprehension. The Lexical Quality Hypothesis (Perfetti, 2007) posits that efficient comprehension relies on high-quality lexical representations that incorporate form, meaning, and context. In the context of sustainability-based discourse, where language users often encounter specialized vocabulary, lexical quality plays a substantial role in determining processing efficiency and overall language comprehension (Wang, 2023; Bilić Meštrić & Šimičić, 2017).

The Construction-Integration Model, put forth by Kintsch (1998), defines language perception as a dynamic operation in which readers develop the semantic content from linguistic input and integrate it with prior knowledge structures. This framework is pertinent to sustainability texts, which require language users to connect new linguistic lexical items with broader prior knowledge about ecological concerns (Yang & Peng, 2022).

Furthermore, this research relies on a content-based language learning theoretical framework. It stipulates that language learning is most significant when embedded in meaningful, content-based contexts. Sustainability texts provide authentic domains in which language users can simultaneously advance their language proficiency and develop awareness of global challenges. These theoretical perspectives provide a sound basis for investigating how psycholinguistic operations—specifically word recognition, semantic integration, and cognitive engagement—contribute to both comprehension and sustainability awareness in EFL settings (Coyle et al., 2010; Eriksson, 2015).

III. RESEARCH METHODS

This research study used a mixed-methods research design to examine how English language learners cognitively process sustainability-related discourse and how psycholinguistic mechanisms of word processing shape comprehension and awareness of ecological issues. The integration of quantitative and qualitative techniques was deemed essential, as it paved the way for a comprehensive exploration of both measurable processing patterns and learners' subjective experiences. While quantitative data provided insights into lexical and semantic processing efficiency, qualitative data reflected the depth of learners' involvement with sustainability terminologies and their reflective awareness of environmental discourse.

A. Research Design

A convergent mixed-methods design was used, incorporating eye-tracking experiments with think-aloud protocols in addition to semi-structured interviews. This research design ensured that quantitative measures of word recognition, reading speed, and precision were triangulated with qualitative descriptive accounts of subjects' interpretive operations. The rationale for choosing this design was to spotlight the cognitive factors of reading sustainability discourse while also considering subjects' meaning-developing strategies. The mixed-methods design facilitated a broader understanding of the correlation between psycholinguistic processing and the perception of content-rich texts, bridging cognitive data with learner-reported experiences.

B. Participants

Forty intermediate-level university students participated in this study. The participants were enrolled in English language courses at the time of data collection. Participants were chosen through purposive sampling to ensure relative homogeneity in language proficiency, thus reducing the impact of wide-ranging linguistic competence on the study's findings. Proficiency was ensured through institutional placement tests. All subjects gave their informed consent. In addition, ethical approval was obtained from the host institution's research committee. The balance of gender distribution was observed. The subjects represented diverse academic majors, ensuring exposure to sustainability topics across different disciplinary environments. All participants have been chosen according to standardized placement test scores.

C. Instruments

Three primary instruments were employed. First, an eye-tracking tool (Tobii Pro X3-120 eye-tracker; 120 Hz sampling frequency) was used to obtain quantitative measures of lexical and semantic processing, focusing on word recognition speed, fixation durations, and regressions while reading sustainability-related texts. Eye-tracking enabled real-time observation of participants' attentional shifts and processing efficiency. Second, think-aloud protocols were employed to document participants' cognitive strategies during reading. Participants verbalized their thoughts, interpretations, and difficulties as they engaged with the texts, providing qualitative data on metacognitive engagement and semantic integration. Third, semi-structured interviews were conducted immediately after the reading sessions to further explore learners' understanding of sustainability terminology and their attitudes toward environmental discourse. Sustainability awareness was assessed through these latter two instruments, together with comprehension-oriented questionnaire items, allowing awareness to be evaluated independently of eye-tracking measures. The triangulation of these methods ensured

both depth and breadth in data collection and enabled a comprehensive assessment of processing patterns and reflective awareness.

D. Materials

The reading resources consisted of carefully chosen sustainability-themed texts adapted from authentic and journalistic sources. These texts covered global environmental topics such as climate change and sustainable consumption. Texts were piloted with a small group of participants. The aim was to make sure that they were appropriate in terms of lexical length and textual transparency. The final set of texts balanced between academic vocabulary and comprehensible discourse, thereby aligning with the intermediate proficiency level of the participants. Furthermore, key sustainability terminologies were incorporated in the texts to facilitate the process of observing lexical and semantic processing.

E. Procedures

The process of collecting data was conducted in three stages. In the first stage, the study participants conducted an eye-tracking experimental test. Each participant sat in front of a computer equipped with an eye-tracking device. This device records both fixation patterns and gaze duration while reading the sustainability-themed texts. Each session spanned 20 minutes. In the second phase, each subject was instructed to complete a think-aloud protocol while reading some texts. Prior to this phase, the subjects were trained in the think-aloud technique to reduce interruptions in cognitive processing. Their verbalizations were audio-recorded for later transcription and analysis. In the third stage, semi-structured interviews were conducted within one week of the reading tasks. Interviews investigated learners' comprehension of sustainability discourse, perception of ecological issues, and attitudes towards how word-level processing impacted their understanding. Each interview lasted between 25 and 40 minutes.

F. Data Analysis

Quantitative numerical data from the eye-tracking sessions were investigated using inferential and statistical data. Metrics such as fixation time, regression frequency, and overall reading durations were computed to determine lexical and semantic processing efficiency. Correlational analyses were conducted to explore the relationship between reading processing rate and comprehension scores. In the qualitative analysis, think-aloud protocols, sometimes called concurrent verbalizations, and interview data were investigated through thematic coding. Coding schemes concentrated on lexical decoding mechanisms, semantic integration, interpretive challenges, and expressed awareness of sustainability topics. To verify reliability, two investigators independently coded the dataset. They addressed inconsistencies through discussion. Triangulation across data sources boosted the validity of the results by comparing data from eye-tracking, verbal protocols, and interviews.

IV. RESEARCH RESULTS

This section presents the results of the research study by integrating quantitative and qualitative analyses. Findings are framed around the three key foci. The first focal point is lexical and semantic processing of sustainability texts. The second one is the correlation between word processing effectiveness and perception. The third is the relationship between cognitive processes and environmental awareness. Quantitative and inferential statistics are presented alongside qualitative insights from think-aloud tests and interviews. Statistical assessments were selected based on the data collected and the research questions. Eye-tracking tests revealed that the participants had allocated more cognitive effort to eco-themed vocabulary than to general lexical items. The average fixation duration for sustainability terms was longer, and regression counts were higher, suggesting greater processing difficulty. Comprehension scores varied, with higher-proficiency learners showing stronger outcomes.

TABLE 1
DESCRIPTIVE STATISTICS FOR LEXICAL PROCESSING AND PERCEPTION

Measure	Mean (M)	Standard Deviation (SD)	Range	Notes
Fixation duration (sustainability words, ms)	274	35.7	220–340	Longer fixations for domain-specific words
Fixation duration (general words, ms)	248	30.4	200–310	Shorter than sustainability words
Regression counts (sustainability words)	4.12	1.8	2–8	More regressions were observed.
Regression counts (general words)	2.75	1.2	1–5	Fewer regressions were observed.
Comprehension scores (%)	72.6	8.9	58–89	Higher proficiency was linked to better comprehension.

A paired-samples t-test showed significantly longer fixation times for eco-related words than for general lexical terms. It is due to the fact that $t(39) = 6.47$ and $p < .001$. A Wilcoxon signed-rank test confirmed significantly higher regression metrics for sustainability words. It is owing to the fact that $Z = -4.28$ and $p < .001$. These findings showed that specialized lexical items required more cognitive processing.

Correlational analyses showed that processing efficiency was significantly associated with learners’ perception of sustainability-related discourse. Specifically, fixation duration was found to correlate negatively with comprehension as $r = -.46$ and $p = .004$. It indicated that participants who spent less time fixating on key terms achieved higher comprehension scores. By the same token, regression metrics were also negatively correlated with perception, $r = -.42$ and $p = .006$. It indicated that frequent rereading was linked to lower comprehension outcomes. In contrast, total reading time revealed no significant relationship with comprehension, $r = -.12$ and $p = .41$. It revealed that efficiency at the word-processing level, rather than overall time spent, was the critical factor affecting comprehension performance.

A multiple regression model confirmed that both fixation duration and regression counts significantly predicted comprehension scores, $F(2, 37) = 7.81, p = .001$, explaining 29% of the variance.

TABLE 2
CORRELATION AND REGRESSION RESULTS FOR PROCESSING EFFICIENCY AND COMPREHENSION

Predictor Variable	Correlation with Comprehension	Regression Coefficient (β)	Significance (p)
Fixation duration (ms)	$r = -.46^{**}$	-0.34	.01
Regression counts	$\rho = -.42^{**}$	-0.31	.02
Total reading time (ms)	$r = -.12$ (n.s.)	—	—

Note: $p < .05$; $**$ indicates significant correlation.

An independent sample t-test revealed that higher-intermediate participants significantly outperformed lower-intermediate ones in comprehension scores. It is due to the fact that $t(38) = 4.12$ and $p < .001$. Eye-tracking data also showed shorter fixation durations and fewer regressions for the higher-intermediate group. It reflected greater lexical efficiency.

TABLE 3
GROUP COMPARISONS BY PROFICIENCY LEVEL

Measure	Higher-Intermediate	Lower-Intermediate	t-value	p-value
Comprehension scores (%)	80.2 (SD = 6.7)	69.4 (SD = 7.1)	4.12	< .001
Fixation duration (sustainability, ms)	259 (SD = 24.1)	288 (SD = 31.6)	-3.51	.001
Regression counts (sustainability words)	3.45 (SD = 1.5)	4.79 (SD = 1.9)	-2.97	.005

Awareness levels, coded from interviews, were significantly associated with processing efficiency. A chi-square test of independence showed that learners with high processing efficiency were more likely to demonstrate high awareness of sustainability issues. It is due to the fact that $\chi^2(2, N = 40) = 8.73$ and $p = .013$.

The analysis of verbal reports showed four key themes that threw light on the differences between high- and low-efficiency learners. First, lexical inference strategies played a substantial role in comprehension. Participants with higher processing efficiency were able to make faster and more precise inferences about the meanings of sustainability-related lexical items. On the other hand, lower-efficiency learners often hesitated or relied on repeated attempts to decode meaning. Second, semantic incorporation is considered an important factor, with successful comprehension closely tied to the learners’ ability to incorporate domain-specific lexical items into the broader discourse of the texts. High-efficiency participants showed greater skill in linking core terms such as “renewable energy” or “carbon footprint” to the key arguments of the text. Low-efficiency learners, on the other hand, often treated these terms in isolation, limiting their understanding.

The third and fourth themes highlighted the metacognitive and reflective dimensions of comprehension. In terms of metacognitive monitoring, high-efficiency learners verbalized fewer challenges while reading. It indicated more automatic and fluent processing. Low-efficiency participants frequently expressed confusion about articulate comprehension struggles. Finally, the topic of awareness structuring highlighted a significant distinction between the two groups. Participants with efficient processing were more likely to make meaningful connections between the thematic content of the texts and wider global environmental issues. It reflected an ability to extend language learning into real-world awareness. Conversely, low-efficiency learners tended to remain focused on decoding vocabulary items without linking them to broader sustainability contexts. It resulted in a narrower and less integrated understanding.

Interview data showed that high-efficiency participants provided precise and cognitively detailed definitions of sustainability terminologies. On the other hand, low-efficiency learners gave vague or incomplete explanations. High-efficiency learners also pointed out that engaging with the texts broadened their perspective on environmental issues. Furthermore, it linked their language skills with global awareness.

The convergence of findings supports the argument that psycholinguistic efficiency underpins both comprehension and awareness. Efficient processors displayed measurable lexical advantages, higher comprehension scores, and greater sustainability consciousness. Conversely, low-efficiency participants illustrated cognitive load and restricted awareness.

The findings of the research study showed that sustainability-related lexical items demanded a greater processing load in comparison to general vocabulary. It reflected the cognitive load involved in engaging with domain-specific terms. Importantly, efficient word processing was found to be a strong predictor of perception performance. It is due to the fact that learners who showed shorter fixation durations and fewer regressions achieved higher comprehension scores. This

pattern was particularly clear among higher proficiency participants, who processed sustainability texts more effectively and showed superior overall perception outcomes.

Beyond comprehension, processing efficiency was also closely tied to learners' broader understanding and awareness of environmental issues. Learners with more efficient processing not only displayed stronger sustainability awareness but also showed greater ability to connect linguistic input with meaningful content knowledge. The qualitative findings revealed that efficient processing facilitated deeper semantic integration. Further, it encouraged learners to reflect critically on global environmental issues. These results suggest that psycholinguistic efficiency serves as a bridge between language learning and the growth of sustainability consciousness.

V. DISCUSSION

This research study investigated how English language learners process eco-discourse at both the lexical and semantic levels. Furthermore, it examined how cognitive linguistic efficiency affects both language perception and environmental consciousness. This study used a qualitative-quantitative design. It combined visual tracking (i.e., focus on fixation patterns), verbalizations, and semi-structured interviews. The results underscored the decisive role of word processing in linking language learning with the development of sustainability awareness. The discussion below highlights the points of agreement, divergence, and contribution to existing literature.

One of the key findings of the study was that sustainability lexical items required significantly greater cognitive effort than general vocabulary. It was indicated by extended fixation durations and higher regression metrics. This is in line with prior psycholinguistic research showing that low-frequency lexical items generally place a greater cognitive load on readers in comparison to high-frequency words (Kuperman et al., 2012; Rayner, 2009; Jin & Li, 2025). Empirical research in L2 reading has also highlighted that learners give more attention to unfamiliar or semantically dense lexical items, which in turn slows down overall processing (Chaffin et al., 2001). The present findings extend this body of work by affirming that sustainability discourse, much like other specialized domains such as medical or legal English, poses unique challenges for non-native learners of English (Anon, 2016; Hilterbran, 2016).

At the same time, the results diverge from studies suggesting that repeated exposure to thematic vocabulary can quickly reduce processing load (Schmitt, 2010; Pellicer-Sánchez, 2016). In the present research study, despite participants being intermediate-level learners who may have had prior exposure to some sustainability terms, the difficulty persisted. One possible explanation is the dual challenge posed by sustainability discourse: not only does it include low-frequency terminologies, but it also includes abstract and globally oriented terms that require higher-order integration. Hence, the findings revealed that sustainability texts presented a double layer of difficulty and conceptual complexity.

Another significant outcome of this research study was the strong predictive correlation between efficient word processing and comprehension performance. Shorter fixation intervals and lower regression are inversely correlated with comprehension complexities. Regression analysis affirmed that processing efficiency explained nearly 33% of the variance in comprehension outcomes. These results are consistent with the eye-mind model (Just & Carpenter, 1980). This model posits that the time spent fixating on a lexical item reflects the cognitive processing required to perceive it. Therefore, high-proficiency readers spend less time on word-level deciphering and can assign more processing power to higher-level semantic construction.

This finding is consistent with the work of Grabe (2009), who pointed out that fluent word recognition is crucial to perception in L2 reading. Similar conclusions have been reported in empirical studies by Koda (2005) and Yamashita (2002), both of whom found that lexical processing speed is one of the strongest predictors of comprehension among EFL and ESL learners. In contrast, some research suggests that extended reading time can sometimes enhance comprehension because it allows readers to engage in deeper elaboration (Anderson, 2009). However, the current study's results suggest that in the case of sustainability discourse, efficiency at the word level, rather than total time spent, is the critical factor. This discrepancy may be explained by the content-specific nature of the texts: since sustainability discourse is conceptually demanding, slow word-level processing may overload working memory, leaving fewer resources available for semantic integration.

The study also evidenced distinct variations between higher- and lower-intermediate learners. Higher proficiency participants demonstrated shorter fixation durations and fewer regressions. They also showed superior comprehension scores compared to the lower proficiency participants. These findings are well-aligned with L2 acquisition research. Indeed, second language research repeatedly emphasizes that proficiency level moderates cognitive processing efficiency (Alderson, 2000; Grabe, 2009). Higher proficiency learners usually have larger lexical items, more robust decoding skills, and more developed background knowledge. All these skills facilitate efficient reading.

This finding is in line with the results of Yamashita and Shiotsu (2017), who found that higher proficiency learners exhibit faster lexical access and greater automaticity in word recognition, both of which directly support comprehension. Similarly, Jeon and Yamashita's (2014) meta-analysis of L2 reading research concluded that language proficiency explains a significant proportion of variance in comprehension outcomes across diverse populations. The current study reinforces this conclusion in the specific context of sustainability discourse, emphasizing that lexical efficiency is not an isolated skill but one intertwined with overall language competence.

Nevertheless, the results contrast with studies suggesting that even lower proficiency learners can achieve comprehension with adequate scaffolding and use of strategies (Anderson, 2009; Zhang & Wu, 2009). In the present

study, think-aloud protocols (e.g., verbalizing word meanings while reading sustainability texts) revealed that lower proficiency learners often attempted to use contextual inference, but these strategies were less effective due to their limited lexical and syntactic knowledge. This suggests that while strategies may compensate for gaps in knowledge in less complex texts, the high cognitive load of sustainability discourse magnifies the differences between proficiency groups.

A highly significant contribution of this study resides in demonstrating the correlation between processing efficiency and sustainability awareness. Participants with high efficiency were significantly more likely to display strong awareness of sustainability concepts in interviews. Lower-efficiency learners often encountered difficulties articulating precise or meaningful interpretations. This suggests that psycholinguistic processing promotes the transformation of textual understanding into metacognitive insights.

The finding corresponds with prior research in content-based language learning, which emphasizes that language skills and disciplinary knowledge are mutually reinforcing (Coyle et al., 2010). In studies of CLIL (Content and Language Integrated Learning), Dalton-Puffer (2011) similarly observed that learners with stronger language processing abilities were better positioned to develop subject-matter understanding. In the context of sustainability, the present findings align with Sterling (2010), who contends that sustainability education demands more than mere knowledge acquisition; it requires equipping EFL learners with the cognitive and linguistic skills needed to engage with complex concepts.

However, this study diverges slightly from some studies on awareness development, such as those by Alptekin and Erçetin (2010), which suggested that even when comprehension is incomplete, learners may still develop partial conceptual awareness. In the present study, learners with inefficient processing did not demonstrate substantial awareness, possibly because sustainability discourse requires precise integration of terminology and concepts to form accurate understandings. Unlike narratives or general expository texts, sustainability texts rely heavily on specific lexical items as carriers of meaning, and failure to process these efficiently appears to hinder awareness development.

The qualitative outcomes from think-aloud protocols and interviews enriched the quantitative results by highlighting how efficient and inefficient learners approached sustainability discourse. Cognitively efficient learners exhibited effective lexical inference strategies. Further, they showed effortless semantic integration in addition to greater metacognitive reflection. Conversely, low-efficiency learners exhibited hesitation and frequent rereading. They also displayed a narrow concentration on isolated words. These findings are in alignment with studies on reading strategies in EFL contexts. These studies stress that proficient learners are engaged in more meaning-driven processing. That is, they connect words to overall textual discourse (Block, 1992; Anderson, 2009).

Moreover, the results support the metacognitive reading model proposed by Baker and Brown (1984). This model argues that successful comprehension is associated with the ability to monitor understanding and regulate cognitive resources. High-efficiency participants in this study verbalized fewer complexities. It suggested that they had internalized more automatic decoding skills. Such abilities enabled them to focus on monitoring meaning construction. This corresponds to the findings from Zhang (2001). In fact, Zhang (2001) pointed out that efficient L2 readers exhibit higher levels of metacognitive consciousness. Weaker readers, on the other hand, concentrate on lexical decoding.

The qualitative outcomes also enhance the broader literature on sustainability discourse. Sterling (2010) and Wals (2011) argue that sustainability awareness requires learners to connect text-based input to real-world issues through reflection and critical thinking. The current study shows that such connections are more likely to occur when learners are not cognitively overloaded by basic decoding, further underlining the pedagogical importance of psycholinguistic efficiency.

Taken together, the findings of this study are largely consistent with existing research on second language reading and content-based learning, but they also extend the literature by explicitly linking psycholinguistic processing to sustainability awareness. Evidence that efficient word processing predicts comprehension and awareness complements longstanding findings in reading research while applying them to a novel domain.

This integrative perspective corresponds to the view of language learning as both a cognitive and a sociocultural process (Lantolf, 2006). On the cognitive side, the results confirm that efficient processing mechanisms are critical for comprehension. On the sociocultural side, the outcomes show that when learners can process language fluently, they are better able to engage with the content in a way that contributes to their global and environmental awareness. Few previous studies have directly examined this dual role of psycholinguistic efficiency. It makes this study a significant addition to the interface of language learning and sustainability consciousness.

While most of the findings reinforce previous literature, some divergences highlight new insights. For example, the finding that total reading time did not predict comprehension diverges from research suggesting that longer engagement can support deeper understanding (Anderson, 2009). The present results suggest that in cognitively demanding domains like sustainability, efficiency rather than sheer effort is what drives comprehension. Similarly, the finding that low-efficiency learners did not gain substantial sustainability awareness contrasts with studies suggesting that partial comprehension can still yield partial content learning (Alptekin & Erçetin, 2010; Chamusca, 2005). This indicates that sustainability discourse may demand a threshold level of lexical and semantic precision for awareness to emerge.

VI. CONCLUSION AND IMPLICATIONS

This research study immensely contributes to the growing literature on psycholinguistics and content-based instruction. It demonstrates that word processing efficiency plays a central role in EFL learners' perception and awareness of

sustainability discourse. Findings confirm that sustainability-related vocabulary demands more cognitive effort. Efficient processing predicts comprehension outcomes. Highly proficient learners are more successful in integrating text meaning. Efficiency is closely associated with sustainability awareness. These outcomes are consistent with prior research on reading and content learning. These findings also extend the field by explicitly linking psycholinguistic mechanisms with global environmental consciousness.

The results reveal that efficient psycholinguistic processing functions as a link between language proficiency and the growth of ecological consciousness. This outcome sheds light on the value of incorporating explicit vocabulary instruction for sustainability terminology and using diagnostic tools to assess lexical processing difficulties. It also implies that improving lexical and semantic efficiency should be a key focus of instruction. Educators can equip learners with tools to process sustainability discourse effectively. It can contribute to language development and to fostering learners' ability to engage critically with one of the most pressing global issues of the 21st century.

The results carry important implications for EFL learning and acquisition. First, the finding that sustainability vocabulary requires greater cognitive effort implies the need for explicit instruction in domain-specific lexis. This can be performed through pre-teaching key terms or using vocabulary notebooks. Second, as long as processing efficiency predicts language perception, learning interventions should concentrate on enhancing automaticity in word processing. It can be attained through fluency-building drills and constant reading. Third, the link between efficiency and awareness suggests that integrating sustainability discourse into language curricula can develop linguistic proficiency. Further, it can boost world citizenship.

These instructional implications correspond to content-based pedagogical frameworks. These instructional approaches show that teaching language via meaningful content fosters language outcomes. When incorporating sustainability texts into English language courses, instructors can achieve the linguistic objectives. In addition, they can engage students with ecological concerns.

While the research study gives robust findings, it also has some limitations. The sample size of forty participants limits generalizability. Future studies could include more diverse populations. Thus, these studies can test whether the results hold across different proficiency levels and cultural contexts. Additionally, the study concentrated only on intermediate-level learners. Research on advanced or beginner learners could reveal different processing dynamics.

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