한국심리학회지 : 인지 및 생물
The Korean Journal of Cognitive and Biological Psychology
2025, Vol. 37, No. 2, 55-71
http://dx.doi.org/10.22172/cogbio.2025.37.2.002

Original Article

OPEN ACCESS

The Effect of Contextual Diversity on Korean Visual Word Recognition

Jisoo Song[1], Sangyub Kim[2‡], Kichun Nam[1†]

[1]School of Psychology, Korea University
[2]Department of Psychology, Chonnam National University

Word frequency is a critical factor in language processing and memory in a variety of dimensions, as demonstrated by extensive research in psycholinguistics. However, recent studies have indicated that contextual diversity, which counts the number of materials in which a word appears, can be a more reliable predictor of language processing than word frequency. The objective of this study was to examine whether the effect of contextual diversity and word frequency varies across language registers in the process of Korean visual word recognition. We calculated word frequency and contextual diversity measures from the written and spoken corpus of the National Institute of Korean Language and analyzed the lexical decision time data in the Korean Lexicon Project (KLP) using hierarchical regression. The results from both corpora commonly elicited a significant facilitatory effect of contextual diversity when word frequency was controlled with other lexical variables. The results of the analysis showed that contextual diversity has a facilitative effect on Korean word recognition when controlling word frequency and other lexical variables in both corpora. However, the effect of word frequency was not observed in the written corpus when contextual diversity was under control. On the other hand, in the spoken corpus, the effect of word frequency was significant, although it was less pronounced compared to the effect of contextual diversity. These findings suggest that contextual diversity may play a significant role in facilitating visual word recognition in Korean, in terms of both written and spoken language.

Keywords: contextual diversity, word frequency, visual word recognition, lexical decision, KLP

1차원고접수: 24.08.10; 수정본접수: 25.01.20; 최종게재결정: 25.04.10

A large body of research in psycholinguistics has focused on investigating lexical variables that enhance language processing and memory. Among these variables, word frequency has been considered the strongest factor that facilitates lexical processing and memory. Studies over the past few decades have demonstrated the word frequency (hereafter WF) effect, indicating that more frequently occurring words are processed more efficiently than less frequently occurring ones (Howes & Solomon, 1951; Balota & Chumbley, 1984; Jescheniak & Levelt, 1994; Monsell et al., 1989). This facilitative effect of WF has been demonstrated in word-based tasks such as lexical

† Corresponding author: Kichun Nam, School of Psychology, Korea University, (02841) 145 Anam-ro, Seongbuk-gu, Seoul, E-mail: kichun@korea.ac.kr

‡ Co-corresponding author: Sangyub Kim, Department of Psychology, Chonnam National University, (61186) 77 Yongbong-ro, Buk-gu, Gwangju, E-mail: sangyub0310@jnu.ac.kr

decision (Balota & Chumbley, 1984; Grainger, 1990), naming (McRae et al., 1990; Schilling et al., 1998), and word recall (Balota & Neely, 1980; Yonelinas, 2002), as well as in eye-tracking tasks using sentences (Plummer et al., 2014). Word recognition studies in Korean have also reported the WF effect (Koh et al., 2008; Kwon & Lee, 2014). Previous studies suggest that the facilitative effect of WF is rooted in the principle of repetition (Monsell, 2012), which posits that words encountered frequently become more strongly represented in our memory due to repeated processing. This strengthens the associated neural pathways, facilitating subsequent word recognition and learning. Based on the principle of repetition, WF serves as a basic element in major models of visual word recognition. For instance, the interactive activation model (hereafter IA; McClelland & Rumelhart, 1981) postulates that WF is a crucial factor in determining the activation level of word nodes within the network. In the IA model, each word is represented by a collection of nodes, with each node representing a certain letter in a word. These nodes are connected in a hierarchical network, with activation propagating through the network based on the input and the connections between nodes. The model assumes that nodes representing high-frequency words have a higher resting level of activation compared to those representing low-frequency words. This allows high-frequency words to reach the threshold with less input, resulting in more efficient recognition of frequently occurring words. Researchers have proposed a variety of explanations for the basis of the word frequency effect. Guttentag and Carroll (1994) suggested that the WF effect is based on recollection-based processes rather than familiarity. On the other hand, studies suggest that the WF effect is confounded with a range of other lexical variables, such as word length and age of acquisition (Brysbaert et al., 2016). To sum up, the effect of WF has largely been interpreted as a learning effect (Brysbaert et al., 2018), but despite being widely recognized as a key lexical variable, there is still no established consensus on its basis.

However, studies over the last decade have demonstrated that contextual diversity is a better predictor of language processing than WF. Contextual diversity refers to the number of linguistic contexts in which a word appears. It is distinct from WF in that it does not consider the recurrent use of words in a particular linguistic context, which is typically defined as a text or a film within a corpus. Adelman et al. (2006) found that contextual diversity had a significant facilitative effect, even when WF was under control. Conversely, the effect of WF was absent when contextual diversity was controlled for in three different English lexical decision and naming databases. This phenomenon is referred to as the contextual diversity (hereafter CD) effect, where words that appear in a wide range of linguistic contexts are processed more efficiently than words that appear in relatively few contexts.

The fundamental basis of the CD effect has been the subject of much debate. Plummer et al. (2014) proposed that the root of the CD effect could essentially be analogous to the WF effect. This is due to the high correlation between WF and CD, as the frequency of a word increases as it is used more commonly in various contexts. If this is the case, lexical access models could replace WF with CD without significant theoretical implications. On the other hand, Adelman et al. (2006) postulated that the CD effect is based on semantic variables, independent from the effect of WF. Since words with high CD appear across a variety of documents, they could have diverse semantic characteristics. To explore the factors underlying the CD effect further, Vergara-Martínez et al. (2017) observed differences in N400 ERP waveforms according to the level of CD (high vs. low) of words during the lexical decision task. The investigation primarily focused on the N400 waveform, as previous studies have observed that lexical and semantic factors have a contrasting effect on the amplitude of the N400. At the lexical level, high-frequency words elicit a reduced N400 amplitude compared to low-frequency words. However, on the semantic level, words with high semantic richness elicit an increased N400 amplitude compared to words with low semantic richness, which refers to the variability of semantic information associated with a word's meaning (Kounios et al., 2009). According to Vergara-Martínez et al. (2017), N400 amplitudes were notably greater in high CD words than in low CD words. Moreover, the study revealed an anterior scalp distribution for the CD effect, while the effect of WF was displayed in the central region of the scalp. This indicates that the CD effect is linked with a distinct neural substrate, which is in line with previously reported N400 effects associated with words that have more semantically rich characteristics. For these reasons, the study concluded that the CD effect is not simply a secondary outcome of the WF effect but rather a distinct phenomenon. Another explanation for the independent effect of CD can be made with the notion of need probability proposed by Anderson and Milson (1989). They emphasized a rational model of memory, which supposes that human memory is optimized to access information based on how likely it is to be needed in the future context. They claimed that this concept of need probability significantly influences word retrieval because words experienced across various contexts can have a diverse range of retrieval cues. Thus, the CD effect may be interpreted as indicative of a variety of contexts in which a word is required rather than a mere count of overall occurrence, providing an independent foundation for the CD effect beyond WF.

Studies have demonstrated that CD predicts several domains of linguistic information processing and memory more significantly than WF. These domains encompass word learning (Hills et al., 2010; Johns et al., 2016; Pagán & Nation, 2019; Rosa et al., 2017), reading in children (Perea et al., 2013; Hsiao & Nation, 2018; Joseph & Nation, 2018), and adults (Plummer et al., 2014). The facilitative effect of CD is commonly observed in numerous studies conducted in various languages, including English (Adelman et al., 2006; Brysbaert & New, 2009; Johns, 2021), Spanish (Perea et al., 2013; Vergara-Martínez et al., 2017), Portuguese (Soares et al., 2015), and Chinese (Chen et al., 2017; Huang et al., 2021; Mu, 2024). However, the presence of the CD effect on lexical processing in Korean has not yet been investigated. The unique writing system in Korean, Hangul, makes it vital to confirm the effect of CD in Korean. Unlike other writing systems with alphabetic orthography, Hangul is characterized by the arrangement of letters in syllable blocks (Pae et al., 2019). Since many words in Korean are based on Chinese characters, orthographic syllables in Korean are more than a mere phonological unit; they can also serve as morphemes with their own meaning (Kwon & Nam, 2011). In fact, the orthographic syllable frequency measures in Korean significantly interact with WF (Kim et al., 2023). Moreover, unlike ideographic Chinese characters, where the letters themselves indicate meaning, Hangul is a phonographic writing system, which makes the meaning of a word more ambiguous than Chinese. For instance, the word '초록' in Korean can refer to both the color green and a brief writing that includes the necessary parts of an article: an abstract. If the ambiguity of the word meaning is high, the linguistic context in which the word is used is likely to play a more significant role in resolving the ambiguity. In other words, it is essential to study the effect of CD in Korean because these distinctive features underlying the Korean writing system may have a significant impact on the effects of WF and CD, unlike in other languages.

The aim of this study is to investigate whether the CD effect appears distinct from the word frequency effect in Korean visual word recognition while accounting for other lexical variables. We sought to examine the effect of WF and CD on Korean visual word recognition as a function of language register. Language register is "a variety of language, corresponding to a variety of situations" (Halliday, 1989). It indicates that when people write or speak, they employ various linguistic forms or styles for the same content, depending on the audience, social situation, and purpose. For instance, people's choice of words may differ based on whether they are engaging in written or spoken communication and the particular context in which they find themselves. Previous studies on visual word recognition have primarily employed corpora based on written language, such as books and newspapers, which frequently serve as sources of visual input. For instance, the Brown corpus (Kučera & Francis, 1967) and CELEX (Baayen et al., 1996) have been widely used in conventional word recognition studies in English. Nevertheless, written language may not accurately reflect our everyday language use because it is basically modified before being read and uses diverse words to circumvent redundancy of expressions. Brysbaert and New (2009) pointed out these limitations and constructed a corpus based on film subtitles. They examined the extent to which WF and CD derived from the subtitle corpus effectively predicted lexical decision times when compared to those from written language corpora widely used at the time. They found out that WF and CD measures from the subtitle corpus, which consists of subtitles from films, were significantly more effective in predicting lexical decision data than those obtained from a written language-based corpus. This led to the construction of subtitle databases, known as the SUBTLEX movement (Soares et al., 2015), to represent the use of spoken language in various languages. This body of research included British English (SUBTLEX-UK; Van Heuven et al., 2014), Spanish (SUBTLEX-ESP; Cuetos et al., 2011), Chinese (SUBTLEX-CH; Cai & Brysbaert, 2010), and Dutch (SUBTLEX-NL; Keuleers et al., 2010). Hence, the present study aimed to investigate the extent to which WF and CD measures computed from two corpora based on written and spoken language predict Korean lexical decision data.

We established two hypotheses in accordance with the findings of prior research. First, we hypothesized that WF and CD measures obtained from the spoken language corpus will more accurately predict lexical decision time than those acquired from the written language corpus. The second hypothesis posits that the effect of CD will be more significant in predicting lexical decision times when comparing the effects of WF and CD in both corpora. We utilized a lexical decision database from the previous mega-study to examine the extent to which the four measures—written WF and CD, spoken WF and CD—predict lexical processing while controlling for other lexical variables such as first syllable token frequency. As in prior research (Adelman et al., 2006; Johns et al., 2016; Senaldi et al., 2022), we performed hierarchical regression analysis to ascertain the extent to which WF and CD from the two corpora predict existing lexical decision data after accounting for the effects of control variables. We entered lexical variables, which have been reported to significantly affect visual word recognition in previous studies, as covariates in the analysis. The number of syllables was included to control the effect of word length, which is regarded as a significant variable in Korean visual word recognition research (Kim & Nam, 2018; Kim et al., 2020). The number of meanings was incorporated to account for the potential influence of semantic factors, as CD is known to be linked with semantic richness (Adelman et al., 2006; Vergara-Martínez et al., 2017; Kim & Nam, 2018). Orthographic first syllable token frequency measure was controlled because it is known to exert a significant impact on Korean visual word recognition throughout a range of prior studies (Kwon, 2012; Lee & Nam, 2020; Kwon et al., 2023; Lee et al., 2023; Kim et al., 2023; Lee et al., 2023).

Methods

Outcome Variable

We used the mean response times (RTs) from the Korean Lexicon Project (hereafter KLP) database as the outcome variable. The KLP database is a large-scale lexical decision dataset obtained from 52 participants (23 males and 29 females) across four universities in Korea (Yi et al., 2017). Individuals with a mean age of 21.9 years and an age range of 18-25 years participated in the study. Out of the total of 30,930 words in the KLP data, we analyzed the RTs of 20,604 words that were present in both written and spoken corpora. All words were nouns with one to five syllables.

Predictor Variables

We used WF and CD computed from two corpora as predictor variables. In line with previous research, we calculated WF as a total sum of occurrences within each corpus and calculated CD as the number of documents where a word appeared within each corpus (Adelman et al., 2006; Brysbaert & New, 2009). To compute CD, we preprocessed the raw corpora by dividing them into documents and then counted only the number of documents in which each word appeared, disregarding the number of co-occurrences of a word within a single document. The written corpus and spoken corpus produced by the National Institute of Korean Language (hereafter NIKL) were utilized to compute the WF and CD measures. The NIKL Written Corpus (version 1.2, 2020; hereafter written corpus) consists of 10,045 raw text materials from books or magazines. It comprises 13.87% of the book-imagination genre, including novels and children's books; 86.12% of the book-information genre, encompassing ten types of subgenres, such as philosophy, religion, art, history, social sciences, natural sciences, and technical sciences; and 0.01% of magazines. Each document in the written corpus corresponded to an individual book or magazine, and the total number of words in the corpus was 267,147, excluding stop words based on Kil (2018) and Lu & Jin (2022)'s list of Korean stop words. The NIKL Spoken Corpus (version 1.2, 2021; hereafter spoken corpus) comprises 25,696 transcribed raw public spoken materials, including broadcasts, lectures, and scripts from television show episodes. The spoken corpus primarily consists of 9.69% public monologues, 74.35% public discussions, and 16% of television show screenplays. Each document in the spoken corpus represented a single transcription of public monologues from broadcasts and lectures or a script of an individual television show episode. The overall count of words in the corpus was 141,818, omitting stop words with the same criteria as the written corpus. Both corpora can be downloaded by registering and requesting on the NIKL's Modu Corpus (국립국어원 모두의 말뭉치) website. Our analyses included a total of 20,604 words with one to five syllables present in both corpora and the KLP database.

Covariates

We included the count of meanings and syllables and orthographic first syllable token frequency as covariates in the analyses. The number of meanings of each word was obtained from the KLP database. The orthographic first syllable token frequency measure came from Lee & Nam (2020), which was calculated across all parts of speech (POS) using the Sejong corpus (Kang & Kim, 2009).

We applied a logarithmic transformation to the WF, CD, and orthographic first syllable token frequency measure for normalization, with the aim of mitigating the bias of the data. Morpheme analysis of the corpora was conducted using the *Mecab-Ko* package in Python (Version 3.8.10; Van Rossum & Drake, 1995). The R software was utilized for preprocessing the corpora, computing WF and CD measures, and performing statistical analyses (Version 4.1.2; R Core Team, 2021). The corpora were preprocessed and computed using the *tidyverse* package in R (Wickham & Wickham, 2017). Regression models were built with the *lm* function, and the statistical values of the models were computed with the *anova* function in the *car* package (Fox et al., 2012).

Results

In the present study, we aimed to investigate the effects of WF and CD on Korean visual word recognition and whether these effects vary by language register. First, we hypothesized that WF and CD from the spoken corpus will better predict lexical decision times than those from the written corpus. Second, we predicted that CD will have a more substantial effect in predicting lexical decision times than WF in both corpora.

Consistent with previous research on CD, we conducted hierarchical regression analyses to test these two hypotheses and utilized the R-squared change statistic to interpret the results (Adelman et al., 2006; Johns et al., 2016; Senaldi et al., 2022). The R-squared change statistic indicates that the explained variance increases as new variables are added to the model. This enables the evaluation of the distinctive contribution of each block of variables. We performed hierarchical regression analyses for each of the WF and CD variables to determine which variable more effectively predicts the RT data. Each regression analysis was composed of three levels, and a total of four regression analyses were conducted for each predictor variable, which were WF and CD computed from the written and spoken corpus. The first model incorporated the following control variables: the number of syllables, the number of meanings, and the orthographic first syllable token frequency. The second model introduced a secondary predictor variable (either WF or CD) in addition to the control variables in the previous model. The secondary predictor variable depended on the primary predictor variable being examined in each analysis. For instance, we placed WF in the second model when we examined the effect of CD in the third model and vice versa. This enabled the assessment of each predictor's unique effect while controlling for the influence of other factors. In the third model, the primary predictor variable of interest, either WF or CD, was entered along with the control variables and the secondary predictor. Considering the effects of the secondary predictor and control variables, this third model allowed for the examination of the direct effects of each predictor variable. To ensure the robustness of the results, we repeated this procedure for both WF and CD computed from each corpus, interchanging their roles as secondary and primary predictors in different models. This approach was implemented to ensure that the observed effects are not solely driven by the order in which predictors were entered into the model. In the final model, we included an interaction term between WF and CD to test if their effects depend on the level of the other. To differentiate the unique and interaction effects of each variable, the target variables and interaction terms were not incorporated concurrently in the same model; instead, they were introduced sequentially into the hierarchical regression model in consecutive stages. Table 1 presents the formulas for the hierarchical regression models of each predictor variable.

Table 1. Formulas for the hierarchical regression models of each predictor variable

Model	Predictor variable	Formula
1	WR_WF	RTs ~ Meanings + Syllables + Token
	WR_CD	
	SP_WF	
	SP_CD	
2	WR_WF	RTs ~ Meanings + Syllables + Token + WR_CD
	WR_CD	RTs ~ Meanings + Syllables + Token + WR_WF
	SP_WF	RTs ~ Meanings + Syllables + Token + SP_CD
	SP_CD	RTs ~ Meanings + Syllables + Token + SP_WF
3	WR_WF	RTs ~ Meanings + Syllables + Token + WR_CD + WR_WF
	WR_CD	RTs ~ Meanings + Syllables + Token + WR_CD + WR_CD
	SP_WF	RTs ~ Meanings + Syllables + Token + SP_CD + SP_WF
	SP_CD	RTs ~ Meanings + Syllables + Token + SP_WF + SP_CD
4	WR_WF	RTs ~ Meanings + Syllables + Token + WR_CD + WR_WF + WR_CD * WR_WF
	WR_CD	RTs ~ Meanings + Syllables + Token + WR_CD + WR_CD + WR_WF * WR_CD
	SP_WF	RTs ~ Meanings + Syllables + Token + SP_CD + SP_WF + SP_CD * SP_WF
	SP_CD	RTs ~ Meanings + Syllables + Token + SP_WF + SP_CD + SP_WF * SP_CD

Note. RTs = Mean response times from the KLP database; WR_WF = Word frequency from the written corpus; WR_CD = Contextual diversity from the written corpus; SP_WF = Word frequency from the spoken corpus; SP_CD = Contextual diversity from the spoken corpus; Meanings = Number of meanings; Syllables = Number of syllables; Token = Token frequency of the first syllable.

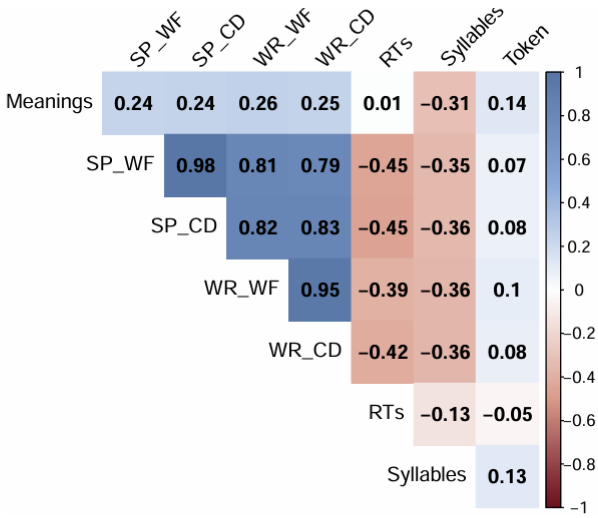

Figure 1. Correlation matrix among variables considered for hierarchical regression analysis
Note. SP_WF = Word frequency from the spoken corpus;
SP_CD = Contextual diversity from the spoken corpus;
WR_WF = Word frequency from the written corpus;
WR_CD = Contextual diversity from the written corpus;
RTs = Mean response times from the KLP database;
Meanings = Number of meanings; Syllables = Number of syllables;
Token = Token frequency of the first syllable.

Correlation Analysis

First, we examined the correlation coefficients (Pearson's r) between the following variables: RTs, WF, and CD from the written corpus; WF and CD from the spoken corpus; number of meanings; number of syllables; and token frequency of the first syllable. As illustrated in Figure 1, there was a substantial correlation among the predictor variables, with particularly strong positive correlations between WF and CD in both the spoken corpus (r = .984, $p < .001$) and the written corpus (r = .953, $p < .001$). These results are consistent with previous studies regarding the effects of WF and CD, as high correlations of 0.7–0.9 or more between word frequency and contextual diversity have been reported in previous studies in other languages as well (Steyvers & Malmberg, 2003; Adelman et al., 2006).

Table 2. The results of the multicollinearity analysis of variables in the hierarchical regression on both corpora before and after residualizing word frequency

Variable	Written		Spoken	
	Before residualization	After residualization	Before residualization	After residualization
Meanings	1.17	1.17	1.17	1.17
Syllables	1.28	1.28	1.27	1.27
Token	1.07	1.07	1.07	1.07
WF	11.35	1.01	33.16	1.00
CD	11.23	1.19	33.39	1.19

Note. Meanings = Number of meanings; Syllables = Number of syllables;
Token = Token frequency of the first syllable; WF = Word frequency; CD = Contextual diversity.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Multicollinearity Analysis

An analysis of multicollinearity was performed due to the strong correlation among the predictor variables to assess whether the correlation of each variable was significant enough to skew the results of the regression analyses. The assessment of collinearity involves the use of the variance inflation factor (VIF), which serves as a measure to determine the presence of a linear relationship between variables. A VIF value exceeding 10 denotes a significantly high level of collinearity (O'Brien, 2007). The results revealed a significantly high VIF above 10 between WF and CD in both corpora. To address this multicollinearity issue, WF was residualized and incorporated into the hierarchical regression model. The subsequent multicollinearity analysis indicated that all variables included in the model exhibited low VIF values of approximately 1. Consequently, all ensuing hierarchical regressions employed the residualized WFs rather than the original WFs. Table 2 presents the results of the multicollinearity analysis of the variables included in the hierarchical regression, both before and after residualizing WF.

Hierarchical Regression Analysis

Table 3 presents the results of the hierarchical regression analysis for WF and CD from the written and spoken corpus, and Table 4 presents the unique effects of each predictor variable. In the written corpus, residual WF did not significantly predict the RTs when accounting for the effect of CD and the control variables [$\triangle R^2$ in %= 0.00, p = .691]. In contrast, CD was a significant predictor even after controlling for residual WF [$\triangle R^2$ in %= 26.64, $p < .001$]. This indicates that the CD plays a key role in predicting the RTs, while residual WF had a negligible effect. There was a significant interaction between residual WF and CD in the written corpus, meaning that the effect of WF or CD on RTs depends on the level of either CD or residual WF. To interpret the interaction, we additionally conducted simple slopes analysis, which is used to demystify how the relationship between one predictor (e.g., residual WF) and RTs changes depending on the value of the other predictor (e.g., CD) in three different levels: one standard deviation (hereafter SD) below and above the mean and at the mean level (Bauer & Curran, 2005). The results of the simple slopes analysis on the written corpus indicated that CD had a strong negative effect on RTs when residual WF was low (one

Table 3. Percentages of variance explained by residualized word frequency and contextual diversity from the written and spoken corpus

Corpus	Model 1	Model 2		Model 3		Model 4
	Covariates	R_WF	CD	R_WF (after CD)	CD (after R_WF)	R_WF * CD
Written	1.90	1.94**	26.64***	26.64	26.64***	26.77***
Spoken		1.92*	30.8***	30.81*	30.81***	30.9***

Note. R_WF = Residualized word frequency; CD = Contextual diversity.
* $p < .05$, ** $p < .01$, *** $p < .001$

Table 4. Unique percentages of variance explained by residualized word frequency and contextual diversity from the written and spoken corpus

Corpus	R_WF	CD	R_WF * CD
Written	0.00	24.70***	0.13***
Spoken	0.01*	28.89***	0.09***

Note. R_WF = Residualized word frequency; CD = Contextual diversity.
* $p < .05$, ** $p < .01$, *** $p < .001$

SD below the mean; β = −71.33, $p < .001$), when residual WF was at its mean level (β = −76.26, $p < .001$), and when residual WF was high (one SD above the mean; β = −81.19, $p < .001$). This means that RTs decreased with increasing CD, regardless of the level of WF. On the other hand, residual WF had a strong positive effect on RTs (β = 14.31, $p < .001$) when CD was low (one SD below the mean). Conversely, when CD was high (one SD above the mean), residual WF exhibited a negative effect on the RTs (β = −11.10, $p < .001$). Residual WF had no significant effect on the RTs when CD was at its mean level (β = 1.60, p = .480).

In contrast, in the spoken corpus, residual WF had a significant effect in predicting the RTs when controlling for CD and covariates [$\triangle R^2$ in %= 0.01, p = .041]. As in the written corpus, CD also significantly predicted the RTs when WF was controlled [$\triangle R^2$ in %= 28.89, $p < .001$]. These results demonstrate that while CD remains a strong predictor of RTs in both corpora, the predictive effect of WF may vary depending on the language register of the corpus, with WF playing a more significant role in the spoken corpus than in the written corpus. The interaction between WF and CD was significant in the spoken corpus, indicating that the effect of WF or CD on RTs was influenced by the level of the other predictor variable. The simple slopes analysis revealed that CD exerted a significant negative effect on RTs when residual WF was low (one SD below the mean; β = −56.78, $p < .001$), when residual WF was at its mean level (β = −59.43, $p < .001$), and when residual WF was high (one SD above the mean; β = −62.09, $p < .001$). On the contrary, residual WF was positively associated with RTs (β = 8.64, p = .044) when CD was low (one SD below the mean). When CD was high (one SD above the mean), residual WF showed a negative effect on RTs (β = −19.13, $p < .001$), indicating that RTs decreased with increasing WF under high CD conditions. At the mean level of CD, residual WF did not have a significant effect on RTs (β = −5.25, p = .091).

Semi-partial Correlation Analysis

As a supplementary analysis, we additionally conducted a semi-partial correlation analysis between WF, CD, and RTs to ascertain each variable's pure contribution to the RTs when the effect of a highly correlated variable is partialed out, as in Adelman et al. (2006). This compensates for collinearity issues in the regression analysis and clarifies how much each variable, CD and WF, independently contributes to the RTs (Cohen et al., 2003). In the semi-partial correlation analysis, we employed the original WF values instead of residualized WF, as the method inherently controls for the influence of other factors, making the use of residual WF, which has already been adjusted for the effect of CD, redundant. Table 5 displays the results of the semi-partial correlation analysis. Regarding the measures from the written corpus, there was a significant negative correlation between CD and RTs when eliminating the effect of WF, which means that RTs for high-CD words are significantly shorter than those for words with low CD. On the other hand, no such correlation was observed between WF and RTs after partialing CD out. In the spoken corpus, there was no significant correlation between CD and RTs when controlling for WF, nor between WF and RTs when controlling the effect of CD. Nonetheless, the correlation between CD and RTs was marginally significant when the

Table 5. Semi-partial correlation between the predictor variables and response times

Correlation coefficient	WR_WF (controlling for WR_CD)	WR_CD (controlling for WR_WF)	SP_WF (controlling for SP_CD)	SP_CD (controlling for SP_WF)
RTs	0.009	-0.051***	-0.003	-0.013

Note. RTs = Mean response times from the KLP database; WR_WF = Word frequency from the written corpus; WR_CD = Contextual diversity from the written corpus; SP_WF = Word frequency from the spoken corpus; SP_CD = Contextual diversity from the spoken corpus.

* $p < .05$, ** $p < .01$, *** $p < .001$

effect of WF was controlled (p = .063).

Discussion

This study used hierarchical regression to evaluate the predictive effects of WF and CD on large-scale lexical decision data, aiming to investigate if their effects vary across language registers (written and spoken), which reflect the actual use of the language. To separate the unique effects of WF and CD, lexical variables such as the number of syllables were controlled.

We hypothesized that WF and CD measures obtained from the spoken language corpus will better predict lexical decision times than those obtained from the written language corpus. Another hypothesis was that when comparing the effects of WF and CD in both corpora, CD will more significantly predict lexical decision times than WF. The results from the written corpus showed that even after controlling for WF, the effect of CD remained significant. This finding is consistent with prior research that utilized corpora composed of text materials in English (Adelman et al., 2006) and Spanish (Perea et al., 2013). The results from the spoken corpus have demonstrated that the effect of WF remained when taking CD into consideration as well, although the effect of CD was more prominent than the effect of WF. In addition, CD computed from the spoken corpus predicted lexical decision times more effectively than CD calculated from the written corpus. This confirms the results of previous research that demonstrated spoken language-based WF and CD measures to be a more reliable predictor of lexical processing than measures derived from written materials (Brysbaert & New, 2009; Keuleers et al., 2010; Soares et al., 2015). The overall results indicate that CD predicts lexical decision times more precisely than WF, regardless of the language register. These results are in line with previous studies, which demonstrated that CD outperforms WF in predicting a range of behavioral data, including lexical decision in adults (Adelman et al., 2006; Brysbaert & New, 2009; Keuleers et al., 2010; Vergara-Martínez et al., 2017) and children (Perea et al., 2013; Huang et al., 2021), naming (Adelman et al., 2006; Brysbaert & New, 2009; Johns, 2021), word learning in children (Hills et al., 2010), and eye-tracking data using sentences (Plummer et al., 2014; Chen et al., 2017; Mu, 2024). Studies have also reported that WF exerts little or no effect when the effect of CD is under control, whereas the effect of CD remains substantial even when WF is controlled (Adelman et al., 2006; Perea et al., 2013; Chen et al., 2017; Hamrick & Pandža, 2020; Huang et al., 2021). We also found a significant interaction between WF and CD in both the written and spoken corpora. While CD constantly had a facilitative effect on RTs under all conditions of WF, the effect of WF was insignificant when CD was at the mean level in both corpora. Additionally, WF had a facilitative effect on the RTs when CD was high, whereas the WF had a negative effect on RTs under low CD conditions. This pattern of interaction between WF and CD aligns with prior evidence from eye-tracking experiments (Plummer et al., 2014; Chen et al., 2016) and word recognition studies (Perea et al., 2013). Our result suggests that repeated exposure to a word in limited contexts may hinder its processing, despite increased frequency. A potential explanation is that words encountered in redundant contexts (low CD) may establish robust semantic representations but can hinder word recognition speed and accuracy compared to words learned in varied contexts (Jones et al., 2012; Huang et al., 2017).

The semi-partial correlation analysis elicited a significant negative correlation between written CD and the RTs, meaning that RTs decreased with increasing CD in the written corpus. However, WF and CD in the spoken corpus, which exhibited significant effects in the hierarchical regression, did not demonstrate a significant correlation with RTs. There are two possible explanations for these results that are challenging to comprehend. First, it could be because of the difference in the analytical conditions. In the semi-partial correlation analysis, only the effects between the predictor variables (WF, CD) were controlled for, whereas in the hierarchical regression, the unique effects of each predictor were assessed within a model that incorporated control variables, including the number of syllables, meanings of words, and the token frequency of first syllables. Due to these differences, it is possible that the hierarchical regression may more accurately represent the actual processing of words. The second explanation is the issue of shared variance due to the high correlation between WF and CD. In semi-partial correlation analysis, the variance shared by the two predictors may have exerted a suppression effect, leading to an underestimation of the correlation between each predictor variable and the RTs, resulting in a minor or statistically insignificant correlation (Maassen & Bakker, 2001; Cohen et al., 2003). Conversely, in the hierarchical regression analysis with residual WF, the common variance between WF and CD was removed, thereby potentially elucidating the unique effect of each predictor variable.

The question arises as to why CD exhibits a more pronounced facilitative effect in comparison to WF. This might seem unexpected, given that the effect of WF has been widely recognized for decades, even being designated as one of the benchmark effects of working memory (Oberauer et al., 2018). The theoretical foundation of CD is closely linked with likely need, which is a concept that was initially introduced in research on memory (Anderson & Milson, 1989; Anderson & Schooler, 1991). Anderson and Milson (1989) coined the term 'need probability,' which refers to the retrieval probability of an item. They investigated the factors that influence need probability, including the quantity of distinct contexts in which an item is presented. Since retrieving irrelevant memory consumes time and effort, they postulated that it is logical to retrieve items based on their probability of need in each circumstance (Westbury, 2021). Adelman et al. (2006) extended this notion of need probability to the domain of lexical processing, proposing that the facilitative effect associated with WF might more reasonably be attributed to need probability, which serves as the basis of CD. In other words, WF might be one of the indicators of need probability but may not provide the most comprehensive explanation; CD may more accurately reflect the concept of need probability, which led to the absence of the WF effect while controlling for CD.

Yet it should be noted that CD cannot simply substitute for the WF measures since WF and CD may potentially represent distinct neural processes. Vergara-Martínez et al. (2017) observed distinct ERP effects for both WF and CD in terms of their amplitude and spatial distribution. The results showed the opposite direction of N400 amplitudes for WF and CD: CD elicited larger negativity in N400, whereas the effect of WF showed less negative amplitude in the same time window. In addition, while the WF effect was displayed on the central region, the effect of CD was observed in the anterior part of the scalp, which is primarily associated with semantic richness effects (Amsel, 2011). These results imply that WF and CD may stem from a distinct neural mechanism. However, although the ERP results revealed a clear distinction, their behavioral data only showed a significant effect of CD. Thus, while behavioral data can offer valuable insights into the explicit effect of WF and CD on lexical processing, further research employing neuroimaging techniques may be necessary to delve deeper into the origin of these effects.

While the results of the present study mainly align with previous studies, there is a difference in the results of the spoken corpus analysis: the effect of spoken WF was significant in the hierarchical regression model, albeit less pronounced than that of CD. It is possible that this discrepancy may be due to a combination of the characteristics of spoken language and the nature of Korean language use. As mentioned earlier, written language uses a range of words to refer to the same concept to avoid using the same expression repeatedly and basically undergoes multiple revisions before being read. Consequently, spoken language may exhibit more redundant expressions, as it cannot be modified after production. This may result in an increase in WF and lower CD compared to written language. Another potential explanation is the way of communicating in Korean. According to Hall (1976), Korea is classified as a country with a high-context culture, in which a large portion of meanings and intentions in communication are conveyed implicitly through nonverbal cues rather than in an explicit way. This style of communication may have made the CD effect relatively small in the Korean spoken corpus, making the results of the analyses different from other languages. However, given that the spoken corpus used in this study consisted of semi-spoken, script-based materials such as television screenplays, which may not entirely represent authentic spontaneous conversational contexts in Korean, it is necessary to confirm this possibility with a more natural spoken language corpus containing daily conversation data. For instance, features such as context-dependent expressions, omissions, and overlapping utterances are prevalent in everyday conversations, but the spoken corpus used in this study may only partially reflect these characteristics. Therefore, to precisely evaluate the influence of the high context-dependent nature of Korean on CD effects, it is necessary to conduct further research utilizing a more natural spoken language corpus, encompassing data from everyday conversations.

The significance of the current study lies in the fact that it investigated the effect of CD on visual word recognition in Korean, which was previously unexplored. In addition, this study made sure that the results regarding the effect of CD were not limited to languages with comparable structures. Although other languages have confirmed the effects of CD, it was imperative to corroborate them in Korean due to its distinctive characteristics. Syllable blocks comprise letters in Hangul (Taylor, 1980; Nam, 2018) and can function as both phonological units and morphemes. Moreover, Korean words have a high level of ambiguity because many Korean words are derived from Chinese characters, but the Korean writing system is phonographic, unlike Chinese characters that directly convey meanings. These characteristics of Hangul could affect visual word recognition processes differently than in languages with alphabetical systems, like English, or non-alphabetic systems, such as Chinese. Therefore, by including Korean in this body of research, the present study could ensure that the findings about the effect of CD are not biased toward languages with similar structures, enhancing the generalizability of the effect.

Nevertheless, the study is subject to several limitations that call for additional research to be conducted. First, although we managed to reduce high collinearity between WF and CD by using residualization, some caution in interpretation is still necessary. Although the original correlation between WF and CD was substantial, we addressed the multicollinearity issue by residualizing WF, thereby substantially reducing collinearity in the regression model (VIF $<$ 1.3). This analytic adjustment allowed us to examine the unique effect of WF after accounting for the shared variance with CD. However, residualization changes the scale and interpretation of predictors, and the presence of strong shared variance between predictors indicates that some theoretically important variance may remain entangled or suppressed. While our residual-based regression model showed significant effects, future studies might further explore this issue by incorporating dimension reduction techniques (e.g., principal component analysis, factor analysis) or the use of alternative variables to mitigate multicollinearity issues.

Furthermore, the relationship between WF and CD might vary depending on the linguistic category in which the word is included. For instance, it may vary depending on whether the context of use is specialized or commonplace. Words that are frequently employed in everyday life are likely to be employed in a broader range of contexts than words that are specialized in specific professions or academic fields. As a result, it is anticipated that the CD of jargons will be lower than that of words that are commonly used (Willoughby, Johnson, & Sterman, 2020). Thus, the correlation between WF and CD is anticipated to be lower, while the correlation between WF and CD is anticipated to be higher for words used in everyday life. Therefore, future research should also explore whether the relationship between WF and CD varies across different categories of linguistic contexts. Moreover, while the study controlled for the number of meanings of words, it could not account for additional semantic variables such as imageability, concreteness, and subjective familiarity. It is necessary to take these variables into consideration when examining the effects of CD and WF on visual word recognition because previous research has demonstrated that they have a significant impact on lexical processing (Soares et al., 2017; Kim et al., 2020). In addition, it is critical to confirm the effect of CD on processing Korean words within a sentence or a paragraph. The current study exclusively utilized isolated words and a lexical decision task to examine the effect of CD on visual word recognition in Korean. Experimental studies in visual word recognition commonly employ this paradigm to explore the process of lexical access. While isolated word recognition tasks clearly examine the effects of word characteristics, studies using stimuli at the level of sentences or larger units are more suitable for exploring how these effects manifest themselves in natural reading situations (Dirix et al., 2019). Hence, it is vital to undertake further research that employs a variety of tasks and stimuli to confirm the effect of CD in Korean. Furthermore, although this study indicated a facilitative effect of CD on Korean visual word recognition based on existing lexical decision data, additional research is required to generalize these findings utilizing a factorial design experiment or linear mixed-effect models. Given that consistent effects have been observed in English across multiple behavioral databases, further analyses or experiments are needed to ascertain whether analogous results hold true in Korean.

Supplementary Materials

The dataset of WF and CD measures utilized in the current study is shared as an attached file. The released data (CDdata.csv) comprises part-of-speech information, the number of syllables, and four metrics we computed (log-transformed WF and CD from the written corpus and spoken corpus) for the 20,604 words used in this study. We did not include measures derived from other studies, including the first syllable token frequency measure, number of meanings, and response times. Further inquiries can be addressed to the corresponding authors.

References

Adelman, J. S., Brown, G. D. A., & Quesada, J. F. (2006). Contextual Diversity, Not Word Frequency, Determines Word-Naming and Lexical Decision Times. *Psychological Science, 17*(9), 814-823.

Amsel, B. D. (2011). Tracking real-time neural activation of conceptual knowledge using single-trial event-related potentials. *Neuropsychologia, 49*(5), 970-983.

Anderson, J. R., & Milson, R. (1989). Human memory: An adaptive perspective. *Psychological Review, 96*(4), 703-719.

Anderson, J. R., & Schooler, L. J. (1991). Reflections of the Environment in Memory. *Psychological Science, 2*(6), 396-408.

Baayen, H., Piepenbrock, R., & Gulikers, L. (1996). The CELEX lexical database (cd-rom).

Balota, D. A., & Chumbley, J. I. (1984). Are lexical decisions a good measure of lexical access? The role of word frequency in the neglected decision stage. *Journal of Experimental Psychology: Human Perception and Performance, 10*(3), 340−357.

Balota, D. A., & Neely, J. H. (1980). Test-expectancy and word-frequency effects in recall and recognition. *Journal of Experimental Psychology: Human Learning and Memory, 6*(5), 576−587.

Bauer, D. J., & Curran, P. J. (2005). Probing interactions in fixed and multilevel regression: Inferential and graphical techniques. *Multivariate Behavioral Research, 40*(3), 373-400.

Brysbaert, M., Mandera, P., & Keuleers, E. (2018). The Word Frequency Effect in Word Processing: An Updated Review. *Current Directions in Psychological Science, 27*(1), 45-50.

Brysbaert, M., & New, B. (2009). Moving beyond Kučera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior Research Methods, 41*(4), 977-990.

Brysbaert M., Stevens M., Mandera P., Keuleers E. (2016). The impact of word prevalence on lexical decision times: Evidence from the Dutch Lexicon Project 2. *Journal of Experimental Psychology: Human Perception and Performance, 42*, 441-458. Crossref. PubMed.

Cai, Q., & Brysbaert, M. (2010). SUBTLEX-CH: Chinese Word and Character Frequencies Based on Film Subtitles. *PLoS ONE, 5*(6), e10729.

Chen, Q., Huang, X., Bai, L., Xu, X., Yang, Y., & Tanenhaus, M. K. (2017). The effect of contextual diversity on eye movements in Chinese sentence reading. *Psychonomic Bulletin & Review, 24*(2), 510-518.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Lawrence Erlbaum Associates Publishers

Cuetos, F., Glez-Nosti, M., Barbón, A., & Brysbaert, M. (2011). SUBTLEX-ESP: Spanish word frequencies based on film subtitles. *Psicológica, 33*(2), 133-143.

Dirix, N., Brysbaert, M., & Duyck, W. (2019). How well do word recognition measures correlate? Effects of language context and repeated presentations. *Behavior Research Methods, 51*(6), 2800-2816.

Fox, J., Weisberg, S., Adler, D., Bates, D., Baud-Bovy, G., Ellison, S., Firth, D., & Heiberger, R. (2012). *Package "car."* Vienna: R Foundation for Statistical Computing, 16(332), 333.

Grainger, J. (1990). Word frequency and neighborhood frequency effects in lexical decision and naming. *Journal of Memory and Language, 29*(2), 228-244.

Guttentag, R. E., & Carroll, D. (1994). Identifying the basis for the word frequency effect in recognition memory. *Memory (Hove, England) 2*(3), 255-273.

Hall, E. T. (1976). Beyond Culture, *New York (Anchor Press)* 1976.

Halliday, M. A. (1989). Language, context, and text: Aspects of language in a social-semiotic perspective. *Oxford University Press.*

Hamrick, P., & Pandža, N. B. (2020). Contributions of semantic and contextual diversity to the word frequency effect in L2 lexical access. *Canadian Journal of Experimental Psychology / Revue Canadienne de Psychologie Expérimentale, 74*(1), 25-34.

Hills, T. T., Maouene, J., Riordan, B., & Smith, L. B. (2010). The associative structure of language: Contextual diversity in early word learning. *Journal of Memory and Language, 63*(3), 259-273.

Howes, D. H., & Solomon, R. L. (1951). Visual duration threshold as a function of word-probability. *Journal of Experimental Psychology, 41*(6), 401-410.

Hsiao, Y., & Nation, K. (2018). Semantic diversity, frequency and the development of lexical quality in children's word reading. *Journal of Memory and Language, 103,* 114-126.

Huang, X. (2017). The role of word frequency and contextual diversity in visual word recognition: A mini review. *New Frontiers in Ophthalmology*, *3*(10.15761).

Huang, X., Lin, D., Yang, Y., Xu, Y., Chen, Q., & Tanenhaus, M. K. (2021). Effects of Character and Word Contextual Diversity in Chinese Beginning Readers. *Scientific Studies of Reading, 25*(3), 251-271.

Jescheniak, J. D., & Levelt, W. J. M. (1994). Word frequency effects in speech production: Retrieval of syntactic information and of phonological form. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(4), 824-843.

Johns, B. T. (2021). Disentangling contextual diversity: Communicative need as a lexical organizer. *Psychological Review, 128*(3), 525-557.

Johns, B. T., Dye, M., & Jones, M. N. (2016). The influence of contextual diversity on word learning. *Psychonomic Bulletin & Review, 23*(4), 1214-1220.

Johns, B. T., Sheppard, C. L., Jones, M. N., & Taler, V. (2016). The Role of Semantic Diversity in Word Recognition across Aging and Bilingualism. *Frontiers in Psychology, 7,* 195083.

Jones, M. N., Johns, B. T., & Recchia, G. (2012). The role of semantic diversity in lexical organization. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale, 66*(2), 115.

Joseph, H., & Nation, K. (2018). Examining incidental word learning during reading in children: The role of context. *Journal of Experimental Child Psychology, 166,* 190-211.

Kang, B., & Kim, H. (2009). The Frequencies of Korean Words. *Hankookmunhwasa.*

Keuleers, E., Brysbaert, M., & New, B. (2010). SUBTLEX-NL: A new measure for Dutch word frequency based on film subtitles. *Behavior Research Methods, 42*(3), 643-650.

Kil, H. (2018). The study of Korean stopwords list for text mining. *URIMALGEUL: The Korean Language and Literature, 78*, 1-25.

Kim, J., Lee, S., Kim, S., & Nam, K. (2023). Syllable frequency effect in visual word recognition: a regression study on morphologically simple and complex Korean words. *The Korean Journal of Cognitive and Biological Psychology, 35*(4), 303-335.

Kim, J., & Nam, K. (2018). Lexical Factors that Influence the Korean Eojeol Recognition. *The Korean Journal of Cognitive and Biological Psychology, 30*(4), 373-390.

Kim, S., Koo, M.-M., Kim, J., & Nam, K. (2020). The Research for Language Information Processing of Bilateral Hemispheres on Korean Noun Eojeol: Visual Half-field Study. *The Korean Journal of Cognitive and Biological Psychology, 32*(1), 29-53.

Koh, S., Hong, H., Yun, S. J., & Cho, B. (2008). The frequency effect in Korean noun eojeols: An eye-tracking study. *The Korean Journal of Cognitive and Biological Psychology, 20*(1), 21-37.

Kounios, J., Green, D. L., Payne, L., Fleck, J. I., Grondin, R., & McRae, K. (2009). Semantic richness and the activation of concepts in semantic memory: evidence from event-related potentials. *Brain research, 1282*, 95-102.

Kučera, H., & Francis, N. (1967). *Computational analysis of present-day American English.* Brown University Press.

Kwon, S., Kim, J., Lee, S., & Nam, K. (2023). The Facilitative Effect of First Syllable Frequency during Visual Recognition of Korean Noun Eojeols. *The Korean Journal of Cognitive and Biological Psychology, 35*(2).

Kwon, Y., & Nam, K. (2011). The relationship between morphological family size and syllabic neighborhoods density in Korean visual word recognition. *The Korean Journal of Cognitive and Biological Psychology, 23*(3), 301-319.

Kwon, Y. (2012). The Dissociation of Syllabic Token and Type Frequency Effect in Lexical Decision Task. *The Korean Journal of Cognitive and Biological Psychology, 23*(3), 301-319.

Kwon, Y., & Lee, Y. (2014). Time Course of Word Frequency and Word Length Effect in Visual Word Recognition: Evidence from Even-Related Brain Potential Study. *The Journal of Linguistics Science, 69*, 43-62.

Lee, E.-H., & Nam, K. (2020). The Distributions and Frequencies of Korean Syllables in Sejong Corpus. *The Journal of Linguistics Science, 92*, 79-130.

Lee, S., Kim, J., Kim, S., Kwon, S., Lee, E.-H., & Nam, K. (2023). The Facilitative Effect of the First Syllable Token Frequency in Visual Recognition of Korean Predicate Eojeols. *The Korean Journal of Cognitive and Biological Psychology, 35*(4), 337-345.

Lee, S., Lee, E.-H., Kim, J., Kim, S., Kim, J., Kang, J., Lee, C., & Nam, K. (2023). The Effect of the First Syllable and Syllables in Other Positions in Visual Word Recognition of Korean Noun Eojeol: Focusing on Token Frequency. *The Korean Journal of Cognitive and Biological Psychology, 35*(3), 151-164.

Lu, X., & Jin, J. (2022). A Study on the Lists of Common Korean Stopwords for Text Mining. *Korean Language Research Circle*, *63*(13), 1-15.

Maassen, G. H., & Bakker, A. B. (2001). Suppressor variables in path models: Definitions and interpretations. *Sociological methods & research, 30*(2), 241-270.

McClelland, J. L., & Rumelhart, D. E. (1981). An Interactive Activation Model of Context Effects in Letter Perception. *Psychological Review, 88*(5), 375-407.

McRae, K., Jared, D., & Seidenberg, M. S. (1990). On the roles of frequency and lexical access in word naming. *Journal of Memory and Language, 29*(1), 43-65.

Monsell, S. (1991). The nature and locus of word frequency effects in reading.In D. Besner, & G. W. Humphreys (Eds.), *Basic processes in reading: Visualword recognition* (pp. 148-197). Lawrence Erlbaum Associates, Inc.

Monsell, S., Doyle, M. C., & Haggard, P. N. (1989). Effects of frequency on visual word recognition tasks: Where are they? *Journal of Experimental Psychology: General, 118*(1), 43-71.

Mu, Z. (2024). Effect of contextual diversity on word recognition in different semantic contexts. *PsyCh Journal, 13*(1), 44-54.

Nam, K. M. (2018). How young children make sense of two different writing systems: Korean written in the Hangul alphabet, and English written in the Roman alphabet. *Journal of Early Childhood Literacy, 18*(4), 490-517.

National Institute of Korean Language. (2020). NIKL Written Corpus (v.1.2). URL: https://kli.korean.go.kr/corpus.

National Institute of Korean Language. (2021). NIKL Spoken Corpus (v.1.2). URL: https://kli.korean.go.kr/corpus.

Oberauer, K., Lewandowsky, S., Awh, E., Brown, G. D. A., Conway, A., Cowan, N., Donkin, C., Farrell, S., Hitch, G. J., Hurlstone, M. J., Ma, W. J., Morey, C. C., Nee, D. E., Schweppe, J., Vergauwe, E., & Ward, G. (2018). Benchmarks for models of short-term and working memory. *Psychological Bulletin, 144*(9), 885-958.

O'Brien, R. M. (2007). A Caution Regarding Rules of Thumb for Variance Inflation Factors. *Quality & Quantity, 41*(5), 673-690.

Pae, H. K., Bae, S., & Yi, K. (2019). More than an alphabet: Linguistic features of Korean and their influences on Hangul word recognition. *Written Language & Literacy, 22*(2), 223-246.

Pagán, A., & Nation, K. (2019). Learning Words Via Reading: Contextual Diversity, Spacing, and Retrieval Effects in Adults. *Cognitive Science, 43*(1), e12705.

Parmentier, F. B. R., Comesaña, M., & Soares, A. P. (2017). Disentangling the effects of word frequency and contextual diversity on serial recall performance. *Quarterly journal of experimental psychology (2006)*, *70*(1), 1-17.

Perea, M., Soares, A. P., & Comesaña, M. (2013). Contextual diversity is a main determinant of word identification times in young readers. *Journal of Experimental Child Psychology, 116*(1), 37-44.

Plummer, P., Perea, M., & Rayner, K. (2014). The influence of contextual diversity on eye movements in reading. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40*(1), 275-283.

R Core Team. (2021). R: A language and environment for statistical computing. R Foundation for Statistical Computing. https://R-project.org/

Rosa, E., Tapia, J. L., & Perea, M. (2017). Contextual diversity facilitates learning new words in the classroom. *PLOS ONE, 12*(6), e0179004.

Schilling, H. E. H., Rayner, K., & Chumbley, J. I. (1998). Comparing naming, lexical decision, and eye fixation times: Word frequency effects and individual differences. *Memory & Cognition, 26*(6), 1270-1281.

Senaldi, M. S. G., Titone, D. A., & Johns, B. T. (2022). Determining the importance of frequency and contextual diversity in the lexical organization of multiword expressions. Canadian Journal of Experimental Psychology / Revue Canadienne de *Psychologie Expérimentale, 76*(2), 87-98.

Soares, A. P., Costa, A. S., Machado, J., Comesaña, M., & Oliveira, H. M. (2017). The Minho Word Pool: Norms for imageability, concreteness, and subjective frequency for 3,800 Portuguese words. *Behavior Research Methods, 49*(3), 1065-1081.

Soares, A. P., Machado, J., Costa, A., Iriarte, Á., Simões, A., de Almeida, J. J., Comesaña, M., & Perea, M. (2015). On the Advantages of Word Frequency and Contextual Diversity Measures Extracted from Subtitles: The Case of Portuguese. *Quarterly Journal of Experimental Psychology, 68*(4), 680-696.

Steyvers, M., & Malmberg, K. J. (2003). The effect of normative context variability on recognition memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*(5), 760.

Taylor, I. (1980). The Korean writing system: An alphabet? A syllabary? A logography?. In *Processing of visible language* (pp. 67-82). Boston, MA: Springer US.

Van Heuven, W. J. B., Mandera, P., Keuleers, E., & Brysbaert, M. (2014). Subtlex-UK: A New and Improved Word Frequency Database for British English. Quarterly *Journal of Experimental Psychology, 67*(6), 1176-1190.

Van Rossum, G., & Drake, F. L. (1995). *Python reference manual* (Vol. 111, pp. 1-52). Amsterdam: Centrum voor Wiskunde en Informatica.

Vergara-Martínez, M., Comesaña, M., & Perea, M. (2017). The ERP signature of the contextual diversity effect in visual word recognition. *Cognitive, Affective and Behavioral Neuroscience, 17*(3), 461-474.

Westbury, C. (2021). Prenominal adjective order is such a fat big deal because adjectives are ordered by likely need. *Psychonomic Bulletin & Review, 28*(1), 122-138.

Wickham, H. (2017). Tidyverse: Easily install and load the 'tidyverse'. *R package version, 1*(1), 2017.

Willoughby, S. D., Johnson, K., & Sterman, L. (2020). Quantifying scientific jargon. *Public Understanding of Science, 29*(6), 634-643.

Yi, K., Koo, M.-M., Nam, K., Park, K., Park, T. J., Bae, S., Lee, C. H., Lee, H.-W., & Cho, J.-R. (2017). The Korean Lexicon Project: A Lexical Decision Study on 30,930 Korean Words and Nonwords. *The Korean Journal of Cognitive and Biological Psychology, 29*(4), 395-410.

Yonelinas, A. P. (2002). The Nature of Recollection and Familiarity: A Review of 30 Years of Research. *Journal of Memory and Language*, *46*(3), 441-517.

한국어 시각 단어 재인 과정의 맥락 다양성 효과

송지수[1], 김상엽[2], 남기춘[1]

[1]고려대학교 심리학부
[2]전남대학교 심리학과

언어심리학 분야에서 광범위하게 이루어진 연구에 따르면, 단어 빈도는 언어정보처리와 기억을 촉진하는 데 중요한 역할을 한다. 그러나 최근 연구에 따르면, 단어가 사용된 언어적 맥락인 문서의 수를 가리키는 맥락 다양성이 단어 빈도보다 언어정보처리를 더 정확하게 예측하는 것으로 나타났다. 이에 본 연구는 한국어 시각 단어 재인 과정에서 맥락 다양성이 어떠한 영향을 미치는지 단어 빈도와 비교하여 알아보고자 하였다. 이를 위해 국립국어원 문어 및 구어 말뭉치에서 단어 빈도와 맥락 다양성 측정치를 산출한 다음, 위계적 회귀분석을 이용하여 한국어 어휘판단 데이터베이스(KLP)의 반응시간 데이터를 분석하였다. 분석 결과, 두 말뭉치 모두에서 단어 빈도와 다른 어휘 변인들을 통제하였을 때, 맥락 다양성은 한국어 단어 재인에 촉진적 효과를 가지는 것으로 나타났다. 반면, 문어 말뭉치의 경우 맥락 다양성과 다른 어휘 변인들을 통제하였을 때 단어 빈도의 효과는 나타나지 않았고, 구어 말뭉치의 경우 단어 빈도의 효과 역시 유의하게 나타났으나 맥락 다양성 효과에 비해 작게 나타났다. 이러한 결과는 맥락 다양성이 문어와 구어 모두에서 한국어 시각 단어 재인 과정의 촉진에 중요한 역할을 할 수 있음을 시사한다.

주제어: 맥락 다양성, 단어 빈도, 시각 단어 재인, 어휘 판단, KLP