Lexical Processing of Tertiary- Level Students: A Cognitive Scientific Experiment

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ABSTRACT

This paper is about the lexical processing performance of 144 college students from Zamboanga City, Philippines, and how their cognitive processing abilities can be empirically evaluated using a cognitive experiment Lexical Decision Task (LDT) administered and processed via SuperLab Pro 5 software. In such an experiment, participants determine as quickly and accurately as possible whether visually presented stimuli are real words or non-words, with stimuli being derived from the University Word List and pseudowords from established sources. Following Morton's Logogen Model [28], the study examines accuracy, reaction time, and possible sex differences in lexical processing. The students performed quite well, scoring an average of 73.26% accuracy rates, while the mean reaction time was 1,211.63 ms. Females performed better on tests (74.79%) than males (70.25%), but their male counterparts had speedier reaction times. It is in line with the Word Frequency Effect since high-frequency words are faster processed due to their lower cognitive load. The results underscore the value of exposure beyond the classroom in promoting good lexical access. Future experiments should consider factors like vocabulary knowledge, socio-economic status, and other stringent tools for assessing lexical processing mechanisms.

Keywords: lexical processing, vocabulary knowledge, cognitive experimental task, reaction time, accuracy

INTRODUCTION

Vocabulary knowledge, a body of word knowledge, is an essential component for effective communication. One way to understand a learner's vocabulary knowledge is to understand the lexical processing. Studies on the lexical processing explore how an individual accesses word which allow researchers and language educators to understand the underlying processes behind the human mind, particularly vocabulary knowledge. The studies on lexical processing mostly focused on international setting and are focused on infants [12]; [8], which means there is a dearth of lexical processing studies in the Philippines.

Shehzadi and Pervaiz [55] examined the correlation of English language exposure and lexical access in the L2 mental lexicon of intermediate level ESL learners. The study found moderate positive correlation between English language exposure and lexical access of familiar lexicons. The utilization of self- practice exercises on English language exposure was found to be strongly correlated with lexical access of familiar words. The traditional ways of lexical activation of L2 was found to be insufficient.

Soussi [56] studied the lexical knowledge depth of tertiary level students, in terms of meaning, synonym and collocation. The study found link between L1 and EFL mental lexicon decreases as academic levels increase which suggest that proficiency level influence the development of these lexical aspects.

Gopika and Kaveevendan [53], analyzed the influence of English language proficiency to university students at a university in Sri Lanka. This qualitative study showed that majority of the students use English in the university than in school. Tertiary- level students were found to be highly engaged in writing (94%), listening (83%), and reading rather than speaking (53%). The study recommends that teachers must frequently use English as a medium of instruction.

Why strengthen the foundation skills in the Philippine Education System?

In September 9, 2024, International Large- Scale Assessments (ILSAs) Online Symposium was organized to assemble representatives from the Second Congressional Commission on Education (EDCOM 2), the World Bank Philippine Country office, the Philippine Institute for Development Studies and the Philippines' Department of Education to deliberate how international assessments can be utilized for educational reforms that address Filipino learners' needs. The World Bank Education specialists highlighted that in order to improve international assessment results, Philippines has to start with the foundational skills focusing on literacy and numeracy in elementary levels which is a crucial phase in building a strong foundational skill.

Based on reports, Philippines lag behind in foundational skills. As seen in EDCOM 2 reports, the highest scores of Filipino students in Program for International Students Assessment (PISA) were comparable with average scores of students in Malaysia, Thailand, Brunei and Vietnam and the weakest scores of Singaporean students. Another EDCOM 2 news release, anchored on DEPED Bureau of Education Assessment Strategic Management Strand to the Commission on March 13, 2024, showed that the Grade 12 Senior High School students across various tracks showed low proficiency in the National Achievement Test (NAT) scores. The students scored lowest in Science, Mathematics, and Language and Communication (EDCOM 2, 2024). Moreover, in the senate press release, a significant number of students in Grade 4 are reported to have Grade 2 or 3 competence. The report indicated that even prior to the pandemic, the Grade 4 students were found to be at least a year below curriculum strands in Mathematics and Literacy. Overall, these reports fall on a gap in "foundational skills". If this is left unaddressed, this may result in high drop- out rates and poor achievement which undermine the aspirations for High School, Technical and Vocational Education and Training and higher education. The FEU Public Policy Center (2023) also stated that this problem requires breaking down the issue in smaller pieces and synthesizes it in meaningful manner.

Based on a report of Raffy Tima in 24 Oras aired on February 21, 2028, the General Manager of the Hopkins International Partners Rex Wallen Tan said that the Philippines lag behind its ASEAN neighbors in terms of English Proficiency which affects the Filipinos' chances of getting overseas jobs. He further added that a nursing program was cancelled in 2017 wherein 90% were already hired but were not permitted to go to the United Kingdom due to their English Proficiency level.

Vocabulary is the heart of language. It serves as a foundation for language comprehension and production. It is a fundamental component for effective communication to exist. Vocabulary is considered as an important ingredient for language learning [15]. Moreover, examined the impact of vocabulary level on students' reading and writing performance using the Vocabulary Level Test (VLT) [29]. The study revealed that reading and writing performances are positively correlated with students' vocabulary level and therefore concluded that vocabulary level is an indicator of reading and writing performances. Moreover, Kilic [19] investigated the vocabulary knowledge's role in both writing and speaking among 54 Turkish learners with B2 level of English as a foreign language (EFL). The study revealed that productive vocabulary size, receptive vocabulary size, and depth of vocabulary knowledge have significant correlation with the university students' writing and speaking performances. Finally, this investigation concluded that an individual's vocabulary knowledge is a significant predictor of students' performance in productive language skills.

Clearly, several empirical studies support that vocabulary knowledge is correlated with the learners' linguistic abilities.

Studies on Lexical Processing

Donnelly and Kidd explored the lexical processing of 120 infants at 18, 21 and 24 months and infants' vocabulary through parents' report [12]. The study showed that the lexical processing efficiency has significant effect on the vocabulary size. It further concludes that the construct stability among infants reflect the structure of the developing lexicon. Moreover, Carlisle and Fleming [8] explored the first and third graders' emerging lexical processes. Words in sentence context for processing task and reading comprehension task were administered in the study. Findings corroborate with the notion that morphological processing development in grade school level possibly depend on the learners' access to full forms, base forms, and affixes representations. Learners' knowledge of the semantic and syntactic morphemes is associated with sentence processing and in turn aid in the reading comprehension in later grade school year level.

Differences of Sex

Asio and Quijano [51] investigated the relationship of the English Language Proficiency Level, alongside the Stress/ Intonation, Verbal Abilities, Correct Usage, Reading Comprehension, Spelling, Punctuation, Identifying Error and Logical Organization and Academic Performance of university students. The study further determined whether there is a significant difference on the respondents' Level of English Proficiency based on course, age, sex and language spoken. Females were found to be better than male in terms of Reading Comprehension, Correct Usage and Identifying Errors. Data also showed that there is a significant relationship between the respondents' English Language Proficiency Level and Academic Performance. No significance found on language spoken, and age (specifically on Stress/Intonation, Verbal Abilities, Correct Usage, Spelling and Punctuation, Logical Organization).

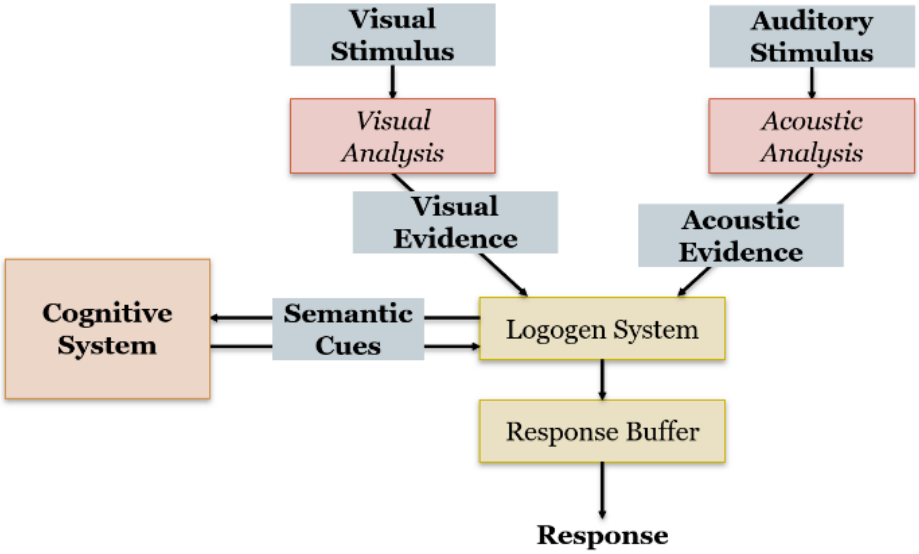
Overall, the literatures elucidated the immense role of vocabulary building in the linguistic abilities of a person. Although reports indicate Filipino learners' performance in international assessment fall behind other countries, there are certainly a number of ways to address the educational problem and building *strong foundation skills* is truly possible.

This study aimed to answer the following empirical questions:

1. What is the lexical processing accuracy and reaction time of the university students in Zamboanga City?
2. Is there a significant difference in the lexical processing accuracy and reaction time based on sex?

This study is anchored on the Logogen Model [28]. This verbal theory depicts that words are represented by a unit, or logogen. Each logogen can hold activation for an entry generated by presentation of a letter string. Elucidated that this activation threshold or activation process refers to the amount of activation that must accumulate in order for the representation to become available to consciousness. To put simply, the term "threshold" refers to the assumption that each stage must be accomplished before one can begin information onto the next stage. It is on this phase that listener recognizes the word or the speaker selects the word to be produced. The resting level of a particular logogen is higher the greater the familiarity with that word, and recognition occurs when activation of a particular logogen exceeds threshold, which explains the advantage for high over low- frequency words [9].

This model is significant in this study since its main objective is to show how an individual accesses words and their meanings. This best supports the notion that the higher the familiarity of an individual to a particular lexicion, the lesser perceptual power in the brain is required to recognize and the faster the recognition for high- frequency terms compared to low frequency lexical items.



Ramoo, D. [52]. *8.1 reading models*. Pressbooks. https://opentextbc.ca/psyclanguage/chapter/reading-models/

This figure shows that when words are presented visually or orally, the brain activates to recognize its meaning and structure. When the presented words are familiar for an individual, the recognition is faster and easier compared to low frequency words.

MATERIALS AND METHODS

Research Design

This study employed Quantitative- Descriptive Research Design. This design aimed to collect quantifiable information to be statistically analyzed to accurately describe the phenomenon which was suitable for the study as it aimed to determine the university students' lexical processing by looking into the accuracy, reaction time and sex- linked differences in the lexical processing performance.

Population and Sampling Technique

144 university students in Zamboanga City were recruited to participate in the study. There were 44 males and 100 female respondents who participated in the study. The respondents were chosen based on the following inclusion criteria: (1) must be 18 years old and above; (2) must be officially enrolled in the university (based on the records of the University- Management Information Systems and Technology Office); (3) must be a reader; and (4) must not have any history/ record of neurological problem/ disorder (based on self- report).

Moreover, these respondents were chosen using the systematic listing sampling technique. The systematic listing sampling technique was used for large population and respondents' names were available. This procedure involves selection of respondents for every nth subject in the population to be recruited in the sample [43].

Instrumentation

Lexical Decision Task

The Lexical Decision Task (LDT), introduced by Meyer & Schvaneveldt (1971), is an experimental task used in Cognitive Psychology. The LDT is used to explore how the brain accesses words and how the word frequency affects the speed and accuracy. Katz et al. (2012) showed association of Lexical Decision Task with word identification.

In LDT, the university students decide whether the stimuli were words or non- words. The target stimuli were derived from the University Word List (UWL) of Xue and [29]. The UWL was designed to help learners of English as a second language acquire academic vocabulary. It is also utilized as a framework for teaching and learning academic vocabulary in a university where English is used as the language. Moreover, the pseudowords were derived [9].

Cognitive Experimental Task

SuperLab Pro 5 software was used to administer the LDT. It is a software that presents stimuli helpful in varied experiments which need the presentation of visual stimuli (on screen), and auditory stimuli (through speakers). The researcher sought the assistance of an expert in the field of Psycholinguistics in the construction of the experimental task. The software also automatically records both the accuracy of responses and the reaction which were saved in text- only file readable for varied spreadsheets or statistics software.

Research Procedure

Prior to the conduct of the cognitive experimental task, the respondents were oriented properly of the data gathering procedures. Using a 14 inches laptop, the stimuli for LDT appear in white background, at the center of the screen with 24 Arial font size and were in capital letters. The laptop was placed at the table, 60 cm away from the respondents and was situated at eye level. The researcher ensured that the respondents were comfortable and were informed to respond as accurately and as rapidly as possible. Since the LDT required the respondents to determine whether the stimulus was a word or non- word, the respondents pressed “D” if the stimulus is a word and “L” if the stimulus is a non- word. It was followed with a fixation point which was a cross symbol that appeared at the center of the screen. The LDT comprised of 108 randomized trials presented in 4 blocks. The fixation point was significant in experimental task to prepare the respondents to focus at the succeeding trials. The LDT was accomplished for approximately ten (10) minutes per respondent depending on the speed of response. Further, the task was used to measure the respond ents’ lexical processing both on accuracy and reaction time.

Data Analysis

After the administration of the LDT, the Cedrus Data Viewer was used for organizing the relevant trials for statistical analysis. These data were transferred for inferential statistical analysis using the SPSS 17 software.

The statistical tools used in this study were the Mean, Standard Deviation and T- test for Independent Sample. The Mean and Standard Deviation were used to compute the Lexical Processing based on accuracy and reaction time. T- test for Independent sample was used to statistically compute the difference of the lexical processing performance for both accuracy and reaction time based on the respondents’ sex.

Results

Table 1 presents the university students’ performance on lexical processing in Lexical Decision Task. The data revealed that the students were proficient in lexical decision in terms of accuracy with the mean of 73.2628 and a standard deviation of 11.60293 which is considered big. It means

that the students' scores were spread out quite far from the mean. Hence, the respondents were homogeneously grouped in terms of their performance of Lexical Decision Task. Moreover, the result signifies that the students were competent specifically in their vocabulary knowledge.

Table 1: *Lexical processing: accuracy*

Lexical Processing	Mean	Standard Deviation	Descriptor
Lexical Decision (Accuracy)	73.2628	11.60293	Proficient

1-20 Low; 21-40 Below Average; 41- 60 Average; 61-80 Proficient; 81- 100 Very Proficient

Lexical processing reaction time

Table 2 presents the students' performance of lexical processing specifically on lexical decision in terms of reaction time. Data revealed that the students appear to be at an *average* normal speed with the mean of 1211.6275 milliseconds and the standard deviation of 440.37563 was considered to be big. It means that their reaction times were spread out quite far from the mean which indicated that the students were heterogeneously grouped based on their speed in responding to the trials of lexical decision experimental task.

Table 2: Respondents' performance on lexical processing: lexical decision based on reaction time in milliseconds (ms)

Lexical Processing	Mean	Standard Deviation	Descriptor
Lexical Decision Task (Reaction Time)	1211.6275 ms	440.37563	Average

100- 400 Very Fast; 401- 800 Fast; 801- 1,300 Average; 1,301- 5000 Slow; 5,000 and above Very Slow

Sex differences in lexical processing accuracy

Table 3 presents the difference on the respondents' accuracy on lexical processing, particularly on lexical decision. A closer look at this table revealed that males and females do differ in their lexical decision ability as evidenced by mean values (M- 70.2545 & F= 74.5865) with the mean difference of -4.33195 in favor of the female group. Their respective t value of -2.088 with its p value of .039 is significant at alpha 0.05. It can be implied that females have better lexical processing ability.

Table 3: Difference on the respondents' accuracy on lexical processing: lexical decision

Dependent Variable	Gender	Mean	Mean Difference	T	Sig	Interpretation
Lexical Decision (Accuracy)	Male	70.2545	-4.33195	-2.088	.039*	Significant
	Female	74.5865				

*Significant at alpha .05

Sex differences in lexical processing reaction time

Table 4 presents the respondents' reaction time on lexical processing. Data showed that males and females do differ on their reaction time as evidenced by the mean values (M= 1,316. 1249 ms & f= 1165.6487 ms) with the mean difference of 150.47619 ms in favor of the male group. The t value of 1.906 with its p value of .05 is significant at alpha .05. It means that the males perform lexical decision task faster than females.

Looking at the previous table on the females' better performance on lexical access compared to males, it is quite probable that the latter may have manifested speed- accuracy trade

off behavior in cognitive experimental psychology in that the male students may have trade off accuracy for the faster response. This happens at times when respondents tend to show off their speed during the experiment, as a result, too much speed may result in errors in their response.

Table 4: Difference on the respondents' reaction time on lexical processing

Dependent Variable	Gender	Mean	Mean Difference	t	Sig	Interpretation
Lexical Decision (Accuracy)	Male	1316.1249	150.47619	1.906	.040*	Significant
	Female	1165.6487				

*Significant at alpha .05

DISCUSSION

The result of the study showed that the university students are proficient in the lexical decision task. This is similar with Madrazo [25] which revealed that the college students performed proficiently on Picture Naming Task which is a lexical processing activity that activates lexical items in the students' bilingual or trilingual mind. Picture naming is similar with lexical decision because it also activates the students' phonological loop which is a component in the individual's working memory.

The students' proficient lexical processing performance may be attributed to the concept of Word Frequency Effect (WFE). Students' performance in lexical processing may imply that the stimuli presented in the Lexical Decision Task may be considered high- frequency (or familiar) for some university students while others categorized it as low- frequency (less common) which affected the variation in students' responses. Hence, the Word Frequency Effect (WFE) can be used to explain the lexical processing of the university students.

Understanding the word frequency effects is fundamental in comprehending aspects of human memory system [62].The word frequency effect influences language processing through the word recognition and production accuracy and speed [60]. The frequent or familiar words are processed more efficiently or a more readily recalled than the unfamiliar lexicons. Berlund- Barraza [61] investigated the differences in the cognitive effort using hemodynamic changes in the prefrontal cortex when the participants engaged I high- frequency versus low- frequency words in a working memory paradigm. The study showed that the word frequency significantly influences the cognitive effort in the working memory which means that the high frequency words require less cognitive load than the low frequency words. This, in turn, affects the language processing and may lead to cognitive biases in memory retrieval and accuracy.

Considering the concept of Word Frequency Effect, significant number of studies elucidate how vocabulary knowledge can be improved both in and out campus learning experiences (Peters, 2018) to contribute for a better lexical processing among students. Peters (2018) explored the effect of out- of- class exposure to English language media on learners' vocabulary knowledge, effect of the out- of- class exposure is correlated with learners' vocabulary knowledge, effect of length of instruction and gender among 79 English-as- a- foreign language learners. The researcher two (2) instruments: (1) frequency- based vocabulary test and (2) questionnaire. The data revealed that there is a significant correlation with the learners' vocabulary knowledge and their exposure on TV programs and with no subtitles, internet and print materials (i.e. books and magazines). Finally, the study showed that the out- of- class exposure had an effect on the learners' vocabulary knowledge. It also revealed that the out- of- class exposure had more effect on vocabulary knowledge compared to the length of instruction. Essentially, the study showed the importance of exposure to linguistic input outside the classroom and its uses in vocabulary learning.

In Mirador and Ellsworth [27] explored the exposure of university students on two (2) vocabulary websites in the academic vocabulary retention. The findings showed the websites aid

in the moderate increase in the university students' vocabulary performance. The study provides an empirical basis on the use of websites to scaffold students' learning on the targeted vocabulary.

Conclusion

The study explored the lexical processing of the university students in Zamboanga. It further investigates the lexical processing performance based on accuracy, reaction time, and sex. Data revealed that the university students are proficient in Lexical Decision accuracy with mean of 73.2628 and average reaction time speed of 1211.6275 ms. Moreover, females are found to have better lexical decision accuracy with mean of 74.7865 compared to men with mean of 70.2545. The study also reveals that males respond faster. The study suggests that high frequency words are processed faster as it required lesser perceptual power for the brain to determine lexicality of the stimuli while low frequency words take longer reaction time. Peters (2018) frequent exposure to words and large exposures to linguistic input play a crucial role in boosting learners' vocabulary knowledge. Moreover, proficient lexical processing enables better comprehension on academic texts and/or lectures. Learners may also able to express ideas more precisely and fluently.

Considering the usefulness of the lexical processing in determining learners' vocabulary knowledge and essence in the language classrooms, future researchers may study lexical processing with greater scope to further validate the result of the study and ensure that sample size for gender is balanced in number. Also, researchers may consider exploring other significant variables like vocabulary knowledge, print/ media exposure, length of vocabulary instruction, and socio-economic status to understand lexical processing and the factors that contribute to better lexical access and retrieval. Finally, future researchers may utilize more challenging assessment tools that assess the learners' depth on vocabulary knowledge.

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