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A Neurolinguistic View of the Visual Stimulus Selection System and the Auditory Processing of Children's Language

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Abstrak

Pertanyaan apakah penyerapan dan tanggapan visual stimulation kata lebih efektif dari pada auditory stimulation bunyi Bahasa Inggris oleh siswa penutur Bahasa Indonesia belum terjawab sampai sekarang. Sehingga tujuan penelitian ini yaitu menjabarkan sistem mental seleksi rangsang visual kata dan pendengaran bunyi bahasa Inggris dan bahasa Indonesia secara lateral dari perspektif neurolinguistik. Penelitian ini menerapkan pendekatan deskriptif kualitatif berbasis fenomenologi. Informan penelitian ini berjumlah 22 anak SD. Metode yang diterapkan untuk mengumpulkan data dalam penelitian ini adalah metode observasi dan kepustakaan dengan teknik rekam dan catat. Teknik yang digunakan untuk menganalisis data yaitu analisis statistik dan deskriptif. Hasil penelitian ini menunjukkan bahwa tanggapan visual stimulation kata lebih lama dibandingkan dengan daya picu auditory stimulation bunyi. Dari sudut mekanisme lateral, tanggapan siswa SD terhadap word stimulation bahasa Indonesia kedalam bahasa Inggris rata-rata lebih lama dibandingkan rentang waktu tanggapan word stimulation bahasa Inggris kedalam bahasa Indonesia. Hal ini disebabkan karena keterbatasan leksikon bahasa Inggris, faktor diluar bahasa yaitu kondisi psikologis, dan kombinasi gerak motorik yang menginterupsi fokus pemanggilan kata. Model sistem pemrosesan lateral kata dan bunyi memberikan kontribusi ke pada guru sebagai panduan penerapan strategi mengajar..

***Kata kunci*:** *Neurolinguistik, Leksikon, Dwibahasa, Pemrosesan Bahasa*

Abstract

The question of whether the absorption and response of visual stimulation are more effective than the auditory stimulation of English sounds by Indonesian-speaking students has just been answered. This study aims to describe the mental system of visual excitatory selection of words and to hear the sounds of English and Indonesian laterally from a neurolinguistic perspective. This study applies a phenomenology-based qualitative descriptive approach. The informants of this study were 22 elementary school children. The method used to collect data in this study is the method of observation and literature with recording and note-taking techniques. The techniques used to analyze the data are statistical and descriptive analysis. The results of this study indicate that the response to word sight stimulation is longer than the sound auditory stimulus trigger. From the point of view of the lateral mechanism, the responses of elementary school students to Indonesian word stimuli in English are, on average, more extended than the period for responses to English word stimuli in Indonesian. It is due to the limitations of the English lexicon, factors outside the language, psychological conditions, and combinations of motor movements that interrupt the focus of word calling. The lateral processing system model of words and sounds contributes to the teacher as a guide for implementing teaching strategies.

Keywords: Neurolinguistics, Lexicon, Bilingual, Language Processing

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1. INTRODUCTION

Language is a mechanism between sensory activity from stimuli to language signs. These are processed in mental cognitive language with motor responses to be realized into concrete forms of language such as speech or writing. (Edmiston & Lupyan, 2019; Utami, 2017). All sensor systems prioritize and select incoming stimuli to avoid overflow or distraction and to provide structure to brain input (Mailani et al., 2022; Zoefel & VanRullen, 2015). The characteristics of each incoming input have different characteristics in the sensor system. Therefore, as a direct result, each sensor system may have a strategy to deal with the continuous flow of information. Understand the mechanism of thought processing the meaning of language from visual and auditory stimuli, including a broader study, cognitive

neuroscience. Cognitive neuroscience aims to understand how people present and structure their knowledge of language meaning. The language contains comprehensive knowledge of language concepts in mind, which are processed for perception and action. In addition, word meanings result from mapping discrete conceptual landscapes where words or other nonverbal signs help speakers construct meaning because words and pictures are treated as clues. It can be said that the speaker's language experience is his language knowledge.

The meaning of the word comes from the effects of mental conditions. Mental conditions are accommodated in words that are activated in response to verbal stimuli such as sensory, motor, and affective stimuli and all their combinations. Seeing or hearing a certain word is made meaningful by activating the same mental stimulation and contains cognitive content. Previous studies have explained that meaning is based on sensorimotor influences (Fries, 2015). In language interpretation, the relationship between words and language concepts is reciprocal or leprocal (Kinasih & Sinaga, 2020; Purwanti, 2018). This means that the relationship between name and meaning is the relationship between meaning and name. If someone wants coffee, then he will say the word coffee in his mind and vice versa. If he hears the sound of coffee, he will think of coffee. The word that is read or heard is outside the speaker, while the meaning or concept of the word is inside the speaker. So, the word that is read or heard stimulates the brain to activate the concept of the word (Keitel & Gross, 2016; Sastra, 2017). There is a statement that words or pictures have no meaning, but speakers who give meaning to words.

However, from the point of view of language symbol processing, each word visual stimulus has a different absorption and interpretation period. It is the same with whether speakers respond to words that are read more quickly and accurately than words that are heard. Of course, this stimulus and response relationship is a scientific question to be investigated further from the point of view of neurolinguistic studies, studies that explain the mechanism of language function in the brain through the interpretation of visual and auditory language stimuli. interpretation of the language of Indonesian speakers and vice versa. In learning English as a foreign language, students who have mastered the regional language or Indonesian as a first language have mastered all elements of the language accurately. Thus, when studying English which has forms, structures and grammar, as well as backgrounds in different cultural systems, students must adapt and instill the concepts of the new language (Fries, 2015; Muhdi et al., 2020; Prasetya, 2021). The application of the method of pronouncing words from both visual and auditory stimuli is assumed to have a different effect on the accuracy of the meaning of language (Bire et al., 2014; Thorne & Debener, 2014). Namun penelitian sebelumnya berpendapat bahwa keakuratan tanggapan kata yang dibaca belum tentu lebih akurat atau lebih cepat akurat dari pada rangsang auditorin (VanRullen et al., 2014).

Several theoretical assumptions are raised in this neurolinguistic study as the basis for scientific studies. Visual and auditory word stimulation reciprocally assumed that the response to the stimulus of Indonesian words with English was longer than the response to the stimulus of English words with Indonesian (Mayza et al., 2018; Rokan & Rambe, 2021). Meanwhile, the theoretical assumption of auditory stimulation with student responses can be stated that the word heard has the same verbal response trigger power as the word read; words that are heard may have triggers a faster response than words that are read, and words that are read may have triggers a faster response than words that are heard (Jailani et al., 2021; Nasrullah et al., 2020). Based on these initial assumptions, this study fills the void in neurolinguistic studies to find concrete evidence about the mechanism of word interpretation with meaning. This study is believed to be able to provide explanations and new models of thought processes in two different languages based on visual and auditory excitability mechanisms in the brain. This research only focuses on words or sentences that have been

mastered by elementary school students.

This is in line with previous research showing that habituation increases a person's ability to use a foreign language (Mulyaningsih, 2015). This habit includes speaking, reading, listening, and writing. This is supported by other research which finds habituation. Children will become fluent in language (Simaremare, 2018). Therefore it is very important to stimulate your visual and auditory abilities. Other studies have revealed that appropriate English teaching methods can stimulate optimal visual and auditory stimulation processes (Fauzia, 2016; Lubis, 2018). This research aims to explain the level and duration of students' responses to visual and auditory stimuli and to analyze the mechanism of interpretation of visual and auditory stimuli in bilingual learning from a neurolinguistic perspective.

2. METHODS

This study uses scientific research procedures, a qualitative approach. A phenomenology-based qualitative approach was applied to explain the difference in the duration of absorption between visual and auditory stimuli. This approach also provides a mechanism for differentiating the response duration of word and image stimuli in English pronunciation. Responses from visual and auditory stimuli can be in the form of speech or writing. Number or numerical quantity in this study to measure the level of mastery of words or response to a series of images. The concepts in the relationship between words and images with one meaning and another are explained through relevant theories in terms of neurolinguistic theory. The descriptive approach explains the differences in students' English responses absorbed from visual and auditory stimuli (Romanti & Rohita, 2021).

The research sample was selected by means of purposive sampling using a lottery technique in the amount of 10% of the 220 total population in elementary schools. This means that the total sample size is 22 sixth graders of elementary school. The collection of samples aims to obtain information or data on spoken or written English collected through the assignment of words and pictures. The method used to collect data in this study is the method of observation and literature with recording and note-taking techniques. In the scientific method, observation is defined as systematic observation and recording related to research objectives (Richards & Rodgers, 2014). Primary data was collected through the observation method with the instruments used to collect data, English word lists that were installed alternately Indonesian-English and English-Indonesian, lists of pictures and Indonesian dictation and students answered in English. The list of words or pictures contains the word addressed and the word the student answered and the time span for mentioning the picture through Praat analysis. All instruments have been validated through the approval of linguists and English teachers. Numerical data were analyzed in a quantitative descriptive manner where the numbers were interpreted into a condition or quality of the variable being studied. Numerical duration data from visual stimuli were compared with auditory stimulus response duration data. Comparison using statistical and descriptive analysis through the average score and standard deviation. Meanwhile, the findings of data that contain qualities that can be explained by neurolinguistic theory can provide data presented in the form of figures and tables.

3. RESULTS AND DISCUSSION

Results

The Characteristics of Visual Stimulation

Visual stimulation of Indonesian words implemented into English has a coding process mechanism identical to reading English words implemented into Indonesian words.

However, the duration of each mechanism can be different. This difference is due to the spontaneous triggering factor of the language mastered with a balanced language learned and the limited mastery of English words. Thus, the lexicon's limitations reduce spontaneity's power to respond to the stimulation of these words alternately. Descriptive analysis of reciprocal word visual stimuli is presented in Table 1.

Table 1. Descriptive Analysis of Visual Stimulation

Words	Total (minutes)	R (seconds)	s.d
1. Indonesian-English	70.36	3.29	1.500469
2. English-Indonesian	64.42	2.93	1.558007
3. Indonesian-English	80.70	3.67	2.208957
4. English-Indonesian	62.23	2.83	1.393182
5. Indonesian-English	76.58	3.48	1.896842
6. English-Indonesian	50.51	2.30	1.561689
7. Indonesian-English	58.99	2.80	1.413559
8. English-Indonesian	91.73	4.17	3.095186
9. Indonesian-English	4.05	4.00	3.259068
10. English-Indonesian	48.84	2.22	1.282772

Based on Table 1, it shows a significant difference in the time span where the visual stimulus response of Indonesian words into English is longer than the response of English words into Indonesian. due to the word selection system in long-term memory. Data shows that elementary school students tend to need longer time to respond to the stimulus of 5 Indonesian words with English, which is 17.26 minutes. Meanwhile, to respond to visual stimuli from English words into Indonesian takes 14.50 minutes. This tendency occurs because the cognition system activates two language systems at once. The first system drills or repeats Indonesian words and concepts and the second system selects the right lexicon to be realized in written form. To ensure the difference in time duration, the average visual stimulus response time for elementary school students is presented in Figure 1.

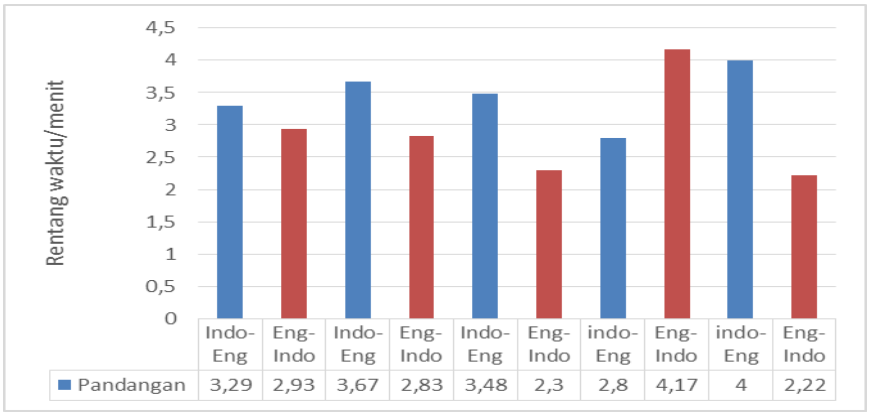


Figure 1. Graph of the Average Response Time of Visual Stimulation Elementary Students

Based on Figure 1, complex words take longer than simple words. Furthermore, the stronger or more popular the words from both languages are stored in the students' memory, the less time it takes to select words and the shorter the response time span required. There are reasons why elementary school children need a longer time to respond to visual stimuli of Indonesian words into English, (1) selection of category pairs and Indonesian word concepts

into English, (2) autographic concepts or English pronunciation that are more complicated, and (3) confirmation of the correctness of the responses. The time span categories for word visual stimulus responses between girls and boys can be presented in Table 2.

Table 2. Categories of Visual Stimulation Response Time Spans

Rentangan	Ing-Indo	L	P	Indo-Ing	L	P
durasi (menit)	Frekuensi (%)			Frekuensi (%)		
1-5 sangat singkat	0 (0) %)	0	0	2 (9%)	0	2
6-9 singkat	7 (32%)	1	6	6 (27%)	4	2
10-18 sedang	4 (18)	3	1	5 (23%)	2	3
19-27 panjang	7 (32%)	3	4	9 (41%)	3	6
>28 sangat panjang	4 (18)	3	1	0 (0%)	0	0
total	22	10	12	22	9	13

Based on Table 2, the visual response time span for English words to Indonesian shows a 3-minute longer time difference from Indonesian to English. The records show that the shortest time required to respond to 5 visual stimuli of English words with Indonesian is only 6 minutes and the longest is 35 minutes. Meanwhile, the shortest time required for students to respond to 5 visual stimuli of Indonesian words with English is only 4.20 minutes and the longest is 25 minutes. For the ability to respond to word visual stimuli, this study shows that girls have faster responses than boys. There were 6 girls and only 1 boy responding to visual stimulation to English words quickly while 4 boys and only 2 girls responding to word stimulation from Indonesian to English quickly.

Auditory Stimulation Characteristics

Based on observation of data that has been analyzed descriptively and direct observation, this study found interesting facts from the process of absorbing oral information. In the auditory system of spoken language, the process of sound coding begins with the interception of sound particles in auditory associations, interpretation of meaning, and implementation of articulation. This study believes that auditory stimulation can activate all stored sound concepts more effectively than visual stimulation. This means that the more focused or the more there is no interruption of other stimuli when absorbing information, the more efficient the time used to respond to auditory stimulation. To determine the duration of auditory stimulation in this study, a descriptive analysis of reciprocal word visual stimuli is presented in Table 3.

Table 3. Descriptive Analysis of Reciprocal Auditory Stimulation

Language	Total/minutes	R/seconds	s.d
1. Indonesian-English	58.3	2.65	2.289728
2. English-Indonesian	49.98	2.27	1.794578
3. Indonesian-English	46.24	2.10	2.011876
4. English-Indonesian	45.99	2.10	1.676219
5. Indonesian-English	49.92	2.27	1.763978
6. English-Indonesian	32.29	1.47	0.895534
7. Indonesian-English	43.83	1.99	1.21508
8. English-Indonesian	56.67	2.58	1.889043
9. Indonesian-English	41.96	1.91	1.146503
10. English-Indonesian	29.9	1.36	0.739781

Based on Table 3, it shows the average score, auditory stimulation of 5 English words into Indonesian requires a longer time, with an average of 11.40 minutes to respond. Meanwhile, the average time needed to respond to auditory stimulation for Indonesian words with English is 9.30 minutes. The more complicated the level of articulation of the words heard, the longer it takes to respond. In other words, as long as all forms and concepts of spoken language including pronunciation, intonation, and word stress patterns are stored in memory, the faster responses can be given. To reinforce the above data, a bar graph of the average time of auditory stimulation responses of elementary students is presented in Figure 2.

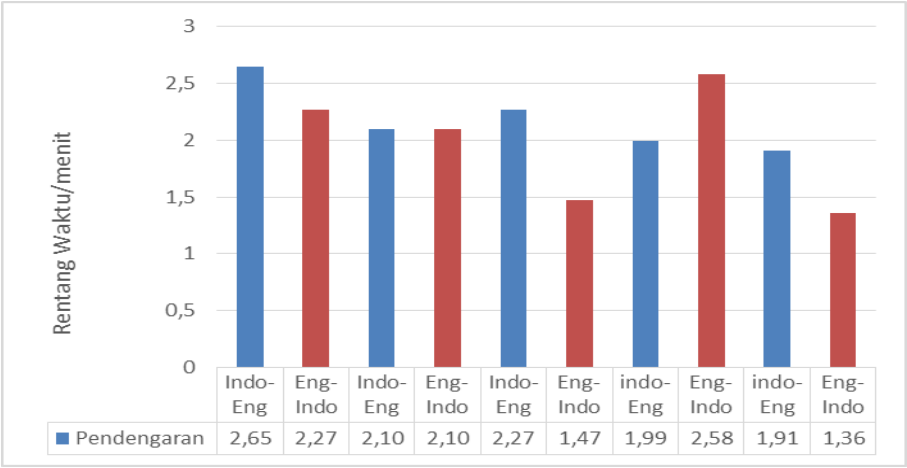


Figure 2. Graph of the Average Response Time of Auditory Stimulation Elementary Students

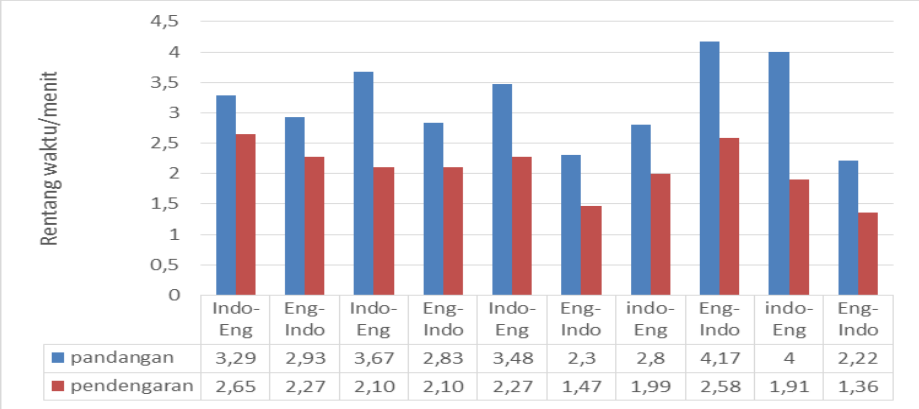
Several important aspects that influence the slow or fast language response from auditory stimulation are (1) psychological aspects; (2) language; and 3) motor. The psychological aspect concerns the readiness of students to focus on listening without a sense of pressure which hinders calling words, the linguistic aspect concerns knowledge of the languages of both languages, and the motoric aspect concerns the speed and accuracy of implementing language abstractions into concrete realizations. Other factors besides language that can influence auditory responses are communication experience, age and gender. The categories and frequencies of male and female students in auditory stimulation responses are presented in Table 4.

Table 4. Category of Auditory Stimulation Response Time Span

Range	Indo-Eng	M	F	Eng-Indo	M	F
durasi (menit)	Frekuensi (%)			Frekuensi (%)		
1-5 sangat singkat	3(0) %)	1	2	5 (0%)	1	4
6-9 singkat	10 (32%)	4	6	8 (27%)	2	6
10-18 sedang	7 (18)	4	3	7 (23%)	4	3
19-27 panjang	1 (32%)	0	1	2 (41%)	1	1
>28 sangat panjang	1 (18)	1	0	0 (0%)	0	0
Total	22	10	12	22	9	13

Based on Table 4, it shows that the shortest time needed to respond to 5 auditory stimulation words in English with Indonesian is only 1 minute and the longest is 30 minutes. Meanwhile, the shortest time to respond to 5 auditory stimulation in Indonesian words with

English is only 4.20 minutes and the longest is 21 minutes. This study showed that 6 girls and 2 boys were categorized as very responsive to auditory stimulation. The difference in reciprocal response time for visual stimulus and hearing in Indonesian and English can be presented in Figure 3.



	Indo-Eng	Eng-Indo	Indo-Eng	Eng-Indo	Indo-Eng	Eng-Indo	indo-Eng	Eng-Indo	indo-Eng	Eng-Indo
pandangan	3,29	2,93	3,67	2,83	3,48	2,3	2,8	4,17	4	2,22
pendengaran	2,65	2,27	2,10	2,10	2,27	1,47	1,99	2,58	1,91	1,36

Figure 3. Differences in Response Time to Visual and Auditory Stimulation

Based on Figure 3, it is known that the response to auditory stimulation is identified faster than visual stimulation because the words read are far more complex than the words heard. This complexity makes the response time longer. There are two reasons for the findings and statements of this study, : Visual stimulation of words not only activates the verbal concepts of the two languages, but all elements of speech (intonation, stress, tone) are absorbed in silence which is then realized into writing or speech, and auditory stimulation only focuses on words heard and responded directly both orally and in writing.

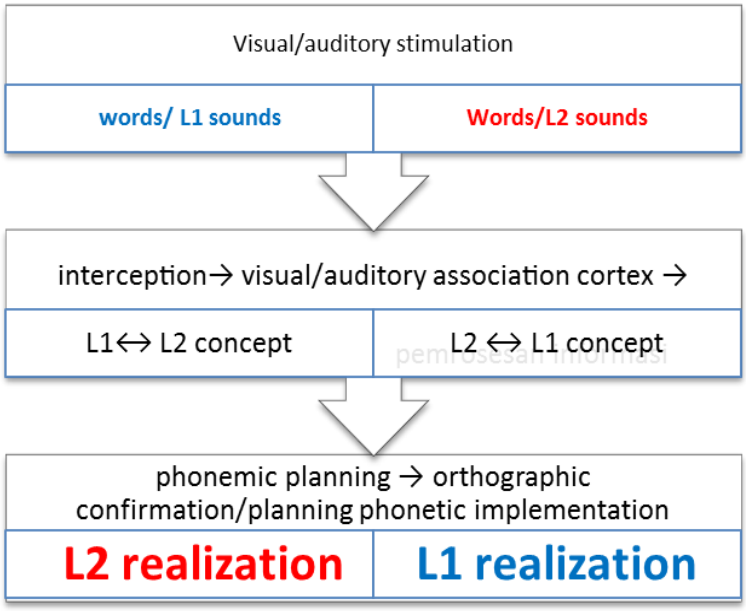


Figure 4. Word and Sound Lateral Processing System Model

Word and Sound Lateral Processing System Model

Based on the two statements above, this study proposes a lateral processing system model for words and sounds. The background referred to here is a crossed language system, L1 and L2, realizing L2 and L1. An image of a lateral processing system model for words and sounds can be presented in Figure 4.The lateral processing system model for words and

sounds as shown in Figure 4 can provide new insights for elementary school English teachers so that they can adapt appropriate and effective learning strategies. The mechanism of this model can be described in detail in Table 5.

Table 5. Mechanism of Word and Sound Lateral Processing Systems

	L2 visual stimulation processing system		L1 auditory stimulation processing system
1	The visual sensor for word stimulation is activated	1	Hearing sensors for auditory stimulation are activated
2	Interception of L1 orthographic stimuli by the occipital cortex laterally to the language cognition cortex (Herrmann, 2001)	2	Interception of excitatory L2 sound particles by the auditory association cortex in the temporal lobe to the language cognition cortex (Sastra, 2011).
3	The process of recognizing/identifying L1 language messages/symbols repeatedly and activating L2 by recalling the mental lexicon in long-term memory	3	The process of recognizing/identifying impulses/features of L2 language sounds repeatedly and activating L1 by recalling mental lexicons in long-term memory
4	if there is no L2 lexicon (No), the order will be returned (blank), if there is, continue (yes)	4	if there is no L1 lexicon (No), the order will be returned (blank), if there is, continue (yes)
5	The mental process of translating L1 to L2 begins with selecting the L2 lexicon and pairing it with the L1 lexicon concepts	5	The mental process of switching the sound of language from L2 to L1 by selecting the L1 lexicon and pairing it with L2 as a reinforcing image
6	Phonemic planning mapping by converting it to L2 orthography	6	L1 phonemic maps and phonetic implementation
7	Realization of writing L2	7	Oral realization L1

Discussion

Based on scientific assumptions, it is stated that children carry out the process of learning English with a different mechanism from learning the language they have acquired so far, Indonesian. This is important so that learning and teaching foreign languages for children can be mapped into an appropriate teaching system. Thus, the results of this study can contribute to aspects of teaching, language theory, and the development of children's language stimulation abilities. From the data analysis and presentation of the research results above, the results of this study have answered two problems: First, the response of elementary school students to Indonesian word stimulation into English is on average longer than the response time span of English word stimulation into Indonesian. This is due to the limitations of the English lexicon, factors outside the language, psychological conditions, and combinations of motor movements that interrupt the focus of word calling (Aini & Nohantiya, 2020; Sari Nur Rohmah, 2019). The average duration of students' responses to the visual stimulation of Indonesian words into English is categorized as moderate. It was also emphasized that girls tend to respond more quickly to word stimuli than boys. Second, elementary school students' responses to auditory stimulation were found to be shorter than visual stimulation responses. This is because the listening process is not interrupted by other processes such as reading words which require time to conceptualize orthographic symbol coding. The lateral processing system model for words and sounds describes the mechanism for processing the language that is read and heard so that educators can use this model as a guide for implementing teaching strategies.

From these findings, there are two important things in language processing through visual stimulation and auditory stimulation, visual stimulation related to the ability to read English texts. While auditory stimulation is related to the ability to respond to speech in speaking English. From these two categories, it can be stated that visual stimulation and hearing are initially passive and then the process of interpreting these language stimuli in the process of responding to meaning is active, in the form of writing and speech. Regarding the model set in this study, the strategy for learning English pronunciation for elementary school children depends on the students' level of L2 phonetic realization. The representation stage in the Word and Sound Lateral Processing System Model shows that students' English pronunciation is purely influenced by Balinese. Therefore, students can adopt basic explicit learning by recognizing the phonological awareness of the English sound system. At the associative process stage, the Balinese and English systems have influenced students' English pronunciation simultaneously and resulted in inconsistent pronunciation; accurate on some occasions but inaccurate on other occasions. So, an intermediate explicit learning strategy might be worth implementing by exploring or rehabilitating some aspects of phonological misconceptions with articulation practices (Alam & Lestari, 2020; Nurhayati, 2019). Finally, students whose phonetic realization is at the referential stage. requires advanced explicit learning strategies to reinforce habit formation.

The results of this study support the findings of several previous studies related to foreign language learning. One of the previous studies stated that the most important thing in second language acquisition is habituation (Mulyaningsih, 2015). This habit includes speaking, reading, listening, and writing. These results are also supported by other studies which state that children will become fluent in language (Simaremare, 2018). Of course the materials are chosen according to the ability of the child. Give freedom to children about the material to be studied. Because the most important principle in learning is fun so by giving this freedom it is hoped that it can make children happy. Other research reveals that appropriate English teaching methods can stimulate visual stimulation and auditory processes to run optimally (Fauzia, 2016; Lubis, 2018). The aim of teaching English at an early stage is to introduce English to children in a fun way, so the methods used must also be adjusted. One such method is TPR. TPR is an effective method of learning English in order to improve children's language skills in the early stages.

Related to language processing systems, other research shows new evidence of a determination level of 40.6%, which means that there is a significant effect of recycle system-based learning media on early childhood English reading skills (Novitasari et al., 2022; VanRullen et al., 2014). Thus educators can take advantage of the recycling system to meet the learning media for early English reading in early childhood education. So visual stimulation can be developed through a drill or repetition system. Meanwhile, the inaccuracy of the auditory response can result in delays in response due to disturbances in language reception. Previous research stated that there is a history of using bilingual languages in more than 3 languages from the family at home, technology, and at school which have an effect on the language development of children with speech delays (Noge, 2019). A history of using bilingual language has an influence on children with speech delays. Based on the two findings of this study, there are 3 factors behind the slow response to English visual stimuli, , English spelling factors, pronunciation factors and speech motor factors. The English spelling factor is different from the Indonesian language that is mastered by children so that it affects the accuracy and speed of student responses (Afriyanti, 2020; Pransiska, 2017). This means that spelling is different from sound realization so that students find it difficult to determine which picture marks represent through words or from words to pictures. The English pronunciation system is still not mastered by the child so that in his mind a sound will appear according to the spelling of the word he is proffered. Lack of reading practice or difficulty

pronouncing words affects reflex responses. The response process is still too long in the process of encoding two different symbols from two languages, English and Indonesian.

Based on exposure and reinforcement from various points of view of learning and acquisition of foreign languages, this study states that the visual and auditory stimulus response systems have different time spans. The length of the language response time span is highly dependent on the language readiness factor stored in memory and the habituation factor. Related, in terms of gender differences, girls are not necessarily able to respond more quickly to every type of visual or auditory stimulation depending on the level of training quantity. The results of this study contribute to the strengthening of children's foreign language processing theory where visual stimulation of words not only activates the verbal concepts of both languages but also all elements of speech, such as intonation, stress, tone) absorbed in silence which is then realized in writing or speech and auditory stimulation only focus on the words heard and respond directly both verbally and in writing. These findings also contribute to teachers who teach English to children so that they can determine innovative English teaching strategies in stimulating the accuracy and acceleration of response to word stimulation and English sounds.

4. CONCLUSION

The main results of this study stated that word selection or mental lexicon discovery for auditory stimulation responses was identified faster than visual stimulation for words read. In addition, English visual input is selected to be faster and stronger to respond to in Indonesian than Indonesian input into English. The mechanism model of the lateral processing system for words and sounds has provided new clues for how a two-language processing system occurs. These two findings become a theoretical source that the stimulation of two different languages can give different response effects with different coding mechanisms. The higher the level of mastery of the two languages, the shorter the time needed to respond. Conversely, the more limited the level of mastery of both languages, the slower the duration of the student's response time.

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