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Development of a Thai naming application for clients with aphasia

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ABSTRACT

Background: Aphasia, as brain damage resulting from a stroke, results in language impairment, including speaking, auditory comprehension, reading, and writing. Modern technology enhances self-administered recovery training, allowing clients to restore and improve communication.

Objectives: This study developed and assessed the effectiveness of an application on Android mobile devices for language rehabilitation with an emphasis on picture naming.

Materials and methods: A small sample research design was conducted with five primary caregivers and five clients with aphasia. The study was divided into two steps: application development and implementation using a single-subject experimental research design. This research design was divided into three phases: (1) Phase A1, a baseline of 2 weeks before applying the training; (2) Phase B, a training period of 6 weeks; and (3) Phase A2, a withdrawal period of 4 weeks. The total study period was 12 weeks.

Results: The naming rehabilitation application was assessed by visual graphical data analysis, with differences analyzed at each phase interval. After using the application for six weeks, the naming scores of the participants as clients were measured by the Thai Adaptation of the Western Aphasia Battery test (WAB). Results showed increased naming scores while the clients developed their naming skills using the application.

Conclusion: This application enhanced the clients' naming skills and reduced the time taken to name the words when conducting repetitive stimulation exercises in the form of intensive training combined with various cueing techniques. This application promoted the ability of clients with word-finding difficulties to retrieve words.

Introduction

Aphasia is a language disorder that affects speech, auditory comprehension, reading, and writing. Approximately 33% of stroke clients with a lesion in the language-dominant brain hemisphere suffer from aphasia.[1] This condition can significantly impact social communication and quality of life for sufferers and their families.[2,3] Common symptoms of aphasia are difficulty with word retrieval and word recall, which negatively impacts speech expression.[4]

The role of the speech-language pathologist (SLPs) is crucial in providing a rehabilitation program in the early stages of recovery and must be consistently maintained.[1,5] However, receiving a conventional rehabilitation approach

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in hospitals is challenging due to the limited availability of SLPs and the clients' economic status, with caregivers having to provide transport. Hence, in several countries, there is growing interest in developing a rehabilitation approach that caregivers can carry out at home. This option provides clients access to language and speech services without incurring high costs. Modern technology has now been integrated into the rehabilitation process as an additional tool to enhance the effectiveness of home treatment.[5]

The recent upsurge in research studies conducted abroad regarding the implementation of computer programs or smartphone-based applications for the rehabilitation of clients with aphasia has revealed that the integration of technology with conventional training can facilitate the recovery and enhancement of speech quality.[5-7] Results demonstrated that this protocol facilitated improved naming skills and enhanced the quality of non-verbal communication.[8] However, currently, in Thailand, only programs are used for communication with service recipients with aphasia that are developed based on the principles of augmentative and alternative communication (AAC). This rehabilitation approach involves devices to assist individuals with aphasia in expressing their needs and feelings or understanding various things around them according to their specific requirements. It utilizes simple devices such as communication boards with pictorial representations to more advanced technology like tablet-based applications.[9,10] No specific computer programs developed for language rehabilitation encompass speech, auditory comprehension, repetition, reading, writing, and naming skills.

In Thailand, the availability of smartphone or tablet-based language rehabilitation applications is limited because most of the existing programs are in foreign languages, expensive, and are exclusively for the iOS operating system.

An application focusing on word retrieval tailored to the Thai language's structure was developed to address this issue to rehabilitate communication impairment. After development, the caregivers used this application for 12 weeks to study its effectiveness in improving their clients' language abilities. Caregivers can utilize the results of this research to enhance word recall among clients with aphasia and better achieve the expected communication capacity.

Materials and methods

Sample group

Five pairs of caregivers and clients with aphasia were selected by purposive sampling using the following inclusion criteria.

1) Caregiver's eligibility criteria for inclusion were as follows:

- 1.1) no abnormal vision or use eyeglasses to correct for normal vision
- 1.2) have no history of hearing impairment
- 1.3) use Thai as the primary language of communication
- 1.4) demonstrate proficiency in reading and writing the Thai language
- 1.5) can use a smartphone or tablet device with a screen size of at least 5.5 inches with an Android operating system version 4.1 or higher
- 1.6) serve as the primary caregiver for service recipients who possess the characteristics outlined in item 2

2) The criteria for the selection of clients were as follows:

- 2.1) were diagnosed with aphasia by qualified SLPs and underwent assessment using the WAB test while also attaining a comprehension score that exceeded 4.[11]
- 2.2) Both genders with aphasia were aged 40 years and over.
- 2.3) normal vision or use of eyeglasses to correct their vision.
- 2.4) no history of hearing impairment or communication difficulties before the stroke.
- 2.5) used the Thai language as the primary language of communication and effectively communicated before experiencing aphasia.
- 2.6) could read and write Thai before experiencing aphasia from the stroke.

Research Methodology

This research was divided into two steps as follows:

Development of the "Thai Naming" *application*

The development of the *"Thai Naming"* application was divided into four steps as follows:

- 1.1) The application utilized a list of fundamental vocabularies from early childhood up to grade six provided by the Bureau of Academic Affairs and Educational Standards, Office of the Basic Education Commission (OBEC).[12] Twelve verbs and 58 nouns were categorized into two groups. Each word was assigned a picture, phonation, and six types of prompts, including semantic cueing (Q1), first letter (Q2), written word (Q3), sentence completion (Q4), phonological cueing (Q5), and spoken word (Q6).
- 1.2) The content validity of each item, such as words, pictures, and cues used in the application, was evaluated by three qualified SLPs utilizing the index of item objective congruence (IOC). The goal was to ascertain whether the items and the proposed measurement construct were congruent. Items with an average IOC score of 0.5 or higher were considered to cover the content adequately. In contrast, items with an IOC score lower than 0.5 were revised according to the experts' recommendations. The content was then integrated into an Android Studio application by programmers and reviewed again by experts to ensure its validity. After confirming that the content aligned with the research objectives, the application was tested and

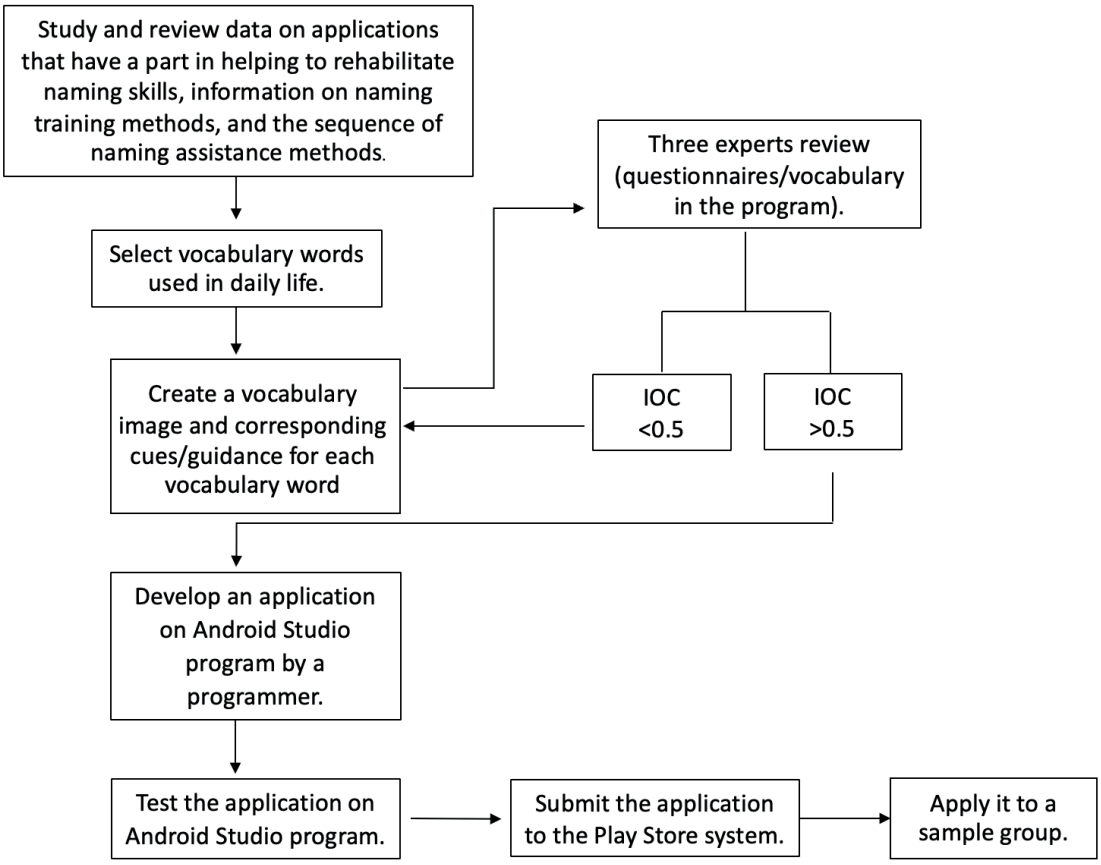

Figure 1 *Development process of "***Thai naming***" application.*

published on the Play Store, as shown in Figure 1.

1.3) After correction, the new application version was sent back to the three experts to evaluate the content. The final version of the application was uploaded to the Play Store. Figure 1 shows the process of application development.

Application of "*Thai Naming*" in the sample group

Purposive sampling was conducted to select five stroke clients with aphasia and their caregivers. The clients were undergoing rehabilitation at the Speech Therapy Unit of the Faculty of Associated Medical Sciences, Chiang Mai University, and the Industrial Rehabilitation Centre Region 3 in Mae Rim District, Chiang Mai Province. The inclusion criteria were as follows:

2.1 Stroke clients were assessed using the WAB test by the researchers.[11]

2.2 The *"Thai Naming"* application was installed on the caregiver's smartphone or tablet, and the utilization steps were clearly explained.

2.3 The application was implemented over 12 weeks, divided into three phases, as shown in Figure 2.

1) Phase 1 was the baseline or pre-application period, which lasted for two weeks. The researchers collected data at week 0 and week 2 before implementing the application.
2) Phase 2 was the experimental period during which clients and their caregivers practiced with the application for 30 minutes every day for six weeks. The researchers collected data on vocabulary practice three times during this phase at weeks 4, 6, and 8.
3) Phase 3 was the withdrawal period when the caregivers no longer used the application. The researchers collected data twice during this phase at weeks 10 and 12. At the end of the 12th week. The parameters of this study were as follows: Naming scores from the WAB test[11] and the score obtained using the application will be recorded as
   - A number of words are named using the application.
   - Average time of word naming.
   - (Sum of Response Times) / (Number of Trials).
   - The average frequency of using cues during naming.
   - (Total Number of Cues Used) / (Number of Trials with Cues).

Results

The content design of the application.

After undergoing content validation by three experts, the Index of Item-Objective Congruence (IOC) for the interview form yielded a total score of 0.90. Additionally, revisions were made in terms of visual representation of

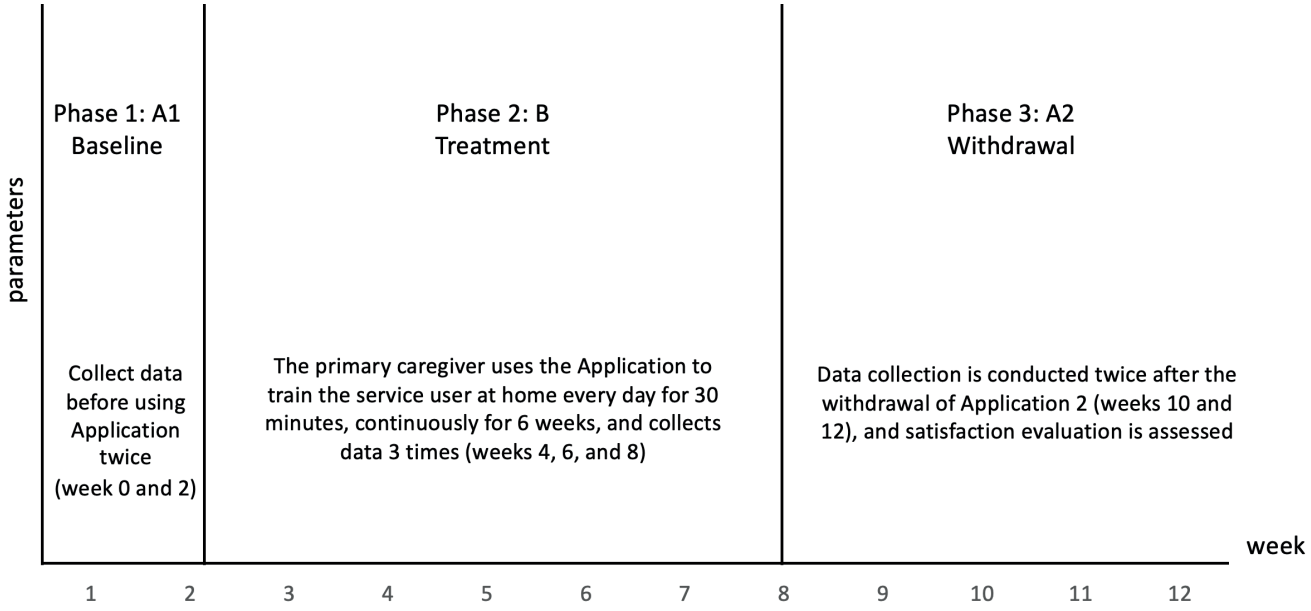

Figure 2 *Data collection for the A-B-A research design during the 12-week study period.*

vocabulary words and cueing methods, such as semantic cueing, first letter, and written word cues. Consequently, the vocabulary used in the application consists of 70 commonly known and frequently used words in daily life. Examples include "apple," "table," "shirt," and "pants," as well as verbs like "walk," "sit," and "sleep." These words will be displayed in the application, as depicted in Figure 3.

Demographic information of the caregivers of the clients

The five caregivers who participated in the study comprised three males and two females. Four of the caregivers were between 40 and 49, while the other was over 60 years old. All five caregivers were native Thai speakers. Three caregivers had a high school education, a diploma, and a postgraduate degree. They provided care for three clients for periods ranging from one to twelve hours and two clients for periods ranging from thirteen to twenty-four hours. The Thai Naming application was utilized for the five groups of clients using four smartphones with a screen size of 5.5 inches or more and a tablet with a screen size of 7 inches.

Demographic information of the clients

The five stroke clients with aphasia were four males and one female, with an average age of 53. Three clients completed primary school, one had a bachelor's degree, and one had a master's degree. Four clients had a history of stroke two years ago, one had a history of stroke one year ago, and one had a history of recurrent strokes. The WAB test [11] was used to assess the results both before and after the *Thai Naming application*, as presented in Table 1.

Visual data analysis results

The results from implementing the application for naming training with the primary caregivers over 12 weeks were presented as line graphs, divided into three phases. The analysis included the four variables recorded from the program, as shown in Table 2.

WAB naming score

The WAB naming Scores of the five clients were evaluated during Phase 1 (baseline), Phase 2, and Phase 3. Results showed an increase in naming scores during Phase 2.

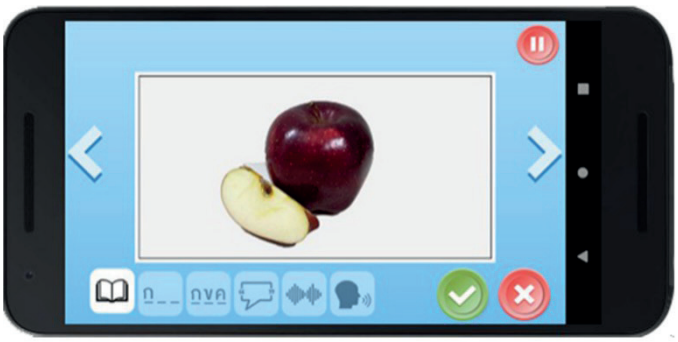

Figure 3 *Example of vocabulary display on the 'Thai Naming' application.*

Table 1. Demographic information of the stroke clients (N=5).

Order	Age (years)	Gender	Education level	Post-stroke duration (years)	Recurrent (times)	Baseline evaluation		Difference in AQ scores	Type of aphasia
						T-WAB (AQ) Pre-week 0	T-WAB (AQ) Post-week 12		
1	75	Female	Elementary education	1	-	23.7	43.8	20.1	BA
2	45	Male	Master's degree	2.4	-	33.6	36.9	3.3	WA
3	53	Male	Elementary education	2.1	-	37.3	56.2	18.9	BA (pre) TA (post)
4	51	Male	Elementary education	3.2	1	63.2	70.2	7	Anomic
5	43	Male	Bachelor's degree	2.8	-	41.3	53.7	12.4	TA

Note: WAB: Thai Adaptation of the Western Aphasia Battery, AQ: aphasia quotient, BA: Broca's aphasia, TA: transcortical motor aphasia, WA: Wernicke's aphasia, BA (pre): Broca's aphasia (pre-test week 0), TA (post): transcortical motor aphasia (post-test week 12)

Table 2. Clients' scores from four variables (N=5).

Oder	Week / Case	Baseline (A1)		Treatment (B)			Withdrawal (A2)	
		0	2	4	6	8	10	12
WAB naming score	1	2.5	2.1	4.2	5.9	7.1	7.6	7
	2	2.3	2.6	2.6	3.6	4.7	4.8	3.9
	3	4	5.7	5.6	6.8	7.1	7.1	7.5
	4	7.6	7.9	7.8	8.3	9.2	8.8	8.8
	5	2.9	4.5	5.2	6.5	6.9	7.9	7.6
Number of words named using the application	1	0	6	34	47	62	55	55
	2	9	7	24	30	27	18	31
	3	3	8	21	29	23	22	29
	4	60	61	64	67	67	68	68
	5	3	4	18	39	38	42	33
Average time of word naming (second)	1	106	53	32	26	26	26	26
	2	56	72	30	30	30	44	28
	3	56	46	32	31	31	31	26
	4	26	26	26	26	26	26	26
	5	82	58	38	27	27	26	26
Average frequency of using cues during naming (time)	1	15	27	24	22	6	14	14
	2	20	18	23	30	32	22	32
	3	28	29	33	30	31	37	39
	4	9	8	5	2	2	1	1
	5	20	26	28	27	27	28	34

Note: Average time of word naming = (sum of response times) / (number of trials), Average frequency of using cues during naming = (total number of cues used) / (number of trials with cues)

After withdrawing the application at the end of the 10th week, the scores of all clients still improved. Figure 4 shows the WAB naming scores from week 0 to week 12.

Number of words named using the application.

Results in Figure 5 showed a significant improvement in naming ability when using the application (Phase 1 vs. Phase 2). During the withdrawal (Phase 3), the number of words all five clients could spontaneously name remained stable until the completion of the 12th week. Findings suggested that using the application for six consecutive weeks effectively enhanced the clients' naming ability. However, the severity and type of client aphasia may impact the results.

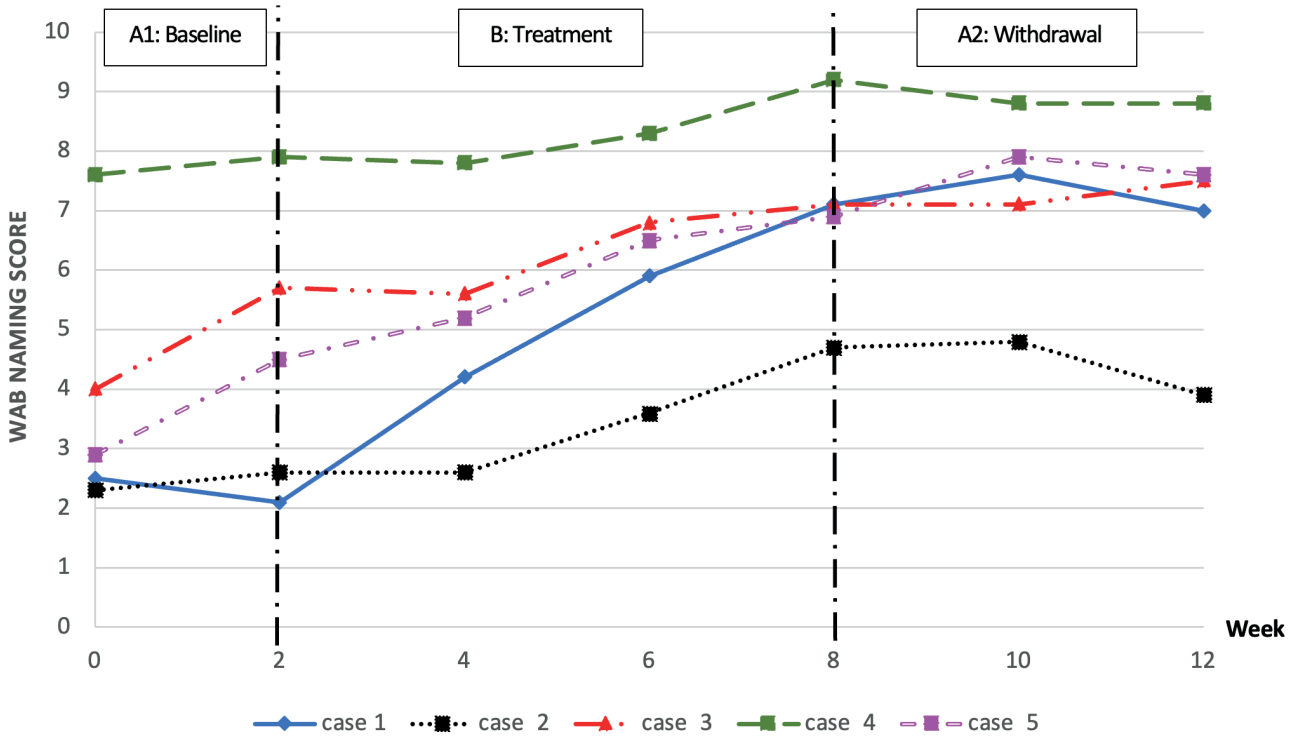

Figure 4 *Naming scores from the WAB test[11] during the 12-week study period.*

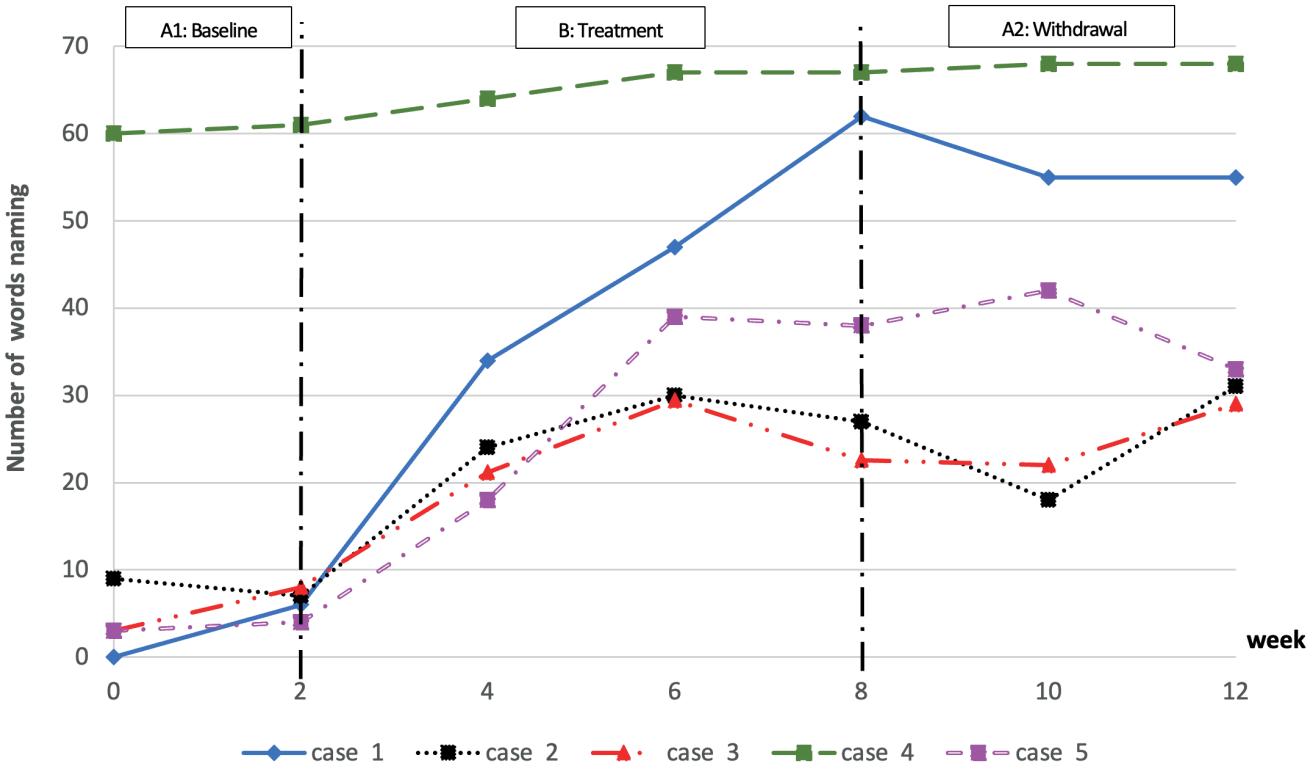

Figure 5 *Number of words named by the five clients during the 12-week study period.*

Average time of word naming by application

Figure 6 demonstrates a significant decrease in time required to spontaneous naming one word in Cases 1, 2, 3, and 5 following instructions using the Thai Naming program. This improvement in naming speed persisted during the 10th and 12th weeks of the withdrawal period (Phase 3), with no significant changes observed in case 4. Results suggested that the application was effective in improving naming speed.

Average frequency of using cues by application

Results revealed a decreasing use of cues among cases 1 and 4 across all three study phases. By contrast, the number of cues used increased in cases 2, 3, and 5 (Figure 7 and 8).

Results in Table 1 and Figure 7 show that five participants had chronic strokes, while participants with shorter stroke durations tended to develop spontaneous naming, as observed in case 1. Those with less severe stroke conditions tended to name spontaneously using fewer cueing, as seen in case 4. Figure 8 shows the frequency of using each cue during naming among the five service recipients. Participants with good auditory comprehension skills most utilized semantic cueing (Q1). This motivated and stimulated individuals with Motor Aphasia, including Broca's Aphasia and Transcortical Motor Aphasia (cases 1, 3, and 5), show enhanced vocabulary. For individuals with Wernicke's Aphasia (case 2), more cueing levels were necessary, including the use of suggesting the first letter (Q2), written words (Q3), sentence completion (Q4), and spoken word (Q6). Cueing effectively enhanced naming skills without relying solely on auditory comprehension, which presents a significant challenge for those with Wernicke's Aphasia.

Discussion

Results showed that the "Thai Naming" application improved the ability to name and increased retrieve words. The training method followed the principles of neuroplasticity, involving short-term, high-intensity sessions. This approach demonstrated improved outcomes in terms of learning and recovery within the nervous system compared to less intensive training methods.[13] This study aligned with previous research, highlighting the effectiveness of utilizing tablets for word retrieval in clients who experienced difficulties with naming due to stroke.[5, 14-16]

The use of cueing, designed with varying levels of guidance, duration, and presentation techniques, is particularly beneficial in improving the word recall capacity of clients with Motor Aphasia, including Broca's Aphasia and Transcortical Motor Aphasia (cases 1, 3, and 5). The effectiveness of this application was demonstrated by a significant increase in the total score of the Aphasia Quotient after training. Results indicated that this application increased spontaneous naming and decreased the response time required for naming, even after a break in training activities. However, in case 4 with mild Anomic Aphasia (according to WAB AQ score (Table 2), the application did not show remarkable improvement in spontaneous naming. It could be due to the lower severity of aphasia at the beginning of the study WAB AQ score at week 0 (Table 1), resulting in a slight difference in WAB AQ scores compared to week 0 (scored at 60) and week 12

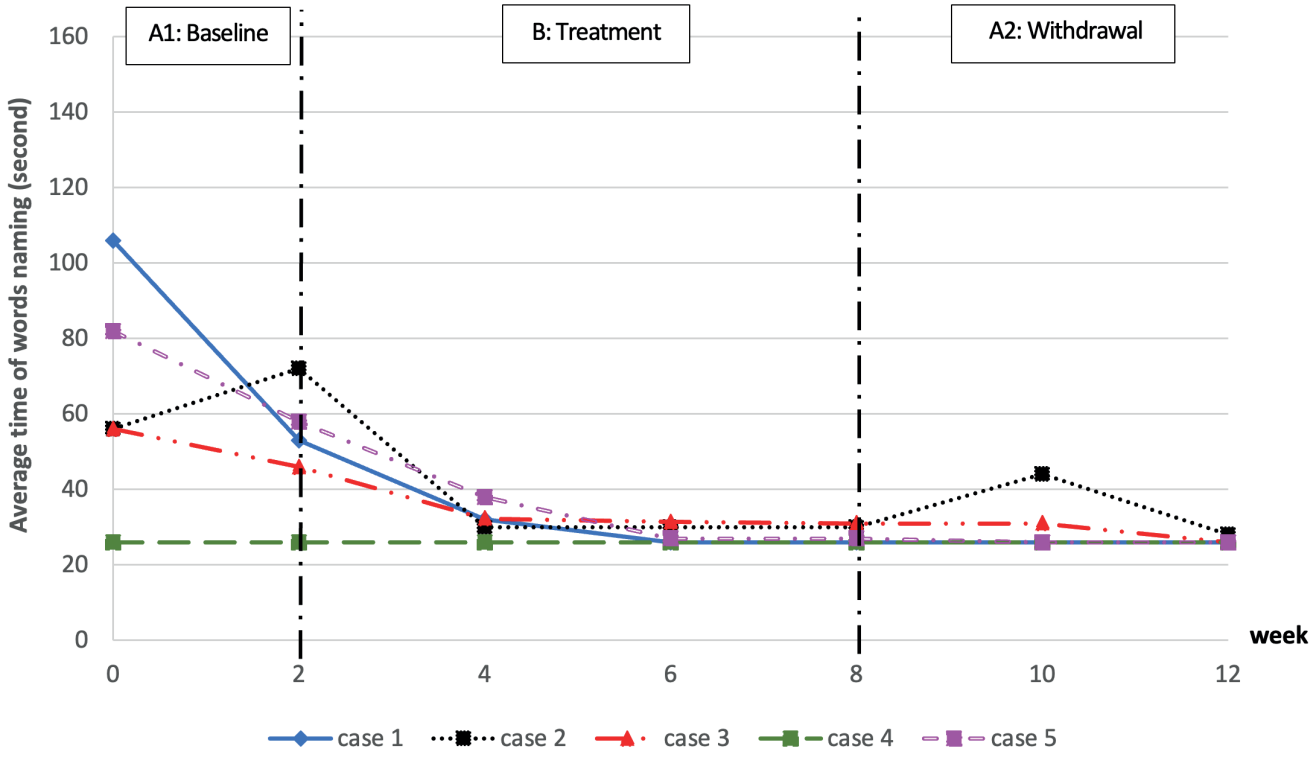

Figure 6 *Average times of words named by the five clients during the 12-week study period.*

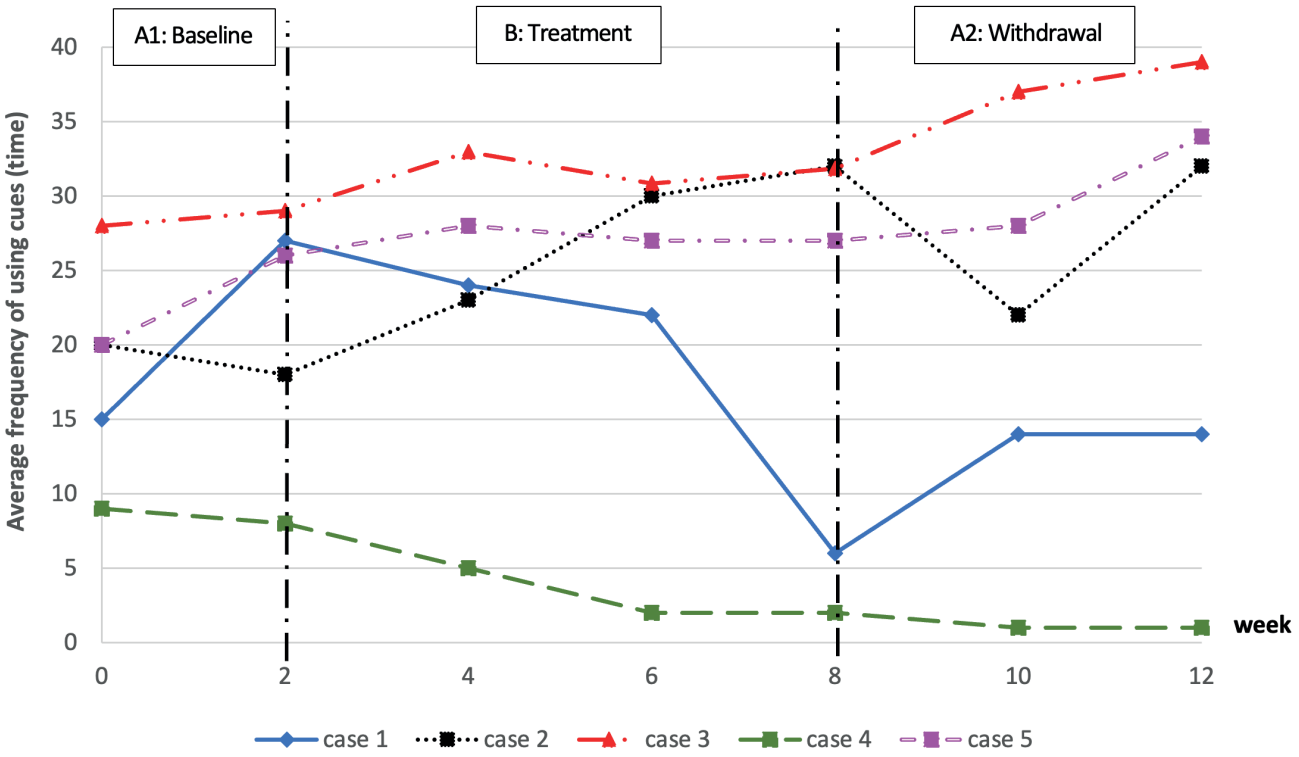

Figure 7 *Average frequency of using cues during naming among the five service recipients.*

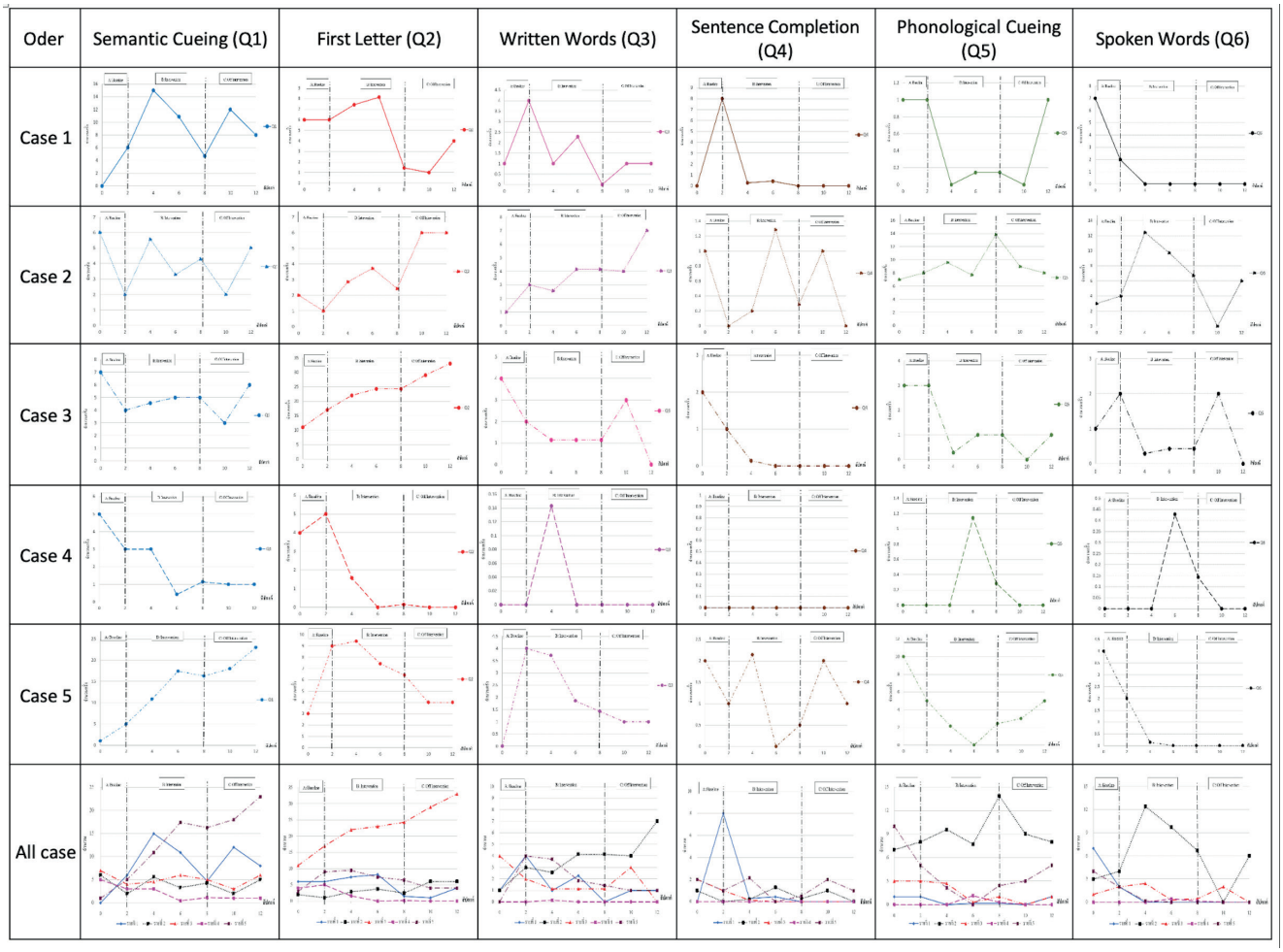

Figure 8 *Frequency of using each cue during naming among the five service recipients.*

(scored at 68). Although recurrent episodes were noted, the client's symptoms were only headache and motor weakness, but the participant showed rapid recovery. Therefore, no remarkable change in the time required for naming was found during data collection (Figure 6).

Results showed that individuals with non-fluent aphasia and/or auditory comprehension skill deficits such as Motor Aphasia (e.g., Broca's Aphasia and Transcortical Motor Aphasia; cases 1, 3, and 5) used semantic cueing (Q1) at a low level to aid in naming. Those who received education at the primary level or higher used letter cueing as a visual aid to help them name objects. By contrast, those with auditory comprehension deficits such as Wernicke's Aphasia (case 2), used phonological cueing (Q5) at a higher level, first letter cueing (Q2), written word cueing (Q3), sentence completion cueing (Q4) and spoken word cueing (Q6) respectively. The cueing method that provided phonological cues was often used. The principle of brain functioning can explain this. When we hear a sound, the brain separates the sound signals into linguistic information such as pitch, rate of sound, and tone of sound sent to the Wernicke's area for further analysis. This area collects information from visual, auditory, and tactile experiences, uses the cognitive and linguistic processes involved in recalling and matching vocabulary with sounds, and sends this data to the Broca's area to organize the response process through communication.[17-19] The Dual Stream Model of Speech and Language explains the roles of the brain's left and right hemispheres in speech perception and production, as well as language comprehension.[20] People with Broca's aphasia typically have a relatively intact receptive language, with the areas of the brain responsible for interpreting sound meaning, specifically the temporal lobe and parietal operculum, still functioning well.[17-20] Therefore, semantic cueing may be sufficient for naming. Individuals with Wernicke's Aphasia, characterized by damage to the parietal and temporal regions that are crucial for interpreting incoming auditory signals and perception, used more effective cueing strategies such as phonological cueing (Q5) or spoken word (Q6) to assist with naming. These cues helped those with WA retrieve words similar to their previous experiences and closer to the target words, as shown by the study results of Case 2. The application did not show remarkable improvement in spontaneous naming.

The result demonstrated that using the application for six weeks improves the ability of clients to do spontaneous naming. After completing the training, clients with motor aphasia could maintain their progress. However, more than simply training on specific words through concentration may be required to result in practical usage without further practice. Short-term training can enhance learning, but further research is needed to determine the long-term capacity for daily communication.[13] Holland *et al*.[21] concluded that sustained and improved language development needs 5-6 months of regular recovery because clients with aphasia have difficulty recalling words.[4] Prolonged training sessions and duration activate neurons in the brain, enhancing the retention and recall of word information stored in long-term memory, consistent with Hebb's theory.[22] Previous research showed that tablets and computer-based interventions improved clients' word recall, but these techniques have not yet been proven effective in improving communication skills with untrained vocabulary.[14-16]

The results of this study indicated that remote rehabilitation, such as the "*Thai Naming*" application, has the potential to increase the intensity of treatment for clients who cannot receive regular therapy or reside in regions with limited access to SLPs. Findings reveal that this application potentially improves clients' naming skills. Results concurred with previous studies conducted by Sukcharoen and Saksiri,[10] Choi *et al*.[23] and Wall *et al*.[24]

Conclusions

The *"Thai Naming"* application designed for training naming skills in clients with chronic aphasia could improve the ability of clients with word-finding difficulties to retrieve words and improve their spontaneous naming. This benefits their rehabilitation by involving the clients and their primary caregivers in the treatment process and helping to intensify the therapy sessions.

Research limitations

Vocabulary should be grouped according to difficulty levels to conform to each client's capabilities. It is also crucial to incorporate a tracking system to record the number of training words during the therapy program to monitor progress and effectiveness. To encourage client engagement and motivation, the application system should be interactive and include online activities such as video chats which can build trust and provide effective treatment. Incorporating medical terminology and concepts in the application can also enhance its relevance and applicability in speech and language therapy. In addition, providing guidance and training to caregivers before using the application at home is crucial to ensure proper understanding and enhance efficiency in its usage.

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