PRELIMINARY STUDY OF VALIDATING VOCABULARY SELECTION AND ORGANIZATION OF A MANUAL COMMUNICATION BOARD IN MALAY

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An integral component of a language-based augmentative and alternative communication (AAC) system is providing vocabulary typical of fluent native language speakers. In the absence of reliable and valid research on Malay vocabulary for AAC, this descriptive study explored the validation process of vocabulary selection and organization for a 144-location manual communication board. An hour of aided language samples (talking while pointing to a prototype display) followed by self-administered surveys were gathered from four typical native Malay speakers *(n=4)*, aged between 22 to 36 years at the University of Pittsburgh. Vocabulary frequency analysis, word commonality, and overall perceptions and feedback on the prototype display were compiled and analyzed. A total of 1112 word tokens and 454 word types were analyzed to support preliminary validation of the selected vocabulary and word organization of the prototype. Approximately 40% of the words on the display were used during the interview and the top 20 words were reported. Findings also suggest the importance of morphology and syntax considerations at early design stages. The positive overall perception of the display including vocabulary selection, the cultural and ethnicity appropriateness, and suggestions for system improvement were confirmed by the usability survey. Minimal rearrangement of the icon display needs to be performed to improve the usability of the system. Thus, the study findings support the early Malay manual communication board for AAC intervention. However, the

limitation of the sample size and additional research is required to support a final display that optimizes vocabulary and morphosyntactic organization of a manual communication board in Malay.

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PREFACE

1.0   INTRODUCTION

Perhaps one of the greatest challenges faced by speech-language pathologists' who treat language disorders is how to provide augmentative and alternative communication (AAC) intervention when the gap of knowledge about Malay AAC language research is enormous. Children and adults with various diagnoses (e.g. autism, cerebral palsy, amyotrophic lateral sclerosis, developmental delay, traumatic brain injury, and aphasia) remain an undeserved population in regards to AAC intervention due to the lack of empirical evidence in research and development (R&D) of AAC intervention tool supporting the Malay language.

AAC as an area of research, clinical and educational practice (ASHA, 2013) aims to achieve the most effective communication possible for the end user who may use a range of intervention to support communication when speech is not functional.   For the augmented communicator, the major contributing factors to successful AAC intervention is the ability to construct sentences and be understood by others. Two approaches to successful intervention are using unaided systems (e.g. sign language) and an aided approach (using photograph, line drawings or graphic symbols) as a medium to transmit language. Both approaches may support the language intervention process through the use of different strategies.   Previous work highlighted the importance of applying morphosyntactic function to be used by augmented communicators in the AAC intervention (Hill, 2001; Adamson et. al. in the Banajee, 2003).

Regardless of level of technology advancement (from low technology to high technology), the primarily aim is to establish both core and fringe vocabulary.

This manuscript illustrates the descriptive research on piloting a manual communication system in Malay language. This scope of this paper includes the background of the study, previous research conducted in Malay, information on Malay language, problem statements, and study objectives. The methodology section includes information on study procedures including participants, instrumentations, language sampling procedures, transcriptions procedures, reliability testing and data analysis. Results are reported based on the language sample analysis and usability survey. Finally, the manuscript covers the discussions, clinical implications, study limitations, future directions and conclusion. Important attachments were compiled in the appendices for future reference.

2.0   BACKGROUND

Augmentative and alternative communication (AAC) treatment as supported by the International Society of Augmentative and Alternative Communication (ISAAC), American Speech and Hearing Society (ASHA), and Persons with Disabilities Act 685 in Malaysian Law (2008) goes beyond today's accessibility mandates. These mandates require that AAC be available for people with disabilities if individual speech skills do not meet their day-to-day needs for people of all ages. AAC would allow people with complex communication needs (CCN) to access core and fringe vocabulary to form sentences, and express themselves effectively. AAC devices can range from easy and low-cost systems to more advance and expensive technology.

The field of AAC in Malaysia, however is very young. The Persons with Disabilities Act 685 in 2008, acknowledged of rights of people with disabilities under Malaysian Law for the first time. People with disabilities (PWDs) became eligible for various financial programs including the provision of no-cost assistive technology (including the AAC systems) and medical care at government hospitals. The growing demand for AAC intervention from medical professionals, users, families and community urged the government to employ more personnel in the rehabilitation field. However, the number of potential AAC speakers presenting with various speech and language disorders exceeded the number of practicing professionals in speech-language pathology.   The scarcity of qualified speech-language pathologists is also a contributing factor to the slow growth of the AAC in Malaysia. According to the Human

Resource Department, Ministry of Health, Malaysia (2013), 65 medical rehabilitation officers are currently employed as speech-language pathologists in government hospitals. Furthermore, less than two hundred practitioners work in the private sector. Malaysia not only lacks trained professionals, but is behind in conducting AAC research and development (R&D). Consequently, the high demand for AAC intervention in hospital based rehabilitation services as well as educational settings exceeds available service providers and AAC resources and tools.

The central focus of AAC interventions is meeting the needs of people with complex communication needs (CCN), their families, teachers / instructors and other people in community. In the United States, eligibility is usually determined by the individual's who demonstrating a severe expressive communication disorder, but has the physical, cognitive, and language abilities necessary to use the specific type of AAC device requested. This must be verified through a comprehensive evaluation performed by a licensed speech-language pathologist within the past 6 months in order to be covered by the Center for Medicaid and Medicare Services (CMS) (2005). The availability of a therapeutic intervention and a wide range of AAC systems can support people who have particular needs or preferences. AAC devices can range from low technology (e.g. the manual communication board) to higher performance technology systems (e.g. voice output speech generating devices) that aim to achieve the most effective communication possible. Furthermore, various intervention strategies are known to have a facilitative effect on speech production (Millar, Light, & Schlosser, 2006), and improve communication and language competency among people with complex communication needs (ASHA, 2013).

Recent reports by the United Nation Economic, Social Commission for Asia Pacific (UNESCAP) (2012) showed the prevalence rate of 0.2% (160,000 people) for speech and

language disorders per year. Based on 2010 statistics, one third of the Malaysian population were children under 18, with 3.2 million under the age of five (Social Statistics Bulletin Malaysia, 2010). Impairment and disability caused by cerebral palsy is likely to be similar in both developing and developed countries (Lim & Wong, 2009). In Malaysia 3-4 per 1,000 children were estimated to have cerebral palsy and are also potential candidates for AAC intervention. In addition, the official statistic for the prevalence rate of autism is 1 case per 600 children in Malaysia (Ministry Of Health Census, 2004). Among adults, the stroke incidence rate was 67 per 100,000 (April 2010 to March 2011).

Given these statistics, Malaysia has a growing need for AAC intervention. Looking at the bright side, although the Malay language has not been rigorously researched in the AAC field, the framework established in other languages has provided advantages to studying the Malay language. In past years, research has been conducted to address vocabulary selection in different languages such as English (Balandin & Iacono, 1999; Banajee, Dicarlo, & Buras Stricklin, 2003), Mandarin Chinese (M.-C. Chen, Hill, & Yao, 2009), Korean (Shin, 2012) and Thai (Chompoobutr, Boriboon, Phantachat, & Potibal, 2009). Previous researchers have provided different methods for researching vocabulary, including the use of multiple informants' in vocabulary selection (D. R. Beukelman & Mirenda, 2012; Bryen, 2008) and comparing predicted vocabulary with real vocabulary use in daily activities (Dark & Balandin, 2007).

Nonetheless, the vast majority of previous literature has systematically followed the framework identified in Balandin and Iacono (1998) and Hill (2006), to establish a core and fringe vocabulary, for use in designing AAC systems. Balandin and Iacono's seven step process for identifying and selecting core vocabulary in English to develop an AAC display has also guided R&D in Malay language research. The steps include: (1) compilation of spoken language

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samples, (2) recruitment of participants, (3) collections of spoken conversational samples, (4) impose sample from the natural environments (e.g. workplace, kindergarten or school), (5) the use of orthographic transcription by more than one person, (6) testing for reliability and (7) the provision of word lists based on the frequency analysis results to be used in AAC intervention (Balandin & Iacono, 1998, 1999; Banajee et al., 2003; D. Beukelman, McGinnis, & Morrow, 1991; M.-C. Chen et al., 2009; Crestani, Clendon, & Hemsley, 2010; Trembath, Balandin, & Togher, 2007). These guidelines are standard, highly replicable, and provide strong reliability for validating vocabulary selection.

Principles of design based on evidence-based practice (EBP) are very crucial for creating AAC displays with the goals of optimizing communication and supporting users with language deficiency (Hill, 2006). The systematic study and application of design principles, development, and improvement of prototypes or new methods, tools and resources are required. Considerations of the population(s) or potential clients benefit for the product are very important from the start. In this study, we aimed to create the prototype for native Malay speakers. Then, a search for current best available evidence was conducted to discover any existing published study of vocabulary selection in the Malay language. Based on the systematic review, four early studies were located and used as our major reference. Hill (2006) also recommended researchers identify current performance related to the proficiency of use for any prototype. Two performance measures were identified and used in a previous study (Hill & Chen, 2011) on the word frequency and word commonality in Mandarin Chinese. The process continues through multiple stages of prototype testing and clinical trials to hypothesis testing for product development.

Unfortunately, due to the lack of research conducted in selecting vocabulary for AAC in the Malay language, many native Malay speakers are denied the opportunity to access the language-based AAC interventions. The current environment in speech and language clinics is use of personalized manual communication boards that are created based on individual's needs. Yet, none of the systems have been tested or evaluate further. For example, the Picture Exchange Communication System (PECS) (Bondy & Frost, 2001) was adapted for the Malay language by clinicians providing speech therapy. However, the adaptation only translated the English graphic symbols into Malay labels. Thus, the Malay PECS program symbols have not been selected based on Malay vocabulary frequency. Consequently, the symbols restrict the users' capabilities to construct grammatical and novel utterances due to the limited access to core Malay. In a need-based system like PECS, nouns are more prominent on a communication board typically used for requesting needs and wants. Although the aim of PECS is to teach language phase by phase, from words to sentences, the communication board displays changes over time as the vocabulary is revised by the therapist. Individuals with complex communication needs are frequently without access or options to other word categories such as adjectives, conjunctions and adverbs in the need-based communication system. This current approach of translating English symbols into Malay for vocabulary limits their capabilities in using the same words for making comments, talking about feelings, telling experiences, relating information across various topics, environments and communication partners.

In contrast, the Pixon™ manual communication system (English and Mandarin Chinese) (Van Tatenhove, 2007; Yao, Tatenhove, & Herrmann, 2010), which is a language-based low technology AAC system was created systematically using the concepts outlined by Hill. This intervention kit was created from compiling knowledge on children's language development, to

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the use of core and fringe vocabulary research to support the vocabulary of a manual system. The development took into evidence-based practice consideration during the product design process. By adhering to a language consideration for people with complex communication needs using a manual system as a transition to speech generating device, the Pixon™ Kit provides the manual communication system as a backup, or to be used as a stand-alone system that allows the user to access an array of high frequency words to express themselves beyond their needs and wants. The Pixon ™ materials also a grammar system and increase vocabulary.

This system uses single-meaning pictures (SMP), (by selecting the picture, users are intentionally communicating the corresponding word), as teachable symbols. Teachable graphic symbols allow a person with disabilities to use graphic symbols to communicate with little to no training. The major benefit of using the Pixon™ as compared to the need-based system relying on nouns is the opportunity to expand language above the word level. Also, the main board display in the Pixon™ board allows users to directly access the vocabulary by pointing directly to the word on the board. Many AAC manual boards use flip pages, navigating through categories and using removable pictures attached to a Velcro board every time a request is made, which discourages users to communicate due to a higher task demand.

2.1   THE MALAY LANGUAGE

The Malay language is the *lingua franca* and a "*language of the learned*" comparable with Latin or French in Europe (Milner, 2008). Malay, a language spoken by nearly 250 million people living in Malaysia, Indonesia, Brunei, and Singapore (Tadmor, 2009) serves as Malaysian statutory language since 1963 (Constitution (Amended), in Article 153A (1)). This Austronesian

language commonly written in Romanized form ("*Rumi*") largely used in the public education, government administration, and religion (Lewis, Gary F. Simons, & Fennig, 2013) while an Arabic form ("*Jawi*") used mainly in Islamic educations. Both domains are still applicable in the standard Malays.

Similar to English, the basic form of the Malay language is the subject-verb-object (SVO) typology. The characteristic sharply contrasts to English, because the Malay language has a shallow alphabetic orthography, simple syllable structure and transparent affixation (Yap, Liow, Jalil, & Faizal, 2010). Seven word formation processes common in Malay are the affixation, reduplication, compounding, blending, clipping, acronyms, and borrowing. Examples presented in Table 1 show the seven types of word formation by Ranaivo-Malançon (2004).

Table 1 Examples of Word Formation in Malay

No.	Word Formation	Example
1.	Affixation	***Ber****perikemanusia****an*** (prefix ber-….-an) (humane)
2.	Reduplication	*Ramai-ramai* (a group of people)
3.	Compounding	Peri + kemanusiaan = perikemanusiaan (humanity)
4.	Blending	Cerita + pendek = cerpen (short story)
5.	Clipping	Mak = Emak (mother)
6.	Acronyms	*Berita Nasional Malaysia* = BERNAMA (name of news channel)
8.	Borrowing	Borrowed from Arabic such as *syukur* means thankful

C. L. Lee, Liow, and Wee (2007) summarizes affixation process in Malay. Malay has at least nine prefixes (meN, berR-, teR- di-, peN-, peR-, se-, ke-, and ,mempeR-), four infixes (-el-, -er-, -em-, and –in-) and thirteen circumfixes (meN-…kan, di-….-kan, meN-…-i, di-…-i, beR-…-kan, peN-…-an, peR-…-an, ke-…-an, mempeR-…-kan, dipeR-…-kan, mempeR…-i, and dipeR-…-i) commonly used in both written and spoken form.

Four affixations process can be used to form sentences using the manual board which include the prefixation, circumfixation, suffixation and infixation. Prefixation process refers to the insertion of prefix (e.g men-) to the left side of the root word, whereas the suffixation is an addition of a suffix to the right side of the root word. Furthermore, circumfixation refers to two affixes simultaneously added on both sides of the root word. Last but not least, the infixation refer to an infixes added in the middle of a root word (Ranaivo-Malançon, 2004) to form new word. Clitics and particles are crucial bound morphemes in Malay. A clitic commonly attached before the base to become proclitic and if attached after the base it becomes an enclitic. Clitics and particles characteristics differ from affixes based on their position and functions. A word containing a clitic or a particle cannot be affixed but an affixed word may receive a clitic and a particle. The Malay language has two proclitics, four enclitics, and three particles that may attach to an affixed word. Table 2 gives the list of affixes and the parts of speech it derive.

Table 2 Examples of Prefixes and Part-of-Speech Derivation

Prefixes and Circumfixes	Word Category		
	Category	Example	Meaning in English
ber-	Verb →like	**ber**kenan	Crush / admire
per-	Noun → feel	perasa	A sensitive person
ter-	Verb → most	**ter**utama	The utmost
ber-….-an	Verb → suit	**ber**sesua**ian**	Suitable
pe(N)-…-an	Noun →deliver	**Pe**nyampa**ian**	Delivery
me-	Verb → feel	**me**rasa	Feeling
peN-	Noun →	**Pen**gguna	User
se-….-an	Adverb →fight	**se**perjuang**an**	Colleagues/worker
se-…-nya	Adverb → have	seadanya	Just enough
ke-…-an	Noun → king	Kerajaan	Government

The final process of word formation in Malay is the reduplication was considered in the development of Malay board. Reduplication is a unique feature in Austronesian language. Duplication of the root words (phonetically, lexically, morphologically, etc.) is use to create reduplication word (Sharum, Hamzah, Wahab, & Ismail, 2010) that brings multiple meaning such as 'multiplicity', 'repetition', 'concentration', and 'variety'. Linguists have divided reduplication processes into full, partial and rhythmic reduplication, and one undefined group called free-form reduplication. Examples of reduplication words are listed in Table 3.

Table 3 Examples of Reduplication Words

Full	Partial	Rhythmic	Free-form
Kayu-kayu (woods)	Berjalan-jalan (jalan/walk)	Riuh-rendah (noisy)	Ipar-duai (brother and sisters in-laws)
Makan-makan (eats)	Berkira-kira (kira/calculate)	Kumat-kamit (Silent self-talk)	Ulang-alik (back and forth)
Persatuan-persatuan (societies)	Pukul-memukul (Hitting each other)	Kucar-kacir (chaos)	
Rama-rama (butterfly)	Pandang-memandang (looking at each other)	Sekali-sekala	
Kura-kura (tortoise)	Lelaki (la +laki/man)	Gunung-ganang	
Kunang-kunang (firefly)	Pepatung (pa +patung/dragonfly)	Kuih-muih	

In the development of a manual communication system, three words formation process were considered including the affixation, reduplication, and compounding for primary prototype includes five prefixes, five suffixes, one clitics "–*nya*" and two particles "-*kah*" and "-*lah*". The selection was based on the their occurrences in Malay (C. L. Lee et al., 2007). Considerably, Malay language has more advance structure, uncommon patterns and exceptions yet to be considered for the early development of this prototype.

2.2   PREVIOUS RESEARCH

Little knowledge on core vocabulary made decision-making in selecting words harder. Although no research was found that addressed the Malay language, the framework established for foreign languages provide advantages to replicate the process. Numerous researches conducted at the AAC Performance and Testing Teaching Lab (PAT Lab) at the University of Pittsburgh had explored vocabulary use in Mandarin Chinese (MC) vocabulary (K. Chen, Hill, & Chen, 2010; K. S.-H. Chen, Hill, & Chen, 2009; M.-C. Chen et al., 2009; M.-C & Hill, 2009), Korean (Shin, 2012), Japanese (Tenny, 2006) and for individuals with blind or low vision (Kovacs & Hill, 2009). For instant, the Mandarin Chinese previous study was conducted to create a spoken language database before designing an early prototype. Then, it was pilot tested for identifying vocabulary frequency and commonality.

The absence of evidence urged researcher to conduct a systematic review for Malay language (Hill & Onwi, 2012) to identify the best available evidence prior to this study. Based on their analysis, four published studies were identified and provided high frequency written words in Malay. Interestingly, Hill and Onwi found these published articles had analyzed millions of digital text corpus within the year of 2009 to 2012. Written samples were resourced from online news, books, manuscript, and children's educational textbooks and databases were created to serve different purposes of their study goals. Studies analyzed in their analysis were summarized briefly here.

First, a study by Tan and Sh-Hussain (2009) has collected nearly 10 million texts to provide phonetic information and high frequency words to improve the quality of speech synthesizer software and creating sentences that mainly consist of high frequency words. A

written word database resourced from digital texts has synthesized the top 10 high frequency word and their database were published in an international journal.

Research by Fatimah et al. (2011) has identified information contained interrogative knowledge for computational grammar for search engines. This study uses an experimental approach using 6,410 words to create Malay Interrogative Knowledge Corpus (MalayIK-Corpus). Due to unavailable public domain tools for Malay language to codify computational grammar, word functions, morphological rules, and semantic or syntactic, motivates researcher to develop MalayIK-Corpus. Numerous resources compiled for this database that include news, technology, editorial columns, sports, letters and e-mails, while texts from children storybooks, articles and magazines were drawn from Internet materials.

The third study is the *The Malay Lexicon Project: A database of lexical statistics for 9,592 words* (Yap et al., 2010) designed at providing measures of frequency, length, orthographic and phonological distinctiveness for a set of Malay words, along with the behavioral measures for 1,520 words. Database is useful for researchers studying Malay lexical and memory processing to support Asian language.

Finally, a study by L. W. Lee and Low (2011) has intended to create an online Malay language word corpus to be used for education and research. Their goals were to provide an appropriate word set for assessing reading and writing skills in primary school students, proper selection of word choices for teaching and intervention activities, and selection of vocabulary to be used in children's literature. MyBaca database was posted online and provided highly usable words covering an elementary school reading materials. Samples were collected from primary school textbooks in Year 1 and Year 2 (elementary school, aged 7 to 8 years old) in the Malay mainstream education.

In summary, all word frequency was compiled, combined and rated for consideration in developing the Malay AAC prototype. The wordlists served as resources for commonality for core vocabulary selection and early vocabulary organization for a Malay manual communication board display. Although a spoken language corpus is the gold standard in identifying vocabulary frequency for AAC interventions, these Malay language studies formed the foundational evidence for our current research to develop the AAC tools.

2.3   PROBLEM STATEMENT

For many years, people with complex communication needs (CCN) have been denied opportunities to access the AAC interventions in the Malay language. At first glance, it may seem like individualized AAC systems designed by speech-language pathologist, teachers, trainers or parents are the best fit to meet users' needs, but sadly no evidence exists to support the outcome of such methods. The individualized systems fail to take into account the linguistic elements needed for Malay speakers to construct novel utterances, and have never been used or tested in a continuous, interactive conversation. Frequency of vocabulary selected and organized for individuals has not been tested, validated or reported in terms of achieved performance and outcomes. A big gap of knowledge is evident with regards to vocabulary selection and the development of a language-based AAC Malaysian display.

2.4   THE OBJECTIVES

The purpose of this study was to initiate the process of validating the vocabulary selection and organization of a manual communication board in Malay for use as an AAC system.   The process required investigators to obtain feedback and input on the design of the graphic symbols and display, vocabulary selection, and the appropriateness of the system based on the participants' views.   The pilot testing with adults who are native speakers was determined necessary before introducing the AAC display to augmented communicators for further testing. The symbols, vocabulary arrangement, and displays took into consideration the Malay culture and ethnicity.

3.0   METHODS

This study was a non-experimental, descriptive study (Thompson & Panacek, 2007) that include interviews to collect aided language samples (Hill, 2001) from four adults without any reported disabilities (Balandin & Iacono, 1999) who were native speaker of Malay. The Institutional Review Board of the University of Pittsburgh approved the study on March 27th, 2013 under the IRB#: PRO13010574. The data collection started on April 12th, 2013 that ended on May 2nd, 2013. All interviews were conducted at the AAC Performance and Testing Teaching (PAT) Lab at 6017 Forbes Tower. This laboratory is design for AAC research activity and for people who use AAC. The PAT lab has been the site of several focus groups and language sample collection studies and provides a comfortable, welcoming environment for participants. All study data were kept with password protected computer and locked cabinets. All language transcripts were de-identified and demographic data were kept separately.

Participants were asked to engage in a conversation while pointing to the vocabulary/symbols on the manual communication board (aided language sample) to carry on an hour of conversation. Participant utterances was recorded, transcribed and analyzed using the *AntConc©* concordance corpus software analysis (Anthony, 2005) and *Word Counter©*. A descriptive method was used to analyze language sample and qualitative methods used to analyze the usability survey. The information that follows describes details on participants,

instrumentations, target practice, language sampling procedures, transcriptions, data analysis and reliability testing.

3.1 PARTICIPANTS

Four (*n = 4*) able-bodied individuals between 18-65 ages were recruited in the study. Selection criteria included negative self-reported and no history of neurological, communication, hearing, or psychiatric disorders and having at least a high school diploma. The participants had at least a minimum of high school diploma and passed two screening tests: (a) a test of listening comprehension using the Malay version of Boston Diagnostic aphasia Examination (M-BDAE) on listening comprehension; and (b) a test of cognitive ability: the Malay version of Mini Mental State Screening Test (M-MMST) (see appendix A and B for the both screening test).

The adapted Boston Diagnostic Aphasia Evaluation in Malay (M-BDAE) is a non-standardized test from original Boston Diagnostic Aphasia Evaluation (BDAE) by (Goodglass & Kaplan, 1983) that had been adapted to Malay language by a group of speech-language pathologists working in Ministry of Health, Malaysia. The subtests of auditory comprehension section were administered to determine the receptive language skills, speech function and intelligibility (subtest for response to social greeting, open conversation, auditory comprehension and answering yes/no questions and pass for scored between 25 to 30 marks). The second test administered to participants is the Mini Mental State Test in Malay (M-MMSE). M-MMSE is a screening tool tested on demented population in Malaysia and known to be reliable and valid (Ibrahim et al., 2009) (pass for scored between 25 to 38 marks). It was carried out to assess participants' mental status prior to interview.

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The exclusion criteria of this study were are as followed: (a) person who failed the phone screening and the screening test prior to the study, (b) person presented with vision impairment with corrections OR (c) person with hearing impairment OR speech and language problems, (d) person with cognitive impairments or learning disability, (d) presented with of psychiatric issues e.g. Bipolar disorder, schizophrenia, etc.

3.2   INSTRUMENTATIONS

3.2.1   Recording equipment

A voice activated digital recorder (Sony Digital Flash Voice Recorder) equipped with a build-in microphone was used to record the language sample from the participants. Video recording was used to confirm the word/ symbol selection used during conversation. Headphones (model Sony MDR-G45LP) were used to listen while transcribing the audio recordings privately in a dedicated room by the transcribers. The transcription process requires two laptops with Microsoft Words and Microsoft Excels software to transcribe both recordings. Both transcribers conducted the transcriptions and analysis independently.

3.2.2   The Prototype

In the development process of language-based AAC interventions, previous researchers recommended the use of spoken language corpus for a better selection of core vocabulary (Trembath et al., 2007). However, the existing data in Malay are largely based on the data

collected through written language corpuses due to the lack of database of spoken Malay. So, based on the written language corpus in Malay, the prototype was developed and additional morphology features were added (see Appendix H for summary on Prototype Development).

To initiate the development of this prototype, 150 high frequency words collected from the written language corpuses were selected. Furthermore, additional word categories were added that included: (a) morphology features (i.e. affixes, clitics, and particles), (b) greeting words ("hai / hi", "apa khabar/how are you"), (c) instructions words ("berhenti/stop", "jangan/no", "tolong/help", (d) general nouns ("benda/thing"), and (e) numeral classifiers (for things, plants, fruits and animals) and etc. A total of twenty (20) word categories were identified related to spoken Malay and tagged words based on their categories (see modified color-coding system for Malay in appendix I).

These word categories were known to be important based on our current knowledge of the spoken Malay language. No nouns were included on the main display but was replaced by a general noun "benda / thing" was included. After selecting the 144 words, the words were organized for the prototype display using the established left to right symbol access method typical of sentence formation and international standard color-coding of grammatical word categories (Goossens, Crain, & Elder, 1992; Russel, 2007). Using results from vocabulary and linguistic element studies has allowed for the development of Mandarin Chinese AAC displays and support the development of a manual communication system for children (Yao, Hill, Baker and Herrmann, 2008).

Our goals were to validate the newly develop pre-made manual communication board, with positive out-of-the-box experience (OOBE) features, based on a language-based system for use by AAC stakeholders (e.g. families, teachers, and inexperienced speech-language

pathologists) in the intervention process. Good OOBE design is not just about being nice but is recognized as a self-explanatory system that requires nearly zero or minimal effort to be able to use the system. Commonly, AAC stakeholders come from various education backgrounds and levels. By using a user-centered design approach, the users can begin the intervention without having to develop the necessary expertise or confidence to make their own communication board.

From the initial idea to the final product, the involvement of users is very critical in producing an OOBE design. A cyclic process of creating, evaluating and analysis over time will help to iron out problems and creating solutions. Although we expect user to be very careful, read the manual, and be systematic to not miss details in a product, they commonly steam ahead and expect to be able to "muddle" through the system directly. So in designing this manual communication system, we applied the OOBE approach to improve system usability.

The display interface was designed using NuVoice PASS Software Installation for All Accent ™ Version 1.08 (Romich, 2013), a free downloadable installation package available online for Windows. Multiple sets of symbols are available in the software (e.g. Clarity, Picture Communication Symbol (PCS), The Pixon™) were used in addition to the symbols created by Malaysian designer, Khairy Ishar (2012) that reflected Malaysian culture to use for the display. No alphabet was provided on the display to allow for spelling words.

Picture producer symbols were created based on the word's direct or concrete meaning and non-picture producers were developed by choosing more closely related meaning or common experience to the word. For example, word "*tengah* / middle", shows the picture of a person with two friends on his side with the middle person's body size relatively bigger than his two friends while standing in front with a bright yellow shirt to highlight the meaning. Second

example is the word like "*di* / at", was matched with a capital letter 'D' to represent the word's sound. The third example is the verb "*ada*" or "have" was matched with the money icon to relate to "usually we have money". Figure 1 illustrated the non-picture producer symbols.

Figure 1 The example of non-picture producer words

All the morphemes were written without any symbols. Affixes usually used by users with more complex language features and for children, the morphemes are more prominent when they are introduced to reading. The affixes include the prefixes and suffixes were separated into two different locations on the board. The prefix (e.g. *me(N)-*, *pe(N)-*, *ter-*, *se-* and *ber-*) were located on the first row and suffixes (e.g. *nya, -pun, -kan, -lah, -kah, -i*) were located at the final row on the board. It follows the verticals scanning to create a word with PREFIX + VERB + SUFFIX. (e.g. MENG- (prefix) + *guna* / use (verb) + KAN (suffix) = using it). Figure 2 explained the location of morphology in the manual communication board.

Figure 2 Morphology Markers Location on a Manual Board

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The contrasting words were presented (e.g words like "ya/yes" and "tak/no" and "sini/ here" and "sana/there") by locating two opposite words farthest away from each other to represent the opposite meaning. This accommodates users that might not clearly point to the word if we put it together or side-by-side. Figure 3 indicated location apart of contrasting word.
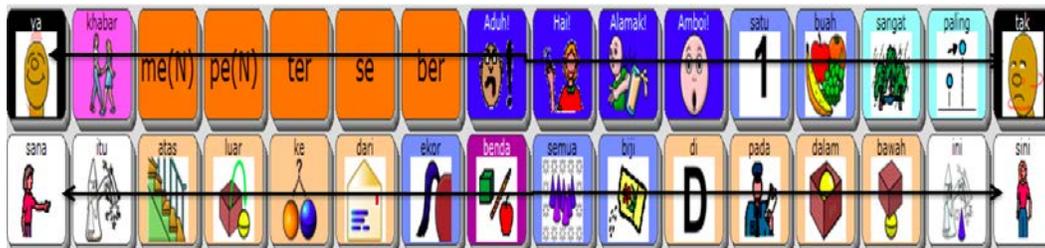
Figure 3 Contrasting Word Located Apart from Each Other

The final prototype includes a pre-made, single display manual communication boards following The Pixon™ Project Kit (van Tatenhove, 2007) with 144-locations and words. A lap tray-style manual communication board was designed following a language-based structure to provide immediate access to vocabulary. The vocabulary set was selected based on the high frequency wordlist from the four language corpuses in Malay (Fatimah et al., 2011; L. W. Lee & Low, 2011; Tan & Sh-Hussain, 2009; Yap et al., 2010). This single-display manual communication board categorizes words into a parts-of-speech arrangement (e.g. pronouns, verbs, adjective and etc). Figure 4 shows the sample word based on S-V-O sentence structure, "*Saya rasa sedih* / I feel sad".

Figure 4 Sample Sentence "Saya rasa sedih / I feel sad".

A modified Fitzgerald key format (the color-coding systems) provides easy navigation through the word categories in the board. With the combination of The Pixon™, Clarity™ and newly designed symbols, the board was arranged in 9 rows x 16 columns with 0.7-inch x 0.7-inch targets. 132 stem (root) words, and 13 morphemes match the symbols based on the meaning of the word were used. Symbols were placed in the middle of targets with the small cases written words printed above it. The manual board was laminated and colored-printed on A3 (11.7" X 16.5") paper. The designed features focus on minimizing costs for manufacturing, portability, out-of-the box experience, and durability to become a user-friendly product. Most importantly, the prototype must be able to support communication for a Malay speaker.

3.3   TARGET PRACTICE

A practice module with 30 prepared sentences (all driven from words available in the manual communication board) was provided to familiarize participants to the symbols, vocabulary and the arrangement of words in the manual board. The lap-tray board was placed on the table in front of participant. Prior to practice, the participants were given a description of the display features. They were given 15 minutes to practice using the prototype. All participants received the same practice and same prototype for both practice and the interview.

The description of the display included pointing out the word categories (e.g. pronouns, verbs, adjectives, etc.), the color-coding system, sentence types (e.g. question forms, statement form, negations, and etc.) that could be constructed, and overall functions of the graphic symbols. The practice list helped participants to self-explore and to become familiar with the arrangement, organization and symbol selection process while using the manual communication board. They were asked to speak aloud for better quality recordings while pointing to the symbol using an index finger or pencil directly on the center of the symbols for the purpose of video analysis (see appendix C for Target Practice). Participants were informed that the speech rate and response time was not important for the study. Slow responses were expected for aided language samples procedures.

3.4   LANGUAGE SAMPLING PROCEDURES

Each participant received a consent form and was informed that the purpose of the study was to validate the vocabulary selection and organization of a manual communication board in Malay.

They were not deceived about the real purpose of this study. They were informed that the study procedures may take up to 2 hours and were assured that they could ask to stop, break or withdraw from the interview at any time during the procedure. The language sampling was collected following a similar protocol used by (Hill & Chen, 2011) on collecting Mandarin Chinese (MC) language samples to report vocabulary frequency.

After that, the investigators made adjustments to the set-up of the voice and video recorder to ensure the recording was working properly. Both interviewer and interviewee were using the manual communication board to maintain communication. Initiation of conversation will included a list of questions including: (a) How are you today?, (b) Tell me about your day so far?, (c) Several probe questions for follow-up including (i) Tell me the details about that (experiences, events, persons, etc), (ii) Can you expand on the topics?, (iii) Let's talk about that (experience, events, persons, etc). After the 60 minute recording nearly was completed, the co-investigator asked the last question, "Do you have anything else that you want to say?", and if yes, that was the final question before all the recording was stopped.

Participants were given time for a break or asked whether they wanted to continue for survey completion. Co-investigator then gave a survey form to participant that took up to 10 minutes to complete five scale rating questions (first part) and the open-ended questions (second part). Survey questions will be based on participants' overall perception of the vocabulary, graphics and arrangement of the communication board. A completed survey was collected before closing the session (see appendix D and E for the Usability Survey).

3.5   TRANSCRIPTION

3.5.1   Orthographic Transcription

A protocol was established for Orthographic Transcriptions of Spoken Malay uniquely for this study. The protocol was provided to both transcribers. The process summary is represented in figure 5.
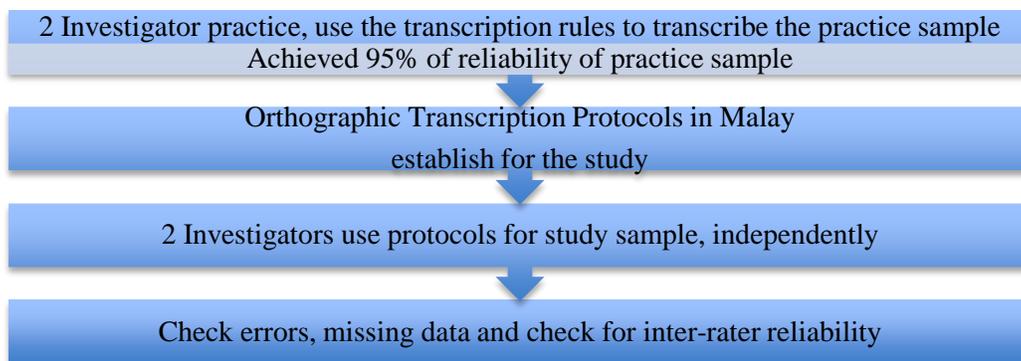
Figure 5 Transcription Process

The transcription protocol outlined the framework for clinicians and researchers in order to follow the rules governing the transcriptions process (Goedertier, Goddijn, & Martens, 2000). The protocol included details based on previous work (Trembath et al., 2007; Van Bael, Boves, van den Heuvel, & Strik, 2007). However items were customized based on the Malay language (see appendix F for Protocol for Spoken Malay language Orthographic Transcription).

The co-investigator and a research assistant involved in the transcriptions process practiced the transcription process following the protocol with non-research data. In the event of unclear recording, video recordings were used to compliment the language transcription. All data than were transferred into a Microsoft Excel spreadsheet for analysis. Both transcribers were native Malay speech-language pathologists, and transcribed the 60 minutes recorded

interview independently. Only 50 minutes of the language transcriptions within the interview were analyzed (the first and the last five minutes were not included due to normal opening and closing of conversation). The database was created for future reference in developing AAC vocabulary selection.

3.5.2   Part-of-Speech Tagging (POST)

All conversational speech samples were orthographically transcribed and every word received a simplified part-of-speech tag set (POST). The part-of-speech tag (POST) is the process of marking up the segment of sentences, into a particular part of speech, and in context i.e. relationship with adjacent and related words in a phrase, sentence, or paragraph. Commonly in education, language learners are taught to identify words as nouns, verbs, adjective, adverbs, etc. This process helps the grouping of words during analysis and organization if included on the future iteration of the board. (See appendix G for Simplified Part-of-Speech Tag set in Malay).

3.5.3   Transcript Cuts

When transcribing the whole sample, the timing cut selection (60 minutes) was considered for the selecting sample for analysis. Then for the composite sample, the selection of an utterance-level cut for analysis were considered. Utterance-level cut of all four participants enabled investigators to level the number of words used for composite sample since one of the participant used more words that the other (Heilmann, Nockerts, & Miller, 2010). In order to avoid bias of analysis towards the participant whom produced the most words, only the first 58 words in continuous and intelligible utterances were selected from each speaker.

3.5.4 Transcription Fidelity

Transcription and database preparation were fully supervised by the primary investigator. Both audio and video recordings were used to compliment the language transcription. Any non-Malay words or utterances were excluded from analysis. Any identifier in the conversation was removed and replaced by brackets [ ] during the transcription process. This procedure is essential to ensure that data were kept secure by removing any personal information. Participants were de-identified and label as P1, P2, P3 and P4. Any typographic errors detected with Microsoft Word with the language set to Malay were corrected before the reliability testing.

3.6 RELIABILITY TESTING

The intra-rater and inter-rater reliability were established for this study. The intra-rater was established by calculating percentage of agreement within the transcriber and the inter-rater reliability was established by calculating level of agreement between two transcribers.

Prior to the study, we established 95% reliability of agreement between the two investigators using non-study data to confirm the orthographic transcription rules. Only after the practice achieved 95% reliability was transcription with research data performed. Both reliability testing were calculated using Kazdin (1977) calculation: number of agreement divided by total number of agreement plus disagreement multiplied by 100%. Finally, the co-investigator reviewed each transcript for any further corrections prior to entering words in the database.

3.7   DATA ANALYSIS

3.7.1   Language Samples Analysis and Results

Four individual samples and a composite sample were analyzed using the combination of *AntCont©* (Anthony, 2005) concordance language analysis tool and *WordCounter©* (Grace, 2002), an online word and sentence count application. The *WordCounter©* application was based on research by Trembath et al. (2007). Vocabulary analysis was calculated to summarize: (a) the number of different words (TYPE), (b) the total number of words (TOKEN), (c) the number of sentences constructed within the interviews, (d) average sentence length, (d) average number of word per sentence, (e) number of words used from the board, (f) number of words not used in the board, (g) number of spoken words that was used but not in the board, and (h) frequency and commonalities of top 20 words in Malay (see the step to use the language analysis tool in appendix O).

In this research, the frequency of words were determined by adding the number of word and morphology (e.g. prefixes, suffixes) being used by participants across the language sample. The term frequency was justified as the arithmetic count of the number of linguistic elements (e.g. tokens) within a corpus that belong to each classification scheme (e.g. Malay vocabulary). Raw frequency is the actual count of the re-occurrences of words in a language sample. Percentage was determined by dividing the initial number to get a fraction and multiply by 100% to get a percent.

3.7.2 Usability Survey Analysis

A satisfaction and usability survey from Vocabulary frequency of AAC Chinese Speakers using a manual board (Hill & Chen, 2011) was modified for this study (see appendix D for Usability Survey Form). Two certified native Malay speakers performed the forward translation (English to Malay), and the backward translation (from Malay to English). The survey was divided into two parts: (a) the nine rating scale statements, (e.g. "The graphic symbol that I was shown are culturally and ethnically appropriate for Malay speakers.") and (b) four open-ended questions, (e.g. "When you use the manual communication board, can you construct sentences that you want to say using the graphic symbol provided? Explain.").

Likert scale survey results were summarized based on the response frequency of the numeral scale from one to five (1-'strongly disagree' and 5-'strongly agree'). Following protocol on analyzing Likert scale survey analysis by Dianne (2000), responses were combined into positive and negative responses. Items that received a rating of agreement ("strongly agree" and "agree") were combined as they reflect positive responses or some degree of agreement and a rating for disagreement ("strongly disagree" and "disagree") were combined as they constitute negative responses or some degree of lack of agreement. In the open ended-questions, the major theme of the comments was summarized to support the rating scales.

4.0   RESULTS

4.1   DEMOGRAPHICS

Four *(n=4)* able-bodied individuals (two males and two females adults) native speaker of Malay and Malay ethnic, aged range from 21 to 36 years (mean: 26.25, standard deviation: ±7.37) were voluntarily participated in the study. Two had a bachelor degree and remaining had an A level certificate. They lived in Pittsburgh during the study period, and had no reported disabilities (physical or mental impairment).

Table 4 Participants Characteristic and Results of the Screening Test

Participant	P1	P2	P3	P4
Gender	Female	Male	Female	Male
Age (mean: 27, s.d ±7.37)	22	25	36	21
Education	*Advance level certificate	Bachelor degree	Bachelor degree	*Advance level certificate
Employed	No	Yes	Yes	No
Ethnicity	Malay	Malay	Malay	Malay
Experience with AAC	No	No	No	No
Screening test (M-MMST)	Pass 38/38	Pass 38/39	Pass 36/38	Pass 36/38
Screening test (M-BDAE)	Pass 30/30	Pass 30/30	Pass 30/30	Pass 30/30

Notes: *The advance level certificates are equal to the certificate credits obtained from U.S community college for credit transfer in applying bachelor degree in the international university.

None of them had experience in using a manual communication board. Recruitment flyers were display around the University of Pittsburgh and Islamic Center of Pittsburgh. All participants interested in this study had contacted the co-investigators and agreed to undergo further screening. Phone interviews were conducted for fluency screening before the interview was scheduled. All four of them were full-time students and one female and one male were currently employed. All of them were able to access the manual board through direct selection techniques to communicate during the interview. Two screening tools were administered to all participants to determine language proficiency and mental status. No data in relation to their socioeconomic status was collected. Table 4 displays the demographic and screening results.

4.2   RESULT OF RELIABILITY

The word-by-word transcription of the conversation was performed within the rater and between the two transcribers. The intra-rater was 97.33% for transcriber 1 and 99.12% for transcriber 2. Inter-rater agreement of 98.25% was obtained by point-by-point agreement ratios between two investigators. Results displays in the Table 5 for percentage of reliability per transcribers.

Table 5 Percent of Agreement between Two Transcribers

Transcriber	P1	P2	P3	P4
1	96%	96.5%	100%	96.8%
2	98%	99.5%	100%	99.2%
Agreement btw 2 investigator	97%	98%	100%	98%
TOTAL AGREEMENT				98.25%

4.3   FREQUENCY ANALYSIS & WORD COMMONALITIES

A total of 1,112 word TOKENS (total number of words) and 450 word TYPES (number of different words) were collected from four participants over 200 minutes of aided language samples. A total of 102 sentences were generated across participants, with an average of 11 words per sentence. Table 6 displays the participants' characteristic for overall language sample.

Table 6 Characteristics of Overall Language Sample

Participants	P1	P2	P3	P4	Average	TOTAL
Total number of running words (TOKEN)	452	285	112	263	278	1112
Total number of different words (TYPE)	154	122	58	116	112.5	450
Standard deviation	4.20	2.72	1.54	2.56	2.75	11.02
Sentences	34	26	15	27	25.5	102
Average sentence length	13	11	8	10	10.5	42

The composite sample consists of 450 word TOKENS (total number of words) and 160 word TYPES (number of different word). The number of different words (NDW) provides measure of semantic proficiency, and total number of words (NTW) represents more global language facility, including skills such as speaking rate, utterance formulation ability, and speech-motor maturation.

A composite sample was selected from a similar number of continuous conversation from each participant. Only 14% of the total sample was analyzed as a composite sample due to imbalanced production of words per participant was observed. Overall, only 40% of the words available on the board were used (58 words used out of 144 words) and the remaining 60% was unused. However, among the 40% used, the top 50 words matches the top 8 high frequency words previously research by Tan and Sh-Hussain (2009). An additional 88 words were used in

the composite sample that was not on the board. Table 7 shows the characteristic of analysis of a composite language sample (see appendix J for top 30 words in the composite sample).

Table 7 Characteristic of Composite Sample

Participants	% (Percent of total sample)	TOTAL
Total number of running word (TOKENS)	98.7	454
Total number of different word (TYPES)	14	160
Average sentence length	44	12
Word used in the board overall	40	58/144
Word used not in the board	60	86/144
Additional word used but not in the board		88

In the top 10 words include verbs (4 words), conjunctions (2 words), pronoun (1 word), preposition (1 word), adverb (1 word) and adjective (1 word) were used across participants. Interestingly, all word listed in the table provided below are those that were made available on the board. Table 8 displays the top 10 words and top 10 morphemes used by participants in the composite sample (see appendix K for top 10 morphemes). The spoken wordlist were attached in appendix L.

Table 8 Percentage of Top 10 Word and Morpheme

Words	English	Frequency/%	Commonality	Morpheme	Functions	Frequency	Commonality
saya	I	34 (7%)	4	an	prefix	19 (4.2%)	3
dan	and	12 (2.4%)	4	me(N)	prefix	16 (3.5%)	4
sini	here	12 (2.6%)	4	di	prefix	15 (3.3%)	4
Suka	Like	12 (2.6%)	4	ber	prefix	9 (2%)	4
dapat	get	11 (2.4%)	3	pe(N)	prefix	9 (2%)	3
lebih	more	9 (2%)	2	Ke-	Prefix	8 (1.8%)	3
ada	have	8 (1.8%)	4	-kan	Particles	7 (1.5%)	3
Baik	Good	7 (1.5%)	4	-nya	Clitics	4 (0.9%)	4
Yang	That	7 (1.5%)	4	Se-	Prefix	3 (0.7%)	4
Buat	Do	7 (1.5%)	2	Ter-	Prefix	3(0.7%)	1

4.4   SURVEY

4.4.1   Part 1: Scale Rating for Usability

From nine, seven statements received agreement rating of 4 ("agree") and 5 ("strongly agree") (statements 1, 2, 3, 4, 5, 8 & 9). The remaining two (statements 6 & 7), received "neutral" and "disagreement" rating of 2.
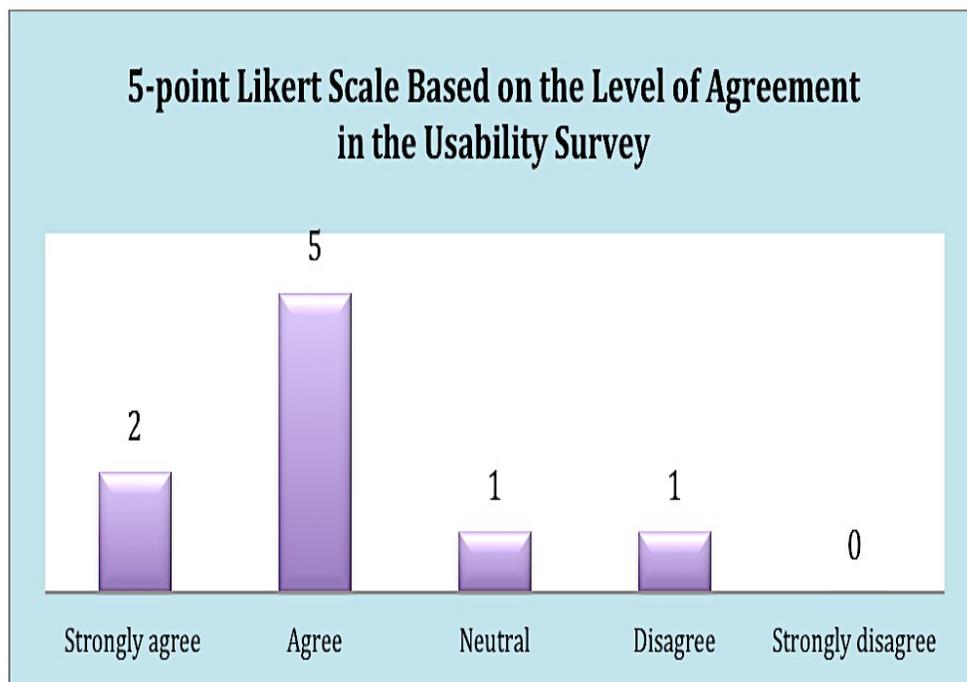
Figure 6 Results of Likert-scale for Usability Rating

Overall, participants were able to use the manual communication board as intentionally designed for but minor changes were recommended based on the organization of the manual communication board. The survey results and information related to system improvement are discussed later was summarized in figure 6. Table 9 described in details each statement as rated by participants following the level of agreement.

Table 9 Results of the Usability Rating

Questions	1	2	3	4	5	TOTAL
1: The graphic symbols that I was shown are culturally and ethnically appropriate for Malay speakers.			1	2	1	4
2: The communication system that I was shown is culturally and ethnically appropriate for Malay speaker.				2	2	4.5
3: The manual communication board that I was shown had words that are used typically in daily conversations by Malay speakers.				1	3	3.75
4: The manual communication system was organized so that I could easily find and remember the words I wanted to use.			1	2	1	4
5: The manual communication system had vocabulary that allowed me to generate the utterances I wanted to say.			1	2	1	4
6: I would not change the appearance of the graphic symbols.		3			1	2.75
7: I would not change how the vocabulary was organized on the manual display.		3		1		2.5
8: The appearance and organization of the Malay manual communication board promotes effective communication.			2	2		3.5
9: A Malay speaker could learn to communicate using this graphic symbol system.			1	1	2	4.25

4.4.2   Part 2: Open-Ended Questions

4.4.2.1 Strength

The strength of this prototype was identified based on the major theme express in the open-ended questions. Participants were in favor of the use of the color-coding system to categorized word based on part-of-speech following the grammatical structure. This feature is commonly applied in AAC system to support usability (Goossens et al., 1992; Russel, 2007; Van Tatenhove, 2007). In addition, the location of opposite words such as "ya/yes" and "tak/no", "sini/here" and "sana/there", "itu/that" and "ini/this", separated away from each other, helped participants to remember the location easily. One also agreed that putting the verbs in the middle section was

helpful for constructing sentences because verbs usually occur in the middle of the sentences. Finally, three participants agree that most of the graphic symbols used were appropriate for the Malay culture (see appendix F for Summary of Usability Theme).

4.4.2.2 Weakness

The weaknesses of this prototype provide the most valuable information for this testing. Major themes of the weakness are based on the arrangements of the graphic symbols, too many color were used, confuse in differentiate the groupings, and the graphic symbols represent the word is vague. Word groups separated from each other forced users to scan two different locations, the arrangements increased time for scanning, and forced them to navigate through the whole word within a group, and was difficult to remember. For example, in figure 7, the purple group for adjectives had been separated into the upper left and lower right corners while the pink group was on the same row but separated by two green words, and the dark purple group was separated horizontally.

Figure 7 Separation of Word into Different Locations.

The other issue was the color-coding used to represent different grammar groups. Since color-coding is known to facilitate searching, the selection of colors in the board was not obvious to make the contrast. Example in figure 8 shows how the two purple schemes make the contrast very vague and confusing.

Figure 8 Unclear Color Scheme Use to Differentiate Word Categories

Finally, only one respondent stated that, "*some of the words are not appropriate to the symbols or at least the symbol used seems not relevant to me*". However, no example was provided with regards to any specific symbols that needed improvement. These responses were very important to this prototype because the symbols were chosen mainly based on iconicity or how transparent the symbol was to the referent word. This issue will be addressed further for future testing.

4.4.2.3 Additional features

The final questions for future improvement led to few suggestions from the participants. They recommended two main changes that included: (a) adding the numbers (zero to nine) for easy access, (b) re-arrangement of words in a group in a way to improve ease-of-use and (c) to add colloquial words to the board that are used in daily conversation. These features will expand the capabilities of the system to provide robust vocabulary for creating novel utterances mainly using the words available on the board.

5.0   DISCUSSION

Our purpose to corroborate the vocabulary selection and organization of a manual communication board in Malay was supported by the results. The findings suggested that the systematic approach to vocabulary selection in the manual communication board for use in the AAC intervention enhance users' abilities to create novel and complex sentences. Furthermore, a key aspect of the study was to compile feedback and suggestions preferred by users for future design modifications. This aspect allowed participants to use the vocabulary to carry on a conversation for the full hour and shared their experience of using the Malay display through the usability survey.

Based on the frequency and word commonality results, all participants were able to construct sentences with a mean length of utterance (MLU) of 11 words. None of the generated utterances were repeated within or across participants. In addition, participants were in agreement that the prototype supported spontaneous novel utterance generation (SNUG). Within the composite sample, the participants used nearly 40% of the words provided and only needed an additional 88 words to compensate their conversations. Furthermore, 50% of the additional words (42 words) used were nouns. Nouns are considered as fringe vocabulary, unique to a person or topic, and can be included using another organization technique. It can be embedded as flip charts on the manual board following the word frequency and commonality results.

Although our composite sample is small, the first 75 words are comparable to the eight of the ten (8/10) top words published by Tan and Sh-Hussain (2009). The words are "*yang* / which is", "*dan* / and", "*untuk* / for", "*tidak* / no", "*pada* / at", "*akan* / will", "*saya* / I" and "*mereka* / they". Therefore, using the results from a corpus based on written language provided a sound foundation for selecting words for spoken language. Consequently, in the absence of a spoken language corpus, a written language corpus can substitute for AAC vocabulary selection. However, spoken language remains the gold standard to support actual conversational potential of the vocabulary display.

To be consistent with a language-based AAC system, the display must allow the learner to access the morphology of a language (Baker & Chang, 2006). As an agglutinative language, Malay relies heavily on the use of affixation process (the use of prefixes, suffixes, infixes, circumfixes and particles) for word formation (C. L. Lee et al., 2007). The original organization of the prototype display provided morphemes for testing how native speakers utilized the morphemes in sentence structure. Although 13 symbols out of the 144 locations on the board were morphemes, 10 morphemes were found within the top 50 words in the composite sample. All participants use the morphemes to formulate words with prefixes, suffixes or circumfixes. Four reduplications words appeared in the samples along with the affixes. The example were "**ber**ubah-ubah / changing", "**mem**beli-belah / shopping", and "**se**baik-baik**nya** / the best way". More importantly, participants used the available morphemes to enhance word choices in their conversation with a short amount of training time (see appendix M for reduplication words).

The high transcription reliability achieved in this study shows the strength of the data analysis. The transcriptions reliability not only provided an insight of transcription fidelity, but also showed the importance of establishing standard convention for transcription prior to the

study. Commonly, establishing training and practice using sample data prior to the study data helps facilitates the quality of transcription among investigators. The use of computerized concordance analysis tools reduces errors for a lengthy language analysis when compared to manual calculations.

The findings of this study contributed to several positive outcomes. The manual communication system in Malay has undergone a usability test prior to the introduction to AAC users. Furthermore, participants' active contributions with feedback and recommendations geared towards the improvements of the prototype were valuable.

Moreover, this prototype required minimal training for participants to start to use vocabulary for functional communication although a successful AAC intervention rely heavily on the intensity of training received by participants. The provision of prolonged usage and training of the AAC system usually increases users' abilities to construct sentences. In this study, participants were given 15 minutes of self-exploration practice with target sentences, yet were able to produce an average of 278 words of complex sentences. Despite the short exposure, they managed to effortlessly use the board to complete the interview session.

More importantly, without prior experience to any kind of AAC, the prototype seems to offer positive out-of-the-box experience (OOBE) to the first time users. Their positive feedbacks included the ease of use, ease of understanding the layout, and ease to access the intended words on the manual board. Designed as a lap tray system, the manual board needed no navigation to different pages or flipping through pages. The manual board brings users an instant portable access to vocabulary, tailored appearance of the graphic symbols culturally, and a low cost solution with long-term durability. Numerous advantages in using the color-coding system were noted inlcuding: (a) speeding up the visual search that helps to convey information quickly and

facilitating the visual search, (b) reducing distractors, (c) following the word groupings more easily, (d) conveying the structure of the whole SUBJECT-VERB-OBJECT order, and (e) the representing moods (e.g. red for negative words) accommodated user's memory.

5.1   MODIFICATIONS TO THE PROTOTYPE

In designing a manual communication board, various modifications are needed to ensure the arrangement of vocabulary is appropriate and promote spontaneous novel utterance generation (SNUG). This prototype is a standard manual board which provide the main core vocabulary to the users of all ages, background and language capabilities.

However, based on this research, several modifications are required to ensure the vocabulary organization support the sentence production and word use in the manual board. Re-arrangement of word groupings, avoiding group separations and consistent use of color groupings techniques will help to reduce navigations and scanning. Furthermore, lesser the colors use for groupings may increase user's ability to navigate through the system without needing to understand the distinctive features of the word groups. Distinctive color can be used to visually distinguished categories such as yellow and green, rather that close related color scheme such as light purple and dark purple were suggested. In fact, three of the respondents suggested re-arrangements of the graphic symbols within a group (e.g. adjectives and verbs) and recommended following alphabetical order for arranging words within a category.

In the future, numerous language features would be added into the system to increase the variety of word selections. An addition of fringe vocabulary (e.g. nouns, less frequent verbs and adjectives) and a spelling/number board rows will enhance the vocabulary options. Use of flip

charts (activity rows) on top of the board would provide access to the fringe vocabulary such as those spoken words collected in the study (see Spoken Word List in appendix M) and the QWERTY keyboard or alphabets layout can be added to provide access to spelling. Currently, this system was intended to be a standard communication board for typical native speakers and does not serve as a personalized system. Due to the fact that standard/formal Malay was used to build the entire system, recommendations to include colloquial words would not be considered at this point. However, in the future, embedding personalized words for a customized manual communication system based on users' communication needs is possible.

5.2   CLINICAL IMPLICATION

Recent approaches in designing the AAC systems have emphasized the use of core and extended vocabulary in developing language skills among children and adults (Van Tatenhove, 2007). Most clinicians in Malaysia construct individualized AAC manual communication boards before the intervention is conducted. Following this prototype testing, clinicians have a model for selecting and organizing vocabulary based on both core and fringe vocabulary. When the display is revised and fully tested with larger groups of users and other AAC stakeholders (e.g. speech-language pathologist, occupational therapist, teachers, AAC users, and parents), planning the intervention process and appropriate treatment strategies can occur rather than starting without a basic display.

In selecting vocabulary for a language that has little external evidence, clinicians must use clinical judgment in selecting the best available evidence to guide decisions. The approach of using translating English symbols and displays into another foreign language does not meet

rigor of a sound vocabulary selection and organization process. More off, this study found that establishing the core vocabulary based on high frequency words provides the foundation for generating utterances. Without using a principled approach to the selection of core and extended vocabulary, the reliability of the whole communication system is compromised. Incorporating aided language sample analysis with intervention will support clinical decisions in selecting vocabulary for improved intervention outcomes (Lisa Hammett, Sean, & Colleen, 2010). The present study is only a single descriptive study and replications are needed to confirm the results with a larger population and different age or disability cohorts. However, there is ample evidence that developing a manual communication system for children and adults must follow a strong background foundation on the best available evidence in decision-making process.

5.3   LIMITATION OF THE STUDY

Methodological limitations may impact the findings of this study. Participants in this study included a small number of typical Malay speakers in Pittsburgh. The participant pool was small and perhaps their use of Malay are not as typical as adult speakers residing in Malaysia. The language samples based on the timing cut (an hour) contributed to unevenly distributed utterances by participants. To help compensate for this problem, only 58 continuous words were used for the composite sample. This method balanced the sample among the participants, but contributed to a smaller sample size. To prevent this issue in the future, multiple recordings may be needed to ensure every participants contributes a similar amount of words following the previous study on language sampling (Heilmann et al., 2010). Therefore, generalization of these study results to different groups of adult speakers may be limited.

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While all of the participants learned to use the system fast and constructed lengthy samples, participants 3 failed to elaborate sentences and only provided the shortest sample. This finding suggests the idiosyncratic nature of speakers and differences in learning requirements among users of the system. Additionally, the limited training time using the manual communication board may have restricted the number of words used and utterances produced by participants during the interview. In any AAC intervention, intensity of training or experience is paramount to building communication competency of using the graphic symbol system. To overcome these issues, longer exposure or multiple training sessions prior to the interview and setting criteria for sentence length may influence the study results.

Finally, no control over the interview topic may have contributed to the short utterances produced by one of the participant. Perhaps specific topic selection may stimulate more conversational discussion among speakers. Therefore, the vocabulary generated by the participants was limited to the immediate environment and may not reflect the broader range of high frequency words that occurring during natural interaction in daily conversation. Despite the limited number of participants and lack of control variables, the current study does provide an insight for possible approaches to future research and development and clinical demonstration for revised prototype.

6.0   FUTURE WORK

A relevant next step in Malay vocabulary research would be to conduct a similar study with the same population to confirm a large percent of the selected high frequency vocabulary is used. Then studies can be conducted with diverse populations, in a variety of natural contexts, prolonged training and exposure, and actual clinical populations.

Larger studies involve the recruitments of more people and a collection of lengthier aided language samples for the next level of testing. Additional reliability and validity testing is needed to support the clinical value and usability of the display. In the future, research should be designed to collect a larger language sample from the participants to avoid an outlier with fewer productions to limit the word count. According to Heilmann et al. (2010), clinicians should remain exercising the traditional procedures for sample length which is between 50 to 100 utterances. Cole, Mills, and Dale (1989) recommended collecting a lengthy sample to examine particular language features, such as grammatical morphemes; lexical fields (e.g. metalinguistic verbs); and discourse features reliably. "In-vivo" approaches or collecting language samples in naturalistic environments (e.g. at home, on a phone or at work) between multiple communicative partners (e.g. spouse, kids, teachers or parents) in various contextual environment (e.g. formal, and informal) may also contribute to more a generalizable sample and reduce bias of one or a few speakers. To achieve that goal, this prototype needs to undergo a series of alpha and beta testing.

Continuous iterations of technology tools are common as additional evidence on performance and user feedback is gathered. Hence, this prototype is expected to be modified to enhance performance and user satisfaction at the next round of testing. In addition, once the vocabulary for 144 locations has been stabilized with a clinical demonstration of the manual board with an attached flip chart, the expectation is to design the board for different levels or skills of users. Consequently, the vocabulary frequency studies will support the essential words to allow for generating utterances using 84, 60, 45, or even fewer locations on the display. In clinical or educational instruction strategies will be important. At this point, with minimal revisions the product is stable enough to be introduced to AAC users in the AAC intervention for alpha and beta testing.

Understandably, the systematic process in researching high frequency vocabulary patterns is time consuming and tedious, especially when using language sample analysis (LSA) techniques. The transcription and coded process are a lengthy exercise to avoid errors in transcription and establish high reliability. Current available technology such as the use of text-to-speech application available in the market such as AZAM™ (2003-2010) can be utilized for language transcription using spoken languages. This software offers capabilities of dictation of voice through conversation, telephone recorded conversations, voice diary, video recording, and can also be used as a translator application into several languages. The three major functions of speak, send and store allow investigators to synchronously transcribe while recording and return to recording to check for errors. This type of software may reduce time for transcriptions and reduces human errors increasing the willingness of research to look with even closer at the vocabulary patterns across various cohorts and contexts.

Other foreign language studies, as described by Moreno-Sandoval et al. (2012) accelerated the compilation of the spontaneous speech corpora using digitized data and transcription selection collected from class lecture, news report, dialogue in public and private locations. The linguistic material used were analyzed and annotated according to different learner levels following Common European Framework of Reference for Languages (CEFR) following learners' age. Three languages were compiled in this study for the Spanish, Chinese and Japanese languages. Several additional linguistic features were extracted from the data that included the grammatical structures, communicative functions and lexical topics, and the diction clarity to support the development of a spoken language. The database was used to develop tools for web-interface design and word lists were used to create text for practice and evaluating listening comprehension skills.

7.0   CONCLUSION

Decision-making related to research and development of AAC intervention tools in the Malay language must be theoretically based pulling from linguistic and communication models that support how language can be presented and generated using graphic symbols on a manual communication board. We highlighted the importance of applying a systematic approach to AAC research and development (R&D) through the collection and analysis of language samples from typical speakers and end users of the system. This study not only achieved the goal of supporting the initial vocabulary selection and organization of a manual communication prototype in Malay, but also provided guidelines for clinicians in developing their own systems in their clinical practices. The ultimate measure of a success of developing AAC system is communication performance. The most robust system should provide for effective and fluent language performance by Malay speakers regardless of disabilities, age, gender and environment. Designing highly usable tools must be based on performance, input and feedback from users during the development process.

APPENDIX A

MALAY-BOSTON DIAGNOSTIC OF APHASIA EXAMINATION (M-BDAE)

Screening Test (adapted from Malay–Boston Diagnostic Aphasia Examination)

PERBUALAN DAN KELANCARAN PERTUTURAN CONVERSATIONAL & EXPOSITORY SPEECH

A. *Respon Kepada Ucapan Sosial (Simple Social Responses)*

Arahan: Berbual dengan peserta secara terbuka untuk mendapatkan respon sebanyak yang mungkin. Rekodkan respon peserta dan catatkan markah pada kotak di bawah. Rakaman audio adalah digalakkan.
Conduct an informal exchange, incorporating suggested questions, to elicit as many of the desired responses as possible. Write responses verbatim. Tape record if possible.

1. *Apa khabar? (Baik, Sihat, atau respon yang bersesuaian)*
   How are you? (Okay, Fine, or other appropriate response)

   _____

2. *Siaoakah nama penuh awak?*
   What is your name?

   _____

3. *Pernahkah awak datang ke sini sebelum ini? (Ya, tidak, atau respon yang bersesuaian)*
   Have you ever been here before? Have I ever tested you before? (Yes, No, or other relevant response)

   _____

4. *Awak suka makan apa?*
   What do you like to eat?

   _____

5. *Di mana awak tinggal?*
   Where do you live?

   _____

   Markah/ marks:___/5
   ☐ **Lulus /Pass (markah/marks: 5/5)**

B. *Perbualan Terbuka* & Penerangan Gambar

i) *Perbualan terbuka* / Free Conversation

Arahan: Berbual dengan peserta. Mulakan perbualan dengan topik yang biasa. Galakkan perbualan sekurang-kurangnya 3 minit dan cuba elakkan soalan dengan jawapan 'ya, tidak'. Tulis respon peserta dan catatkan markah pada kotak di bawah.
In ordert to elicit as much conversation as possible, it is suggested that the examiner start with a familiar topic, such as :

1. *Apakah pekerjaan awak terdahulu?*
   What kind of work were you doing before you are here?

2. *Ceritakan kepada saya apakah sebab awak datang ke sini.*
   Tell me what bring you here

_____

_____

_____

ii) *Penerangan Gambar* / Picture Description
Arahan: Minta peserta menghuraikan gambar "Pencuri Biskut". Catatkan markah pada kotak di bawah. Tandakan (1) jika peserta menunjukkan ciri-ciri pertuturan seperti di bawah:
Present a "Cookie Theft" stimulus tot he participants. 'Tell me everything you see on this picture' and mark (1) if they presented with any of he listed characteristic.

Bil	Ciri-ciri pertuturan dalam perbualan	Respon
1	*Pertuturan lancar* Fluent speech	
2	Memberi respon yang bersesuaian *Provide relevant responses*	
3	*Mengekalkan topik perbualan* Keep to conversational topic	
4	*Menggunakan ayat* Constructing sentences	
5	*Menggunakan frasa* Use phrases	
6	*Menggunakan perkataan tunggal* Use single word	
7	*Menggunakan struktur ayat yang bersesuaian* Using an appropriate sentences structure	
8	*Tiada Parafasia* No paraphasia	
9	*Tiada Circumlocution* No circumlocution	

10	*Tiada verbal stereotype* No verbal stereotype	
11	*Tiada perseveration* *No perseveration*	
12	*Tiada Anomia* No anomia	
13	*Tiada Neologism* No neologism	
14	*Tiada perkataan tidak bermakna (jargon)* No jargon word	
15	*Pemahaman auditori* Auditory comprehension	

☐ **Markah/ marks:___/15**
☐ **Lulus /Pass (markah/marks: 15/15)**
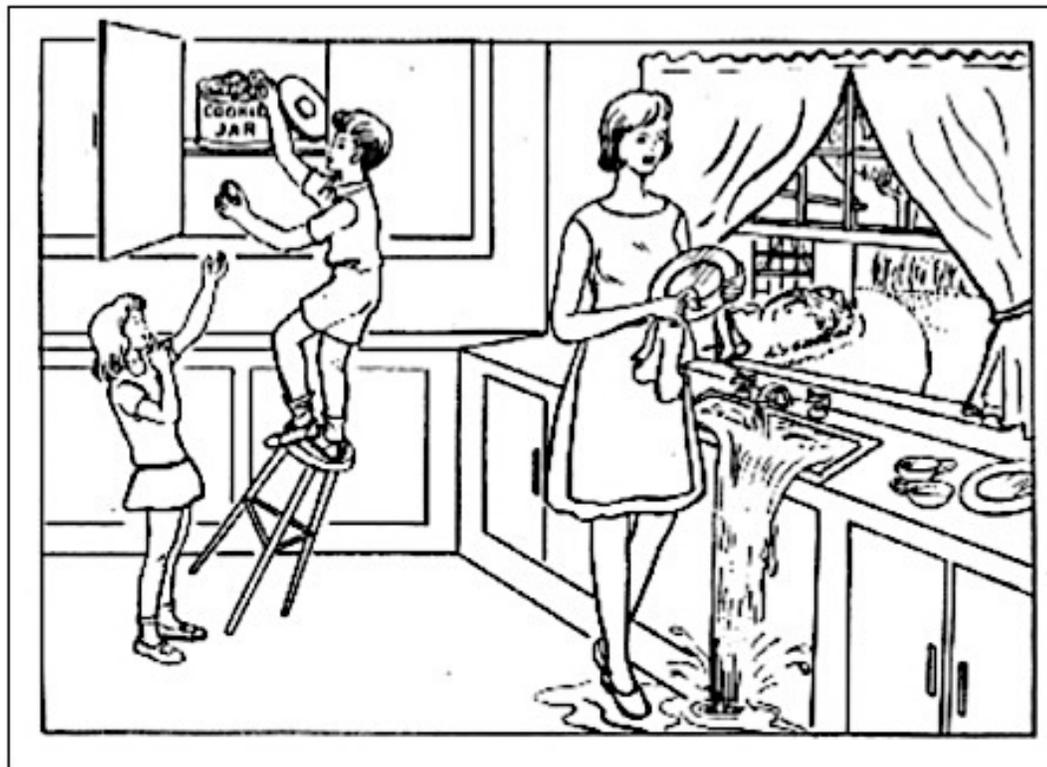
B. Arahan / Commands

Arahan: Baca arahan di bawah dan minta peserta mengikut arahan yang di beri. Satu markah diberi bagi setiap arahan yang dibuat dengan tepat. Ulangan dibenarkan jika diminta tetapi keseluruhan arahan perlu diulang. Rekodkan respon dan catatkan markah pada kotak di bawah.

Have participant carry out the following commands, giving one point of credit for each underlined element that he or she carries out. One repetition is permitted on request, but the whole command must be repeated.

1. *Pejam mata.*
   Close your eyes.

2. *Tunjuk meja dan kerusi.*
   Point to table and chair.

3. *Tunjuk lampu dan pintu.*
   Point to light and door.

4. *Angkat tangan kanan dan geleng kepala.*
   Raise your hand and shake your head.

5. *Sentuh setiap bahu 2 kali dengan 2 jari, dengan mata tertutup.*
   Tape ach shoulder twice with two fingers, keeping your eyes shut.

   Markah/marks:___/5
   Lulus/Pass (Markah/marks 5/5)

C. *Material ideasional kompleks* / Complex Ideational Material

Arahan: Baca soalan di bawah dan minta peserta memberi respon 'ya / tidak'. Satu markah diberi bagi setiap reson tepat. Ulangan adalah dibenarkan jika diminta, dengan syarat keseluruhan ayat perlu diulang. Rekod respon dan catatkan markah pada kotak di bawah.

There are 'yes' and 'no' questions. One mark was given to a correct answer. Repetition is allowed, but all sentences must be repeated. Record the marks on the given box.

1. Lembu boleh terbang?

   Cow can fly?

2. Minyak larut dalam air?

   Oil can dilute in water?

3. 5 lebih besar dari 3?

   5 is bigger than 3?

4. Gula rasa manis?

   Is sugar sweet?

5. Darah warna biru?

   Is blood are blue?

   Markah/marks : ___/5
   Lulus/ Pass (Markah/marks : 5/5)

APPENDIX B

MALAY- MINI MENTAL STATE SCREENING TEST (M-MMST)

Borang Saringan Ringkas

Pengenalan Peserta: _____ Tahap Pendidikan:_____

Umur:_____ Tangan Dominan: Kanan Kiri

No.	Tugasan	Skor	
1.	**Orientasi**	0	1
	Nama:	0	1
	Alamat:	0	1
	Bangunan:	0	1
	Daerah:	0	1
	Negeri:	0	1
	Hari dalam seminggu:	0	1
	Bulan:	0	1
	Tahun:	0	1
2.	**Tumpuan (1 markah bagi setiap nombor bersiri yang diulang dengan tepat – markah tertinggi ialah 7).**		
	5 digit: 2-9-6-8-3	0 1 2 3 4 5	
	6 digit: 5-7-1-9-4-6	0 1 2 3 4 5 6	
	7 digit: 2-1-5-9-3-2-6	0 1 2 3 4 5 6 7	
3.	**Pembelajaran (1 markah bagi setiap perkataan yang dipelajari – rekodkan bilangan ulangan yang diperlukan untuk mempelajari perkataan tersebut; 4 percubaan maksimum dibenarkan)** " Saya akan berikan anda 4 perkataan. Anda perlu mengingati kesemua perkataan tersebut, saya akan arahkan anda untuk mengulang perkataan tersebut. Perkataan: epal, Encik Johnson, kebajikan, terowong Percubaan = _____ (4 kali percubaan)	0 1 2 3 4	

4.	Pengiraan (1 markah bagi setiap pengiraan yang tepat).	
	5 x 13 (jawapan= 65) _____	0 1
	7 tolak 65 (jawapan = 58) _____	0 1
	58 dibahagi 2 (jawapan = 29) _____	0 1
	11 tambah 29 (jawapan = 40) _____	0 1
5.	Abstrak (1 markah bagi setiap intepretasi yang tepat bagi setiap pasangan, intepretasi yang salah atau konkrit = 0)	
	Oren / pisang _____	0 1
	Kuda / Anjing _____	0 1
	Meja / Rak buku _____	0 1
6.	Informasi (1 markah bagi setiap yang jawapan yang tepat)	
	Nama perdana menteri terkini: _____	0 1
	Nama perdana menteri pertama: _____	0 1
	Bilangan minggu dalam setahun: _____	0 1
	Terangkan perkataan "pulau": _____	0 1
7.	Meniru bentuk / konstruksi (Markah: 2 = lengkap; 1 = tidak lengkap; 0 = gagal meniru)	
	Meniru kiub 3-D: _____ (Peserta boleh melihat kiub ketika meniru)	0 1 2
	Melukis jam yang menunjukkan masa "11.15"	0 1 2
8.	Mengulang secara verbal (1 markah untuk setiap perkataan yang diulang dengan betul)	
	Epal:	0 1
	Encik Johnson:	0 1
	Kebajikan:	0 1
	Terowong:	0 1
	JUMLAH KESELURUHAN (Jumlah markah - (# percubaan - 1); Maksimum = 38)	

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TARGET PRACTICE SENTENCES

No.	*Ayat Sasaran* (Target Sentences)	*Tanda* /Tick (/)
1.	*Saya nak awak ambil benda itu.* I want you to take that thing.	
2.	*Awak rasa dia suka tak kerja ini?* Do you think he/she likes the work?	
3.	*Kami tak suka dia, sebab dia agak teruk.* We hate him/her, because he/she is bad.	
4.	*Apa kata kita buat makan-makan nanti?* Can we arrange the party later?	
5.	*Macam mana boleh jadi macam itu?* How can it be like that?	
6.	*Apa dia buat dekat sana?* What is he/she doing there?	
7.	*Macam itu boleh ke?* How can you do that?	
8.	*Ramai juga orang pergi sana nanti.* Plenty of people plan to go there later.	
9.	*Saya rasa seronok bila dapat pergi dengan diaorang (informal word for them / mereka).* I am happy going with them.	
10.	*Macam mana diaorang tahu dia bekerja di sana?* How they discover where he/she works?	
11.	*Saya nak pergi sana, tapi dia tak bagi.* I wanted to go, but he/she refuses.	
12.	*Kalau nak tahu, keadaan mereka di sana agak baik.* For your information, they are healthy.	
13.	*Tolong ambil benda itu dan letak dekat sini.* Please take that and place it here.	
14.	*Jangan ingat saya tak tahu apa yang jadi dekat sana.* Don't you think I am not aware of the event that happened there.	

15.	*Jangan ambil benda orang, tak baik tahu.* It is bad to take someone's belonging.	
16.	*Bila ada sesiapa bercakap, orang ramai kena mendengar.* While the other is talking, other people need to hear.	
17.	*Apa kata, kalau kita jangan ambil tahu, sebab nanti kita yang susah.* What if, we just ignore them to avoid trouble?	
18.	*Sedih sangat kalau teringat macam mana orang itu buat pada saya.* *I am sad just thinking about what he/she does to me.*	
19.	*Dia suka sangat buat benda yang orang tak bagi buat.* He/she likes to break rules.	
20.	*Kebanyakkan pengguna cuma tahu sikit saja mengenai benda itu.* Many consumers knew very little information about that.	
21.	*Amboi, sukanya awak mengata dekat orang.* Wow, you like to talk bad about people.	
22.	*Macam mana kalau ada orang yang nak ambil awak untuk buat kerja yang banyak di sana?* If people want to hire you to do work here, will you consider?	
23.	*Agaknya, bila mereka akan menyiapkan pekerjaan yang terhenti itu?* When will they complete the unfinished work that was stopped before?	
24.	*Adakah encik mempunyai sekurang-kurangnya satu kerja sambilan?* Do you have at least one part time job?	
25.	*Biar orang itu habisan kesemua makanan yang ada di luar sana.* Let them finish all the foods outside.	
26.	*Kalau awak nak tahu, dia sangat baik orangnya, dan selalu mengambil tahu keadaan saya di sini.* If you insist, he/she is a caring person and usually taking care of me while I'm here.	
27.	*Tolong makan dekat sana baik-baik. Jangan orang mengata kita makan teruk sangat.* Please eat carefully. Don't let them talk about our bad eating habits.	
28.	*Tolong jangan berhenti untuk mengambil makanan di sini, sebab kita kena habiskan kesemua makanan ini.* Please continue taking more food because we need to finish all.	
29.	*Sila letak semua benda yang awak ambil di sini cepat.* Please put all your things here faster.	
30.	*Rasa-rasanya kalau diaorang dapat ambil benda itu di sana, boleh tak kita buat makan-makan nanti?* If they can get all the things needed, can we arrange a party then?	

APPENDIX D

USABILITY SURVEY

SURVEY FORM: A Preliminary Study for Validation of Vocabulary Selection and Organization of Manual Communication Board in Malay.

1. When you use the manual communication board, can you construct sentences that you want to say using the graphic symbol provided? Explain.
   Apabila anda menggunakan carta komunikasi manual ini, bolehkah anda membentuk ayat konstruktif menggunakannya? Adakah anda boleh membentuk ayat konstruktif menggunakan symbol grafik yang disediakan? Sila jelaskan.

   ```



   ```

2. What are strengths of the graphic symbols and the layout?
   Apakah kekuatan symbol grafik ini dan susunannya?

   ```



   ```

3. What are weaknesses of the graphic symbols and the layout?
   Apakah kelemahan symbol grafik ini dan susunannya?

   ```



   ```

4. If you can change anything in the board or improve the manual board, what would it be?
   Jika anda boleh mengubah sesuatu didalam carta komunikasi ini, apa perubahan yang anda rasakan perlu ?

   ```



   ```

SURVEY FORM: A Preliminary Study for Validation of Vocabulary Selection and Organization of Manual Communication Board in Malay.

Survey Questions

Using the scale provided, please mark how much you agree or disagree with the following statements.

Dengan menggunakan sekala diberi, sila tandakan persetujuan anda mengenai soalan-soalan yang diberikan:

1. The graphic symbols that I was shown are culturally and ethnically appropriate for Malay speakers.
   Simbol grafik yang ditunjukkan kepada saya bersesuaian dengan budaya dan etnik penutur Bahasa Melayu

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

2. The communication symbols that I was shown are culturally and ethnically appropriate for Malay speakers.
   Carta komunikasi yang ditunjukkan kepada saya bersesuaian dengan budaya dan etnik penutur Bahasa Melayu

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

3. The manual communication board that I was shown had words that are used typically in conversations by Malay speakers.
   Carta komunikasi yang ditunjukkan kepada saya menggunakan perkataan kosa kata yang biasanya digunakan di dalam pertuturan penutur Bahasa Melayu.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

4. The vocabulary on the manual communication system was organized so that I could easily find and remember the words I wanted to use.
   Perkataan di dalam carta komunikasi manual ini tersusun, dan memudahkan saya untuk mencari perkataan yang diingini ketika bertutur.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

5. The manual communication board that I was shown had vocabulary that allowed me to generate the utterances I wanted to say.
Carta komunikasi yang ditunjukkan kepada saya membolehkan saya membentuk ayat yang ingin saya sampaikan.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

6. I would like to change the appearance of the graphic symbols.
Saya ingin membuat perubahan ke atas symbol grafik di dalam carta komunikasi ini.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

7. I would not change how the vocabulary was organized on the manual display.
Saya tidak akan mengubah organisasi perkataan di dalam carta komunikasi manual ini.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

8. The appearance and organization of the Malay manual communication board promotes effective communication.
Penampilan perkataan di dalam carta komunikasi Bahasa Melayu ini tersusun dan membolehkan komunikasi dilakukan dengan efektif.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

9. A Malay speaker could learn to communicate using this graphic symbol system.
Penutur Bahasa Melayu boleh mempelajari kaedah berkomunikasi menggunakan symbol grafik menggunakan system ini.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5	4	3	2	1

SUMMARY OF THE OPEN-ENDED SURVEY

Question	Responses	Theme
1. When you use the manual communication board, can you construct sentences that you want to say using the graphic symbol provided? Explain.	*2 participants answer "Yes" AND:* *a. The graphic symbol used helps me to speak fluently and smoothly in generating basic sentences, and it that can be used during communication.* *b. Because words available in the board are those that we uses daily"* *c. The color structure used made it easy to navigate* *2 participants "Yes" BUT:* *a. The words are somewhat limited and b. It take longer time for me to generate sentences.*	All agree that the board allowed sentence constructions.
2. What are the strengths of the graphic symbols and the layout?	*a. The system arrangement followed color that is easy for me to find words following category.* *b. Red color were used to represent negative words e.g. "no".* *c. The pictures use to represent words are suitable.* *d. The word were grouped into with different color label helps me to talk.*	Factors contributing to preference: a. Color-coding. b. Part-of-speech arrangement. c. Appropriate use of color.

	e. The opposite meaning like "yes" and "no" was put on the opposite site is very helpful. f. Verbs category was put in the middle of the board are really helpful.	
3. What are the weaknesses of the graphic symbols and the layout?	a. Symbols within a group were not arranged in succession. b. Symbols in the same group were separated makes me confused. c. Color coding is not obvious when you are using dark purple versus light purple. d. Some words were not suitable to the symbols or not relevant for me. e. The opposite word arranged far than the other make it hard to find.	Factors contributing to dislikes: a. Confusion due to the inconsistent arrangement. b. Change color scheme to more obvious color. c. Take into consideration of icons selection on the manual board.

ORTHOGRAPHIC TRANSCRIPTION RULES

The protocol provided an optimal consistency, accuracy and usability of the transcriptions (Trembath et al., 2007; Van Bael et al., 2007). Both co-investigator and research assistant follow the transcription rules reliably. Rules used in this study followed Trembath et al. (2007) suitable for Malay language transcriptions. Complete transcriptions were transferred to Microsoft Excel spreadsheet for analysis.

No.	Transcription Rules
1.	A standard Malay spelling system was employed for all conversational samples.
2.	Speech segmentation performed by dividing speech chunks of approximately 3 s each. Then, the chunk boundaries were placed in naturally occurring pauses by transcriber.
3.	Transcribers were instructed to put chunk-level annotation only if speech stretched for substantially longer than 3s without a silent pause.
4.	Proper noun will be transcribed as one word (e.g., Johor Bahru).
5.	All utterances will be transcribed through audio and/or digital recordings individually.
6.	Each utterance will be transcribed separately and utterance boundaries will be defined by intonation or a pause of greater than 2 seconds.
7.	When sound repetitions (e.g., 'm-mengambil) and syllable repetitions (e.g., me-merupakan) occur, only one whole word will be transcribed.
8.	Fillers (e.g., "eh", "oh", "emm", "ek") will be typed orthographically in a consistent

	form but will not be counted as words. Prolongations of these or any other vocalizations will not be represented in any way.
9.	Colloquial substitutions (e.g., "tu" for "itu") will be typed and transcribed as it is.
10.	Similar forms of a word (e.g., reduplication "kadang-kadang") will be coded as two morphemes but categorize accordingly in the calculation.
11.	Numbers will be typed as nouns.
12.	Swear words if any, will be fully transcribed.
13.	Imitated noises (e.g., people walking, knocking on the door) will not be included.
14.	Words use for initial greeting and closing will be transcribed but will not be analyzed.
15.	Person's name will be de-identified using [bracket] in the transcriptions.
16.	All participants will be refer as [P1, P2, P3, P4] and interviewer as [I] in the transcriptions.
17.	Unintelligible part of an utterance will not be transcribed and the whole segment will be omitted from the transcription.
18.	Malay 'spell check' application program will be used to check on the final transcription.
19.	Reliability will be conducted on 100% of the recordings by both co-investigator and the research assistant.

PART-OF-SPEECH TAGGING

Tag	Meaning	Examples
Kata Kerja	Verbs	*makan, minum, ambil, tengok, letak* eat, drink, take, see, put
Kata Sifat	Adjective	*besar, baru, cepat, seronok* big, new, fast, happy
Kata Soal	Question markers	*apa, siapa, kenapa, bila* what, who, why, when
Kata Sendi Nama	Preposition	*akan, pada, bagi, untuk, dari, di, dengan, hingga, sampai, ke, oleh, sejak, seperti, tentang* will, at, give, for, from, at, with, till, until, or, from, since, like, about
Kata Hubung	Conjunction	*dan, dengan, atau, tapi* and, with, or, but
Kata Ganti Nama	Pronoun	*saya, aku, kami, kita, mereka, awak, ia, orang* I, me, we, us, you, it, people
Imbuhan Hadapan	Prefix	*me(N)-, pen(N)-, ter-, ber-, se-*
Imbuhan Akhiran	Suffix	*-nya, -kan, -i, -lah,*
Kata Arah	Direction	*atas, bawah, tepi, dalam, luar, antara, tengah* up, down, beside, in, out, between, middle

Kata Bantu Aspek	Auxilliary (1)	*sudah, pernah, telah, masih, sedang, akan, belum* had, has, still, while, will, yet
Kata Penegas	Determiner	*juga, saja, lagi, pun* too, just, more, too
Kata Bilangan	Adverbs	*satu, semua, biji, buah, ekor, sikit, banyak* one, all, piece, a little, a lot
Kata Tunjuk	Determiner	*itu, ini* that, this
Kata Bantu Ragam	Auxilliary(2)	*mahu, nak, harus, mesti, boleh, dapat* want, need, should, sure, can, get
Kata Nama Am	Noun	*Benda* Thing
Kata Nafi	Negation	*tak, jangan* no, don't
Kata Penguat & Pembenar	Amplifier	*paling, agak, yes* the most, approximately, ya
Kata Seru	Interjection	*aduh, hai, alamak, amboi* ouch, hi, oops, wow
Kata Pemeri	Verb "to be"	*ialah, adalah* that is, which is
Kata Perintah	Verbs	*jangan, sila, tolong, harap, minta* don't, welcome, please, hope, request

SUMMARY OF PROTOTYPE DEVELOPMENT

The prototype includes a pre-made, single display manual communication board based on The Pixon™ Project Kit (van Tatenhove, 2007) with 144-locations with 144 words. A lap tray-style manual communication board was designed based on language-based structure to provide immediate access to vocabulary.

No.	Prototype Features
1	Wordlist was compiled from four studies in Malay language. Approximately 150 root words were identified, and an additional 13 morphology (i.e. affixes) were included. The manual board consists of 131 stem (root) words with 13 affixes, clitics and particles.
2	Words were categorized into part-of-speech tag (POST) (see Part-of-Speech tagging in appendix F).
3.	This manual communication board uses a language-based AAC system compared to pre-stored messages system that allows user to construct novel utterances and support user to say what they want to say.

4.	The color-coding system (Fitzgerald key) was employed to distinguish between categories to support the selection of word during talking. (See appendix I for color-coding charts adapted for Malay).
5.	Vocabulary was arranged based on the Subject + Verb + Object typology.
6.	Nouns were omitted and was substituted to general nouns e.g. "benda" (thing).
7.	Color-printed on A3 paper (11.7 x 16.5 inches), and laminated for durability and portability.
8.	The system was created for direct selection techniques.
9.	Graphic symbols matched words based on single meaning pictures.

COLOR-CODING SYSTEM

NO.	COLOR	WORD CATEGORY
1.		**Kata ganti nama / Pronouns:** **Saya (I), Awak (you), Kita (Us), Kami (We).**
2.		**Kata Kerja / Verbs:** **Nak (want), Ambil (take), Tengok (see), Makan (Eat)**
3.		**Imbuhan hadapan / Prefixes:** **Me (N)-, Pe(N)-, Ter-**
4.		**Imbuhan belakang & Partikel / Suffixes & Particles:** **-nya, -kan, -an, -lah**
5.		**Kata soal & Kata Arahan / Questions markers & Instruction words** **Apa (what), Siapa (Who), Mana (Where), Bila (When)**
6.		**Kata sendi nama / Adverbs:** **Dari (from), pada (at), di (at)**
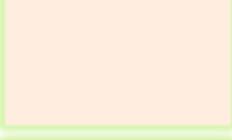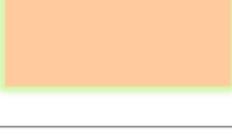
NO.	COLOR	WORD CATEGORY
7.		**Kata sifat (tempat)/ adjectives (location):** Tengah (middle), tentang (about), tepi (beside).
8.		**Kata sifat (benda)/ adjectives (things):** Besar (big), kecil (small), cepat (fast), lambat (slow)
9.		**Kata pemeri / Auxilliary verb@adverb:** Ialah (it is)
10.		**Kata arahan & Kata penguat/ Instructions & Amplifier:** Sila (please), Tolong (please), sangat (too), Paling (the most)
11.		**Kata seru / Interjections:** Aduh (Ouch!), Hai (Hi), Alamak (oops), Amboi (Wow!)
12.		**Kata sifat yang berlawanan / Contrasting adjectives:** Lebih (more), Kurang (less), Banyak (a lot), Sikit (less), Baik (good), Teruk (bad)

TOP 30 WORDS IN THE COMPOSITE SAMPLE (FREQUENCY & COMMONALITY)

Words	English	Frequency	Commonality
saya	I	34	4
di	at	15	4
dan	and	12	4
sini	here	12	4
suka	like	12	4
dapat	get	11	3
lebih	more	9	2
ada	have	8	4
baik	good	7	4
buat	do	7	2

Words	English	Frequency	Commonality
yang	which	7	4
belajar	study	6	3
bila	when	6	2
dalam	in	6	3
sebab	because	6	4
dari	from	5	3
ini	this	5	3
tak	no	5	4
Untuk	for	5	4
dia	he/she	4	2

Words	English	Frequency	Commonality
mereka	they	4	1
tempat	place	4	1
adik	brother/sister	3	2
apa	what	3	2
atau	or	3	3
banyak	a lot	3	1
baru	new	3	2
itu	that	3	2
juga	too	3	2
kerja	work	3	1

TOP 10 MORPHEMES

Words	English	Frequency	Commonality
-an	prefix	19 (4.2%)	3
me(N)	prefix	16 (3.52%)	4
ber	prefix	9 (2 %)	4
pe(N)	prefix	9 (2%)	3
Ke-	prefix	8 (1.8%)	3
-kan	suffix	7 (1.5%)	3
-nya	particles	4 (0.9%)	4
Se-	Prefix	3 (0.7%)	4
Ter-	Prefix	3 (0.7%)	1
-i	Suffix	1 (0.2%)	1

APPENDIX L

LIST OF SPOKEN WORD

Word	Word
Abang (brother)	Belajar (study)
Adik (brother)	Beli (buy)
Ahli (member)	Bentuk (shape)
Anak (child)	Berani (confident)
Asal (origin)	Beri (give)
Baca (read)	Biar (let)
Bahan (materials)	Biasiswa (scholarship)
Balik (go home)	Buku (book)
Banding (compare)	Bulan (month)
Belah (cut)	Cari (find)

Word	Word
Cikgu (teacher)	Ipar (in-law)
contoh	Jalan (walk)
Cuaca (weather)	Jantung (heart)
Daftar (register)	Jawab (answer)
Dahulu (previous)	Johor Bahru (name of state)
Efisyen (efficient)	Kadang (sometimes)
Fokus (focus)	Kahwin (marry)
Gen (gene)	Kait (relate)
Ikut (follow)	Kaji (examine)
Ilmu (knowledge)	Kawan (friend)

Word	Word
Kek (cake)	mei
Keluarga (family)	Minat (interest)
Kira (count)	Minggu (week)
Kuih (dessert)	Negara (country)
Lapang (free time/space)	Nyanyi (Sing)
Lukis (draw)	Pantas (fast)
Malaya (name of place)	Pelajar (student)
Malaysia (country name)	Periksa (check)
Masa (time)	Pilih (choose)
Masuk (enter)	Praktikal (practical)

Word	Word
Protein (protein)	Suatu (some)
Pustaka (library)	Tawar (offer)
Putus (break)	Tempat (place)
Raja (King)	Teori (theory)
Rumah (house)	Tepung (flour)
Saing (rival)	Tuju (aim)
Sarjana (master degree)	Tumpu (focus)
Sekolah (school)	Ubah (change)
Selidik (investigate)	Universiti (university)
Sendiri (self)	Utama (main)
Soal (question)	Yakin (confident)
SPM (name of high school exam)	

REDUPLICATION WORDS

No.	Reduplication words	English
1	**ber**ubah-ubah (prefix + root-root)	Changing
2	kadang-kadang (root-root)	Sometimes
3	jalan-jalan (root-root)	Walking
4	**mem**beli-belah (prefix +root+root)	Shopping
5	**se**baik-baik**nya** prefix + root-root +suffix)	The best way

APPENDIX N

LANGUAGE ANALYSIS SOFTWARE

No.	Steps for analyzing language transcriptions
1.	Download the freeware AntConc© concordance program for Window and Macintosh OS X, and Linux at http://www.antlab.sci.waseda.ac.jp/software.html
2.	Transcribe language sample into a .txt (plain text) file using notepad (Windows) or Text Edit (Mac). Segment your words with space in between to analyze word root, or affixes. e.g. berkerja (working) → ber (prefix) [space] kerja (work) kerajaan (government) → ke- (prefix) [space] raja [root] –an (circumfix)
3.	To upload files: Open file → Choose file → Upload
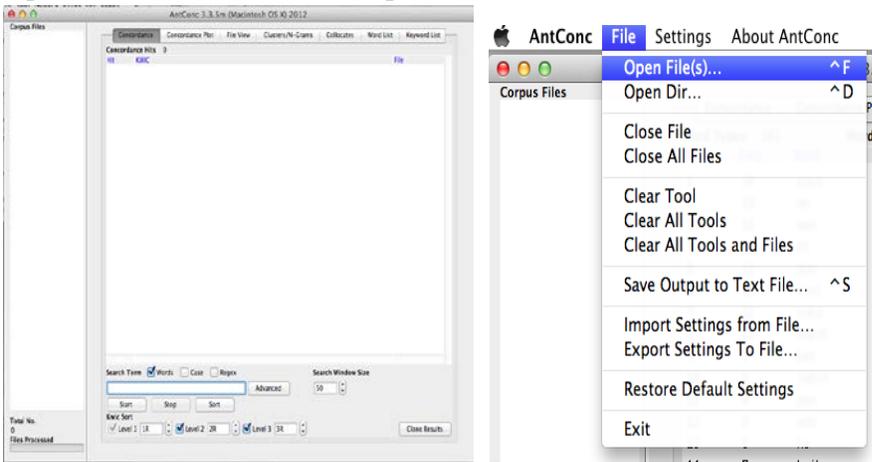
4.	Then, to start analyze Click on file name → Start → Click on Wordlist Choose wordlist to view the list.
5.	High frequency word generated can be safe by selecting CLONE RESULTS at the lower right end.
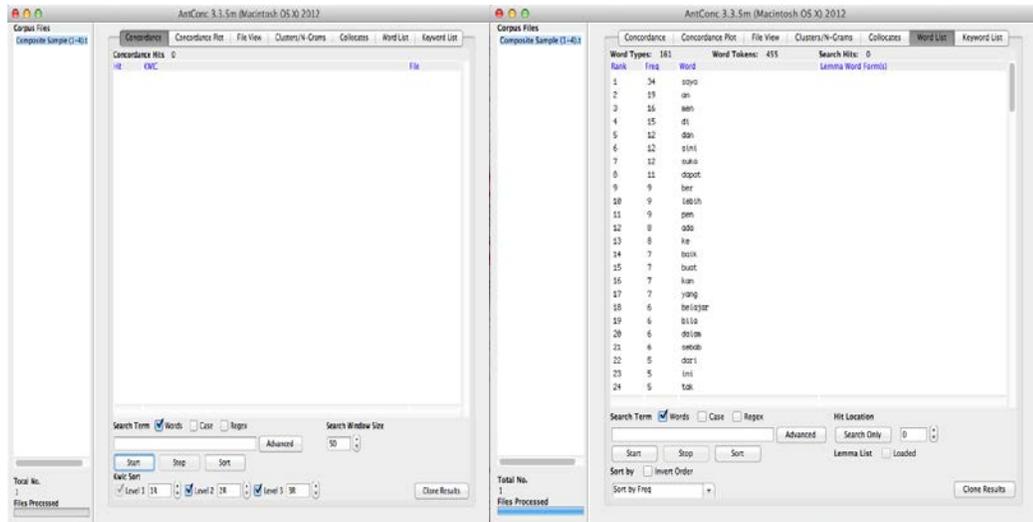
6.	To use the WordCounter©, go to http://www.wordcounter.net/
	Copy and paste your language sample, and the calculation will be completed.

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