A CASE STUDY USING NEUROFEEDBACK TRAINING & SPEECH ASSISTIVE TOOLS FOR CHILDREN WITH SPEECH DELAYS

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A CASE STUDY USING SPEECH ASSISTIVE TOOLS & NEUROFEEDBACK TRAINING FOR CHILDREN WITH SPEECH DELAYS

MUHAMMAD FARHAN IZZUDDIN B. ABD. KADIR

This project is submitted in partial fulfillment of the requirements for a Bachelor of Science with Honours (Cognitive Science)

Faculty of Cognitive Sciences and Human Development
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The project entitled “A case study using speech assistive tools & neurofeedback training for children with speech delays” was prepared by Muhammad Farhan Izzuddin B. Abd. Kadir and submitted to the Faculty of Cognitive Sciences and Human Development in partial fulfillment of the requirements for a Bachelor of Science with Honours (Cognitive Science)
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ABSTRACT

The purpose of this research was to identify and discuss the improvement of speech delayed children in developing speech after undergoing several neurofeedback training with the help of assistive tools through the changes in brainwave pattern. However, when it comes to assistive tools, most of them are develop based on the western culture and based on normal circumstances. This is important as the acceptance and the ability for the special children to learn things are different from the normal children. Hence, this case study use the Pre-test and Post-test design in which a total of 8 session of neurofeedback training (session 1 of NFT without assistive tools and session 2-8 of NFT with assistive tools) is conduct on two speech delays children diagnosed by pediatrician. The brainwave or raw data will be recorded and compared using the average reading from each session. Thus, the research found that the use of Delta Training Protocol helps the subject to show an improvement and increment in which throughout the session the Delta brainwave start to produce a more desirable pattern. In a conclusion, the findings revealed that both subjects improved in terms of speech behavior as shown in the result section. The Delta training protocol was used to inhibit the excessive wave (High Beta & Beta) using neurofeedback training in combination with the assistive tools (game & video).

Keywords: neurofeedback training, assistive tools, speech delays children, delta training protocol, speech check checklist
ABSTRAK

CHAPTER ONE
INTRODUCTION

Speech can be defined as the power or act of speaking (Speech, n.d.). In other words, speeches are simply things that one will do in their daily life in order to carry out a task or socialize with other people. Basically, about 5% to 8% of youth around the world, aged from birth to 21 years old were diagnosed with speech disability or delays which may be associated with later learning, socioemotional, or behavioural problems (McQuiston & Kloczko, 2011) and this were further explained that boys have higher tendency to have this disorder than girls in the ratio of 1.5:2.4 (Zeff, n.d.). This fact shows that there are still people out there who are not able to produce speech like normal people do.

This speech disorder may be caused by several reasons such as cleft palate or lip in which this is where the person has a split in the upper part of the oral cavity or upper lip that will results in the difficulty of speech (Zeff, n.d.). Besides that, one of the causes of speech disability is hearing impairment either total loss of hearing (deafness) or partial hearing loss (Zeff, n.d.). This is in other words will affect the way someone speaks and communicates with others.

Speech disorder or delays should not be taken lightly especially when it comes to children. This is because speech and language development can be considered as one of the distinct features and indicators of child’s overall development and cognitive ability and it is at the end may relate back to the school success (Nelson, Nygren, Walker, & Panoscha, 2015).

Although, as mention above the reason may be due to hearing impairment or condition of the oral cavity (Zeff, n.d.), other risk factors and variable should not be left out such as it is found out that most frequent mentioned variable of speech delays or disorder are male sex, socioeconomic disadvantages, family history and many more (Campbell et al., 2003).
Hence, many interventions have been carried out to alter or solve this problem. This intervention may take place in many different places and situation such as home, school or even clinic. Each and every intervention varies from one another as it may differ from one another due to its resources available, policies, perceived needs and many more (Law, Garrett, & Nye, 2008). Thus, sometimes it is difficult to ascertain that which intervention would give the most suitable result and whether the subject will receive the most benefit from the intervention (Crosbie, Holm, & Dodd, 2005). In other words, to find the best and most appropriate solution in which the subject may get a fruitful result can sometimes be a difficult task.

However, it is not fair to say that nothing may give such result. Nevertheless, there are still several noticeable intervention that has been carried out to investigate the cause and the solutions of this problem such as using the existing speech therapy (Hayes, Keegan, & Goulding, 2012) or a more popular method nowadays which is Assistive Technology (AT) (Yamada, Javkin, & Youdelman, 2000). Despite the growing attention on using assistive technology, little is yet known about the specific uses of assistive technology with person who varies in disability type, severity and age (Alper & Raharinirina, 2006). In other words, these technologies are still in its baby stage and there are still a lot of improvement and areas that should be taken into consideration.

This is important because through this medium, more people would be able to be cured especially children whose are still developing and increasing in their intelligence. Research found out that speech and language disorder are one of the most common developmentally disabling condition of childhood (Macias, 2005). However, further research indicates that 42.5% of young children with this speech impairment show improvement in their speech ability through times (Macias, 2005). Nevertheless, this improvement would not reflect any improvements if
there is no action taken from the early stages.

As mentioned above, one of the solutions that can be taken is through using assistive technology or tools. This method has been increasing in demands as it has been proven to help in improving speech disability such as DrSpeech, Video Voice, Voice Prism and more (Joao Pedro, Claudia, & Pedro, 2014).

Another distinct element that should be noticed was neurofeedback training which has been used as treatment or adjunct treatment for many different conditions such as clinical symptoms which stem from brain dysregulation (McCulloch, 2011). For example, it has been proven to be a promising alternative for the treatment of attention-deficit/hyper-activity disorder (ADHD) (Moriyama, Polanczyk, Caye, Banaschewski, Brandeis, & Rohde, 2012).

Problem Statement

Hence, this study was conducted based on two main problem statements that had been identified. The first problem was speech assistive tools are made for normal circumstances. The existing speech AT are mostly developed for normal circumstances or for normal people and not much are developed for special needs people (Alper & Raharinirina, 2006) in which the development are different from one another such as the time reaction involved, the choice of words, the color used and many more (Joao Pedro et al., 2014). This is important as the acceptance and the ability for the special children to learn things are different from the normal children (Moharir, Barnett, Taras, Cole, Ford-Jones, & Levin, 2014).

Next, speech assistive tools are made based on the western culture. The existing tools are mainly developed based on the western culture instead of the local culture (Moharir et al., 2014). For example, the language used choice of words and more. This is important because as stated by Moharir et al. (2014) children are more easily learned based on the environment they
were raised such as it is suggested that the language used for the assistive tools should be in the same language with the mother tongue. This is to not confuse the children when learning.

Objectives

Thus, with this in mind, several objectives of this study were

- To identify the changes in participant’s brainwave using Neurofeedback Training (NFT).
- To identify and discuss the improvement of a speech delayed children in developing speech after undergoing several neurofeedback training with the help of assistive tools.

Definition of Terms

Speech Disability. Speech or language difficulties can be considered as a neuro-development disorder of childhood (Hayes, Keegan, & Goulding, 2012). Further research has classified speech disability into four types which are voice disorders, motor disorders, articulation delays and dysfluency (Moharir et al., 2014).

Assistive Tools. Any items, piece of equipment, or product system whether acquired commercially, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities (Alper & Raharinirina, 2006).

Neurofeedback Training. It is a type of biofeedback that allows the individual to train and influence brainwave pattern in which this training will makes use of brain-computer interface to rebalance the brain and central nervous system (McCulloch, 2011).

Significance of Study

Several significance of this study might contribute in giving references to the area of special needs education and specifically for speech. On top of that, it may provide parents with a simpler and home based speech tool kits that will fill the gaps of the lack in speech therapist. Besides that, this research will help to treat the children with speech disability especially those
with speech delays using appropriate assistive tools. Lastly, to improve the awareness on the use of speech tool kits with visual and auditory stimulus in stimulating speech production and phonology.
CHAPTER TWO
LITERATURE REVIEW

Speech Delays

Normally, speech disorder or speech delays indicates the problem in creating the appropriate sounds representing the language symbols (the words) and therefore communication might be impaired (Macias, 2005). In other words, speech disorder or delays happens when one person are not able to create the appropriate sounds to represent the words at the given of age. Hence, causing it to have communication impairment.

Basically, about 5% to 8% of youth around the world, aged from birth to 21 years old were diagnosed with speech disability or delays which may be associated with later learning, socioemotional, or behavioural problems (McQuiston & Kloczko, 2011) and this were further explained that boys have higher tendency to have this disorder than girls in the ratio of 1.5:2.4 (Zeff, n.d.). However, one long-term study revealed that 42.5% of young children who’s diagnosed of having this speech disorder show improvement in their speech ability (Macias, 2005).

Table 1

The word milestones for children

<table>
<thead>
<tr>
<th>Word Milestones</th>
<th>CHILD AGE</th>
<th>WORD COUNT</th>
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<tr>
<td>12 Months</td>
<td></td>
<td>3-5</td>
</tr>
<tr>
<td>18 Months</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>2 Years</td>
<td></td>
<td>100-200 (2 word phrases)</td>
</tr>
<tr>
<td>2 ½ Years</td>
<td></td>
<td>350 (3 word phrases)</td>
</tr>
<tr>
<td>3 Years</td>
<td></td>
<td>700+ (5-8 word phrases)</td>
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In order to assess whether a children is found out to have speech disorder or not, parents need to take full responsibility in assessing it. A simple method in identifying this problem is through the guidelines or word milestone (Table 1) which state that different age will have different word count (Moharir et al., 2014). In other words, if the children do not follow these word milestones, the children would be diagnosed with early speech disorder or speech delays and further assessment is needed to be conducted by the professional.

When it comes to the characteristics of speech disorder, there are four distinct characteristics that can be associated with speech disorder which are voice disorder, motor speech disorder, dysfluency and articulation delays (Moharir et al., 2014).

In voice disorder, it is marked by an atypical change in voice quality which may indicate vocal-fold pathology or a more complex disease process (Moharir et al., 2014). In other words, this voice disorder are due to the pathology or diseases which causes poor pitch regulation to be seen in children (Macias, 2005).

Meanwhile, motor speech disorders are defined as the result of neurological impairment affecting motor programming or neuromuscular execution of speech (Moharir et al., 2014). This motor speech disorder can be further classified into two major elements which is apraxia and dysarthria. Children with apraxia will have problem with the movement of speech in which they tend to have trouble using long words or sentences when they are under pressure, errors in the production of vowels, inconsistent speech errors, voicing errors and more (Zeff, n.d.). On the other hand, dysarthria may include feeding difficulty, drooling, open-mouthed posture and tongue protrusion (Moharir et al., 2014).

Dysfluency or fluency disorder deals with the flow of speaking (Zeff, n.d.) in which this may involves speech sound repetitions, prolongations and pauses (McQuiston & Kloczko, 2011).
In other words, a dysfluency are condition in which the children might have problem in creating speech in the sense that they keep on repeating the same words and it took them quite some times to find the appropriate words.

Lastly, the articulation delays can be simply defined as a disorder of the quality of speech characterized by the substitution, omission, distortion and addition of phonemes (Macias, 2005). This is the problem where a child has trouble producing sounds and sound combinations of speech correctly.

Speech disorder or delays should not be taken lightly especially when it comes to children. This is because speech and language development can be considered as one of the distinct features and indicators of child’s overall development and cognitive ability and it is at the end may relate back to the school success (Nelson, Nygren, Walker, & Panoscha, 2015). Although, as mention above the reason may be due to hearing impairment or condition of the oral cavity (Zeff, n.d.), other risk factors and variable should not be left out such as it is found out that most frequent mentioned variable of speech delays or disorder are male sex, socioeconomic disadvantages, family history and many more (Campbell et al., 2003).

Hence, many interventions have been carried out to alter or solve this problem. This intervention may take place in many different places and situation such as home, school or even clinic. Each and every intervention varies from one another as it may differ from one another due to its resources available, policies, perceived needs and many more (Law, Garrett, & Nye, 2008). Thus, sometimes it is difficult to ascertain that which intervention would give the most suitable result and whether the subject will receive the most benefit from the intervention (Crosbie, Holm, & Dodd, 2005). In other words, to find the best and most appropriate solution in which the subject may get a fruitful result can sometimes be a difficult task.
Speech Assistive Tools

In general, assistive technology can be simply defined as any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is to increase, maintain, or improve functional capabilities of individuals with disabilities (Alper & Raharinirina, 2006). In other words, it is anything that could help people with disabilities in improving or maintaining their capabilities and in this case it would be speech capabilities.

For example, computer integrated speech training aid (CISTA) which was developed for persons with speech-impairments, especially for profoundly deaf children (Yamada, Javkin, & Youdelman, 2000). CISTA has been used in rehabilitation centers in Japan and the USA for years and it has been proven that the user has shown improvement in the sounds of the consonants (Yamada, Javkin, & Youdelman, 2000).

However, despite the increased attention to and awareness of the potential of Assistive Technology (AT) to help individuals with disabilities, several boundaries remain (Alper & Raharinirina, 2006). For instance, it is not accessible to all student with disabilities as lack of resources and the cost is high (Alper & Raharinirina, 2006). Besides that, even if one family did manage to get the AT, it would be hard for them to use it as the setup or it is develop not considering the user who does not how to use it (Alper & Raharinirina, 2006). In other words, it is not user friendly as it require professional to operate it. Nevertheless, as mention above, AT has been such a great help in improving disabilities or capabilities.

Neurfeeeback Training (NFT)

Neurofeedback training (NFT) is a type of biofeedback that allows the individual to train and influence brainwave patterns which it will make use of brain-computer interface to rebalance the brain and central nervous system (McCulloch, 2011). Hence, through this NFT, it will
decreases or interrupts inefficient patterns and helps the central nervous system develop patterns which are associated with stability, flexibility and resilience (McCulloch, 2011).

This neurofeedback training has been used as treatment or adjunct treatment for many different conditions such as clinical symptoms which stem from brain dysregulation (McCulloch, 2011). For example, it has been proven to be a promising alternative for the treatment of attention-deficit/hyper-activity disorder (ADHD) (Moriyama et al., 2012). Based on Moriyama et al (2012), it has been shown from different studies that NFT has shown positive and effective changes in brain activity patterns of an ADHD subjects. On top of that, it is also used to treat patient with alcoholism, drug abuse and posttraumatic stress disorder (Hammond, 2005).

\[\text{Figure 1. Electrode placement.}\]

In order to understand the NFT, the mechanism itself needs to be understood. After the QEEG has been conducted, two electrodes will be place on the scalp and one more electrode on the earlobes (Hammond, 2005). Then, subject would listen to audio tones or they could also do some task such as reading and playing games. With continuing NFT, the healthier brainwave patterns are maintained in which some person may need to learn to increase the speed or size of brainwaves and some cases require individuals to decrease the speed and amplitude of certain areas of the brain (Hammond, 2005). Figure 1 shows electrode placement during NFT and
Figure 2 shows setup of NFT.

The brainwaves that will be looked at occur at various frequencies which are delta, theta, alpha and beta (Hammond, 2005). Each brainwave patterns or frequencies have their own characteristics and functions. For example, Beta brainwave (above 13 Hz) are associated with a state of mental, intellectual activity and outwardly focused concentration and Alpha brainwave (8-12 Hz) are associated with a state of relaxation and waiting to respond when needed (Hammond, 2005). Meanwhile, Theta brainwave (4-8 Hz) generally represents a daydream-like state of mind that associated with mental inefficiency and lastly, Delta brainwaves (0.5-3.5 Hz) are what we experience when we are asleep (Hammond, 2005). Normally, alpha brainwave will be used in the NFT as it is important in enabling us to learn and use information (QEEG Brain Mapping, n.d.).
CHAPTER THREE

METHOD

Subjects

Case history. The research was conducted on two speech delays children who were diagnosed by professional pediatrician. Both of them are siblings (identical twins) at the age of 5 years old. Subject 1 was the eldest twins and Subject 2 was the youngest twin. However, at the age of 3, the parents noticed that both of the subjects were only able to produce only few simple words such as mama and papa. They also only understand and responded to only their name or small and simple command given by others.

Research Design

This was a case study using Pre-test and Post-test design to observe the use of speech assistive tools and neurofeedback training in enhancing speech ability of a speech delays children. These case studies were divided into several sub action which were NFT and speech checklist.

Speech Evaluation Checklist. This was the introductory section. In this section, a speech evaluation checklist was done by the researcher in identifying the subject’s capabilities or level of speech. On top of that, through this section also the subject’s characteristics was identified and evaluated. The speech evaluation checklist is adapted from Autism Treatment Evaluation Checklist (ATEC).

Neurofeedback training. After that, neurofeedback training (NFT) was conducted. This was where the speech assistive tools (AT) applied to the subject. 8 sessions was conducted and it was divided into two procedures which were sessions 1 only NFT is present (no assistive tools used) and sessions 2-8 NFT and AT was used. Hence, the result from the first session was then compared with sessions 2-8 in knowing the differences in applying the AT.
Note that, there was two different screen needed for this NFT. One of the screen was displaying the brain wave of the subject and the other screen was displaying the assistive tools. In other words, there would be two different screen involved which was the trainer’s screen and trainee/subject’s screen. As shown in the Figure 3, the trainer screen four brainwave of the subject. The top most was the subject entire brainwave, the second part of the brainwave was the low inhibit, the third part was the reward brainwave and the last part was the high inhibit brainwave. Through this screen the researcher or trainer monitored it and adjusted the training parameter to ensure the best and optimum training session. This was important because if the subject’s brainwave (reward-Delta) does not achieve above the threshold the subject may not be able to produce a better pattern of brainwave.

Figure 3. The trainer/researcher screen.

Meanwhile, the second screen was the trainee/subject’s screen (Figure 4). This was where the subject get the stimulus form which was through assistive tools. Each element of the assistive tool was associated with a specific brainwave. The subject goal was to increase the selected brainwave which was the Delta while decreasing the other brainwave which was Beta and High Beta. However, the subject would not know how well he was doing in which the brainwave reading pattern, so the trainer was required to help and guide the subject to have the