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THE EFFECTS OF FAMILIAR, UNFAMILIAR MUSIC AND AUDIOBOOKS EXPOSURE ON SPEECH PARAMETERS OF ELDERLY WITH ALZHEIMER'S DISEASE: A WITHIN CASE STUDIES

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Abstract

Alzheimer's disease is a cognitive disorder common among elderly whereby neurode generation occurs rapidly as a result of decline in brain activity. There have been many studies linking music memory with cognition among patients with Alzheimer's disease. However, the types of music exposed, the familiarity of the music and their effects on speech production is still not adequately explained. Improvement in speech can be demonstrated in alteration of several speech parameters. This multiple case study (n = 3), seeks to investigate *the effects of familiar and unfamiliar music on the speech fundamental frequency (F_0), intensity range, and speech rate of 3 elderly subjects with Alzheimer's disease. The speech parameters after exposure to familiar and unfamiliar music were measured longitudinally over a period of 21 weeks. A listening task to an audiobook was treated as control. Data revealed that in all of these subjects, there was wide variability in performance with no common pattern for familiar music. However, for unfamiliar music, two subjects showed increase in their speech rate. The third subject showed increase in F_0 range. It is suggested that there may be more to understand how familiar and novel stimuli influence speech production in patients with Alzheimer's disease.*

Keywords

Alzheimer's Disease (AD), Familiar, Unfamiliar, Music, Speech Production

1. Introduction

1.1 Alzheimer's Disease

In Malaysia, 7 out of 100 elderly people experience dementia (Nikmat, Hawthorne, Al-Mashoor, 2011). Elderly people are defined as people above the age of 60 (Minhat, Rahmah, Khadijah, 2013, Minhat, Amin, Shamsuddin, 2012, 2014). A contributing factor to dementia is a reduction in brain activity due to the lack of engagement in cognitive demanding activities, especially after retirement (Wan, Ruuber, Hohmann, Schlaug, 2010). Alzheimer's disease (AD) is the most common type of dementia affecting 60 to 80% of dementia cases in the United States (Alzheimer's Association, 2015, p.6) which occurs during aging. AD is a neurocognitive disorder, whereby neurodegeneration occurs rapidly in the brain, particularly causing memory loss in patients (Alzheimer's Association, 2014).

In the Malaysian context, the elderly in Malaysia generally show less involvement in cognitive and physical activities, instead indulging more in social or passive sedentary activities (Minhat, Rahmah, Khadijah, 2013, Minhat, Amin, Shamsuddin, 2012, 2014). Based on previous findings, the Malaysian elderly tend to gravitate towards sedentary lifestyles such as watching television (74.6%), social activities such as having conversations while relaxing (78.7%), and show poor involvement in constructive and stimulating activities such as playing cards, chess or mah-jong (3.4%), playing musical instruments (1.1%), writing or drawing for pleasure or involvement in formal teaching (Minhat, Rahmah, Khadijah, 2013, Minhat, Amin, 2011). High engagement in passive and sedentary lifestyles could eventually lead to a decline in brain activity among the elderly, putting them at higher risk to suffer from chronic illnesses, mental deterioration and cognitive disorders such as Alzheimer's disease (Minhat, Amin, 2011, Wan, Ruuber, Hohmann, Schlaug, 2010, Hall and others, 2009).

Memory, attention, experience, communication skills and learning are all interlinked as they are influenced by activation of the auditory system (Kraus et al., 2014). There is also an overlap between music and language processing centres in the brain (phonological and tonal loop in the working memory). This is why the hallmark symptoms of AD include memory loss (Alzheimer's Association, 2014) and deficit in the working memory.

As mentioned earlier, Alzheimer's disease is a neurodegenerative disease, progressing with time (Haneishi, 2001, Alzheimer's Association, 2014). In other words, the cognitive skills of an individual with AD will worsen or deteriorate over time. In relation to this, impairment in the working memory from the early stages of the disease, will affect learning, attention span (Lake and Goldstein, 2011, Bourgeois and Hickey, 2009, Cayton, Graham, Warner, 2008), and language (Roark et al., 2011, Bourgeois and Hickey, 2009, Cayton et al., 2008) in these individuals.

1.2 Breakdown in Communication

Language is used during communication as a process of 'transmission of information' (Littlejohn and Foss, 2010). Language in communication plays an important role as it gives us the ability to speak, allowing us to participate in life (Stotsky, 1992 in Morreale, Osborn and Pearson, 2000, Cayton et al., 2008, Stiadle, 2014). As such, debilitation in communication may lead to frustration in patients and their family members, causing them to withdraw from conversation and social activities (Ramig, 1995 in Haneishi, 2001). This in return would seriously impair their quality of life (Haneishi, 2001).

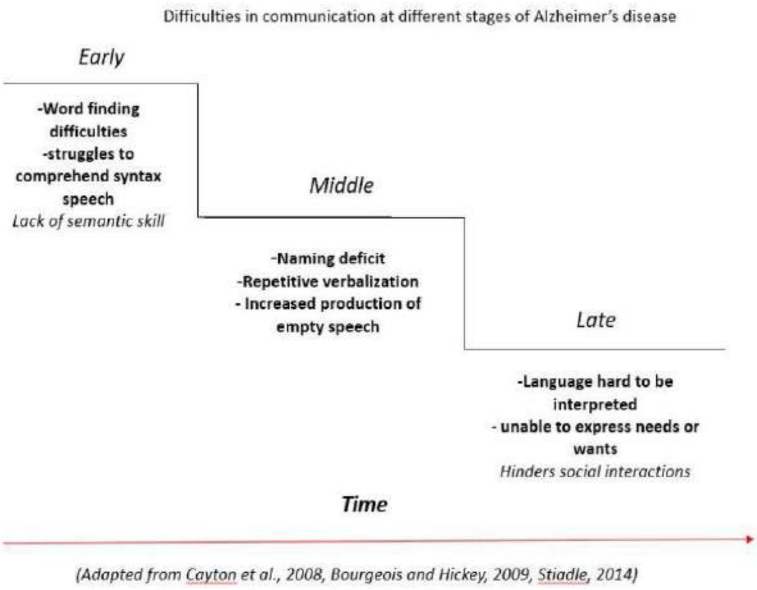

Figure 1: *Difficulties in Communication at Different Stages of Alzheimer's disease*

Difficulty in communication can be observed in individuals with AD; this is due to them demonstrating a lack of semantic skills and suffering word-finding difficulties during the early stages of the disease (Cayton et al., 2008, Bourgeois and Hickey, 2009, Stiadle, 2014). Despite retaining their ability to participate in social conversations, these individuals may struggle to comprehend complex syntax in speech (Stiadle, 2014). Their condition worsens as they enter the middle-stages of the disease, whereby they begin to exhibit naming deficits and increased production of empty speech (Cayton et al., 2008, Bourgeois and Hickey, 2009, Stiadle, 2014). During this stage, individuals experience difficulty maintaining a topic of conversation which leads to repetitive verbalization. Once they move into the severe stages, they experience severe impairment in language, making it extremely difficult for spoken language to be interpreted (Cayton et al., 2008, Lubinski, 1995 in Stiadle, 2014). At this stage, their extreme language impairments and inability to express their needs or wants (Bourgeois and Hickey, 2009), hinders participation in social interactions (Lubinski, 1995 in Stiadle, 2014). They eventually also lose their ability to care for themselves, thus requiring the assistance of a caregiver.

1.3 Music as a Therapy

Since it has been stated that language impairment in AD patients are a result of failure in the working memory (Bourgeois and Hickey, 2009), several researchers have tested the usage of musical encoding on the stimulation on memory (Simmons-sterns, Budson, and Ally, 2010, Simmons-stern et al., 2012). Their studies revealed that musical encoding can facilitate familiarity as well as enhance attention. This is because familiarity for musical stimuli activates medial temporal lobe brain regions (Plailly, Tillmann and Royet, 2007, Simmons-sterns et al., 2012).

This is supported by other studies showing that musical activities such as passive listening have been proven effective in stimulating the insulae (Bamiou, Musiek, Luxon, 2003) which is vital in speech processing and production (Straum and Brotons, 2000). Based on the earlier Baddeley and Hitch's model (1986, 2000, 2003), the working memory (which is affected during Alzheimer's disease) was shown to be comprised of only the phonological loop which processes both music as well as speech. In contrast, recent studies have proven that music and speech have anatomical overlap (Patel, 2014) but are still processed in the phonological loop and tonal loop (Schulze et al., 2010).

Previous researches showed the effectiveness of familiar music in stimulating recollection (Basso, Basso and Belardinelli, 2004 in Platz, Kopiez, Hasselhorn, Wolf, 2015) and enhancing memory in Alzheimer's patients. The effect of unfamiliar music on Alzheimer's disease patients, however, has not yet been fully explored. Pereira's study (2011) postulated that unfamiliar music yielded several active regions in the left hemisphere, specifically the insula, which is vital in speech production.

1.4 Aims

Recently, studies have shown that non-invasive methods such as the measuring of speech parameters can be used in assessing the impact of neurodegenerative impairments of speech and language. This is seen via speech parameters measured in spoken language (Roark et al., 2011) and spontaneous speech (Singh, Bucks and Cuerden, 2001) which can be used as markers in determining the level of severity in demented patients.

Therefore, the principal objectives of the study are as follows.

- To investigate the effect of music therapy on the improvement speech production in subjects with AD based on the measurements of the rate of speech, overall fundamental frequency, and speech intelligibility.
- To observe the changes before (pre-treatment) and after (post-treatment) exposure to the type of stimuli on the speech production of the elderly subjects with AD.

Based on these objectives, this research serves to study the difference in the effect of familiar and unfamiliar music on the verbal memory of elderly patients with Alzheimer's disease.

2. Methodology

2.1 Subjects

Three Chinese females with diagnosis of AD and affiliated with the Alzheimer's disease Foundation Malaysia, ranging from the ages of 70 to 85 years were selected to participate in this study. Selection criteria included individuals who (a) aged 60 years and above; (b) had Alzheimer's disease diagnosed by a neurologist or psychologist with impairment predominantly in memory; (c) had scores of 21 and below in the MMSE and MOCA test.

Subjects were excluded if they (a) demonstrated aggressive behaviours; (b) had severe depression which is determined from their medical records; (c) had other types of dementia (example: Lewy body, Parkinson's disease; (d) had history of traumatic brain injury or neurological diseases; (e) were bedridden, and have significant chronic disease; (f) were under drugs such as psycho(drugs); (g) showed severe depression; (h) showed aversion to music; (i) were in their final stages of Alzheimer's disease; (j) had hearing impairment.

2.2 Pre-experiment

Before beginning the experiment, two neuropsychological tests were carried out to gauge the mental status of the subjects, namely, the Mini-Mental Status Examination (MMSE), and The Montreal Cognitive Assessment test (MoCA), (Razali et al., 2012). The MMSE test required subjects to perform tasks for cognitive domains, including orientation of time and place, short and long term memory, registration, recall, constructional ability, language and the ability to understand and follow commands. The Montreal Cognitive Assessment (MoCA) involved assessments of various cognitive domains: attention and concentration, executive functions, memory, language, visuo-constructional skills, conceptual thinking, calculations, and orientation (Quinn, 2013). For better accuracy, average of total scores from both the MMSE and MoCA test were calculated to determine the mental state of the patients (Moretti, Frisoni, Binetti, Zanetti, 2012, Razali et al., 2012). Table 1 indicates the classification of category based on average of MMSE and MoCA scores:

Table 1: *Classification of stages of AD based on average of MMSE and MoCA scores*

Scores	Category
25-30	Normal
21-24	Mild AD
10-21	Moderate AD
0-9	Severe

Baseline measurements for language were taken from the scores for language and the working memory segments found in the MMSE and MoCA tests.

Apart from the neuropsychological testing, the Assessment of Personal Music Preference (APMP) by Gerdner (2000) (see Appendix 1), was carried out. In the APMP survey, subjects and caregivers were required to fill in the subjects' favourite types of music, favourite artists, and genre or song titles. Based on results from the APMP survey, individualized music playlists were designed for the participants, respectively. Songs in the individualized music playlist were used when subject is exposed to familiar music stimuli. In this study, 'familiar music' refers to music which have been previously heard by the subjects (Plailly, Tillman, Royet, 2007) or was often listened to by the subjects. If there is no information filled in the APMP form, the list of songs played during sing-along sessions in the ADFM day care center will be used as familiar music.

Subjects receiving unfamiliar music stimuli on the other hand, were given music that was not stated in their survey. The unfamiliar music selected were music which the subjects that they have no knowledge of, or have not previously heard. Both familiar and unfamiliar music consisted of vocals, comprising of the same genre of music with similar tempo and rhythm in order to minimize deviation in results (Plailly, Tillman, Royet, 2007, Jungers, Speer, Palmer, 2002). During the experiment, music was played from the media player in a randomized order. A report on the list of songs used for the week was recorded for analysis purposes.

During the control phase, subjects were any music stimuli during therapy sessions. Instead of music, they were exposed to audiobooks based on their spoken language, which will be played via the media player. Audiobooks were selected as a control as it is a proxy to vocal music.

2.2 Procedure

Each subject had to undergo an individual, 20-30 minute, twice a week session, for seven weeks (Lin et al., 2011, Sung et al., 2012, Craig, 2014). During the sessions, the subjects were given either familiar, unfamiliar or audiobooks (control phase). After each phase (14 sessions, 7 weeks), a crossover was done to observe the different effects of stimuli on each subject. This means that each subject went through a total of 42 sessions, with a wash-over period of two weeks in between each phase (14 sessions). The arrangement of sequence of stimuli differed for each subject to observe if it would have an effect on the collected data (Table 2).

Table 2: *Arrangement of stimuli for each subject*

Subject	Sequence of Stimuli
A	F[1] x UF x C
B	UF[2] x C x F
C	UF x F x C[3]

This study is a multiple within subject case study. This method was selected because patients with Alzheimer's disease may present similar symptoms, but, exhibit different patterns of behaviour problems (Bourgeois and Hickey, 2009, p.63). Hence, a within multiple case study method enables us to gain better understanding regarding the effect of the three different types of stimuli on each subject respectively over time (Baxter and Jack, 2008).

During the session, each subject was given a pair of headphones with music playlist in the media player. Headphones were used instead of free-field as the background noise may affect the task performance of the participants. By using headphones, background noises would be filtered out, lowering anxiety among subjects during task performances (Hygge, Evans, Bullinger, 2002). While music exposure usually lasted around 25-30 minutes, the

[1] Familiar music
[2] Unfamiliar music
[3] Control

subjects were given a relatively shorter period of exposure (10 minutes) to stimuli as subjects with AD have shorter attention span (Lake and Goldstein, 2011).

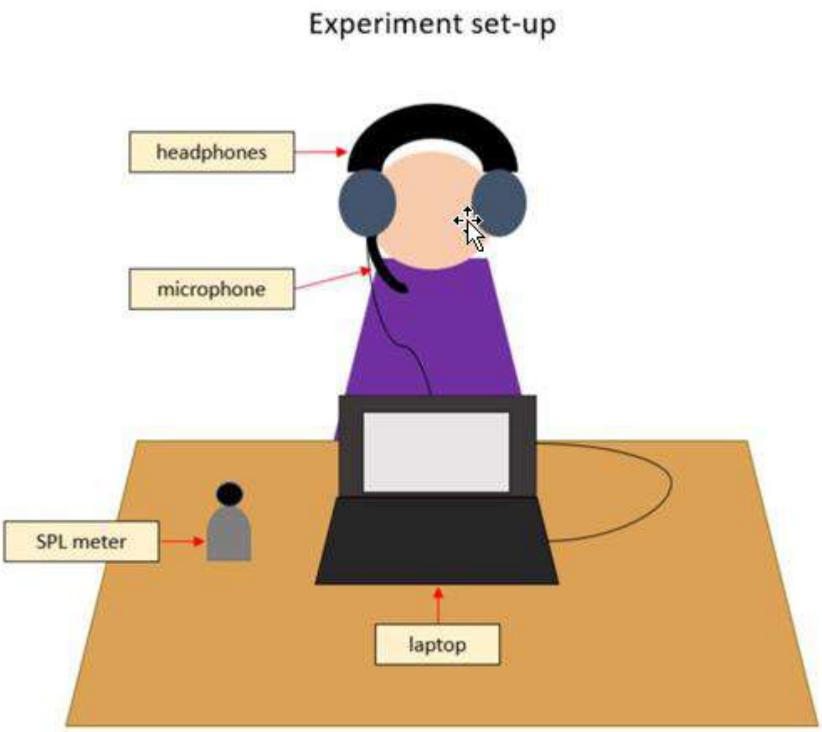

Figure 2: *Virtual image of experiment set-up*

After listening to individualized music for about 10 minutes, the music was stopped. Open-ended questions were used to attain a wide range of responses, and encourage higher verbal rate from subjects (Singh et al., 2001). Subject's responses were recorded using audio recorders. All audio recordings were carried out pre-exposure and post-exposure to music stimuli during every session, throughout the whole duration of the research. Audacity was used to measure the speech rate of the participants. The Phonetogram was used to measure the speech intensity (SPL range), the fundamental frequency (F_0 range) and area of speech. For fundamental frequency, the maxima and minima of F_0 were determined in order to obtain the F_0 range. Pitch intervals of speech were also calculated whereby the highest F_0 value of the recording was divided by the lowest F_0 value (Jones and Knight, 2013). In other words, F_0 range referred to the contour track or 'pitch track' of the speech. The speech rate was calculated based on the number of words uttered per minute (Watt as cited in Jones and Knight, 2013, p. 83). Area of speech showed the relationship between the speech intensity

(SPL range) and (F_0 range). Speech intensity on the other hand, indicated the amplitude or loudness of speech (Jones and Knight, 2013)

The topics of discussion and observations of mood responses from the subjects during each session are recorded in a journal.

3. Results and Discussion

In order to gauge improvement during each session, the difference between the pre-exposure and post-exposure for all speech parameters (speech rate, F0 range, SPL range and area of speech) are calculated. The formulae below shows the way the data was used in determining improvement in various speech parameters.

i) Calculation during each session:
ii) Calculation of average for each phase:

Based on equation (i), a positive value indicated improvement during the post-exposure of that particular session. The *difference* from each session totalled-up at the end of each phase (14 sessions) and divided by 14 to attain the *total average of mean difference* (equation ii), which is calculated using the SPSS program. *T*-test was used to determine improvement of speech parameters before and after exposure to specific stimuli. All results attained were based on comparison within subjects.

Table 3 contains the means (standard deviation) for speech rate, fundamental frequency ranges, area of speech and speech intensity pre and post-session, for each stimulus according to respective subject.

Table 3: *Means and standard deviations of speech parameters*

Subject A												
Parameter	***Method UF*[4]**				***Method C*[5]**				***Method F*[6]**			
	Pre	***Post***	***diff***	***p***	***Pre***	***Post***	***diff***	***p***	***Pre***	***Post***	***diff***	***p***
SR[7] (words per minute)	82.5 (19.5)	81.8 (25.5)	(-)0.8 (26.4)	0.924	67.8 (11.1)	64.0 (21.5)	(-)3.8 (6.0)	0.545	45.6 (21.5)	71.0 (20.0)	25.4 (63.4)	0.117
F0 range[8] (Hz)	211.7 (24.1)	253.0 (30.3)	41.3 (32.9)	<0.001	251.1 (87.4)	254.1 (147.7)	3.1 (107.5)	0.916	186.9 (45.5)	208.3 (26.7)	21.4 (63.4)	0.34
Area[9]	370.8	475.1	104.3	0.024	475.2	369.2	(-)	0.007	259.0	368.0	2.1	0.021

[4] Unfamiliar music
[5] Control (Audiobooks)
[6] Familiar music
[7] Speech rate (number of words uttered per minute)
[8] Fundamental frequency range (Hertz)
[9] Area of speech (decibel)

(dB)	(97.9)	(84.6)	(153.0)		(84.6)	(103.6)	106.0 (124.4)		(90.1)	(130.1)	(7.5)	
SPL range[10] (dB)	38.6 (3.8)	40.6 (4.7)	2.06 (7.5)	0.326	35.7 (3.6)	35.3 (4.4)	(-) 0.3 (3.3)	0.708	36.3 (5.0)	38.4 (7.0)	2.1 (9.4)	0.514
Subject B												
Parameter	***Method UF***				***Method C***				***Method F***			
	Pre	***Post***	***diff***	***p***	***Pre***	***Post***	***diff***	***p***	***Pre***	***Post***	***diff***	***p***
SR (words per minute)	73.3 (43.1)	144.6 (21.3)	71.3 (26.7)	<0.001	122.5 (35.8)	147.1 (33.6)	24.6 (42.4)	0.83	136.1 (36.3)	160.4 (24.8)	24.3 (46.2)	0.071
F0 range (Hz)	121.2 (32.4)	180.7 (77.4)	59.4 (70.3)	0.035	180.6 (69.0)	211.9 (58.2)	31.3 (64.7)	0.093	166.8 (21.8)	173.0 (35.1)	6.2 (47.2)	0.63
Area (dB)	154.6 (91.6)	301.8 (86.8)	147.1 (131.3)	0.01	304.1 (80.0)	314.8 (100.0)	10.7 (114.7)	0.733	270.3 (76.4)	248.1 (69.1)	(-)22.3 (108.4)	0.455
SPL range (dB)	35.6 (7.2)	40.1 (6.0)	4.5 (10.9)	0.247	39.7 (4.2)	38.6 (5.8)	(-) 1.1 (6.2)	0.508	36.6 (6.8)	34.9 (7.8)	(-) 1.7 (9.7)	0.519
Subject C												
Parameter	***Method UF***				***Method C***				***Method F***			
	Pre	***Post***	***diff***	***p***	***Pre***	***Post***	***diff***	***p***	***Pre***	***Post***	***diff***	***p***
SR (words per minute)	99.7 (15.7)	120.2 (11.9)	20.5 (14.6)	<0.001	114.4 (12.5)	114.0 (11.6)	(-) 0.4 (19.4)	0.946	109.6 (13.4)	118.8 (10.4)	9.2 (15.9)	0.084
F0 range (Hz)	245.4 (47.5)	279.0 (36.2)	33.6 (51.7)	0.03	218.4 (40.0)	192.5 (28.7)	(-) 25.9 (44.5)	0.048	222.1 (34.1)	201.8 (28.8)	(-) 20.4 (45.2)	0.116
Area (dB)	356.7 (96.7)	439.8 (114.8)	83.1 (126.2)	0.028	288.7 (88.9)	257.7 (71.1)	(-) 31.1 (88.1)	0.21	320.5 (70.2)	287.6 (77.5)	(-) 33.0 (93.6)	0.21
SPL range (dB)	38.8 (7.9)	41.6 (11.7)	2.8 (12.9)	0.439	32.7 (4.8)	30.0 (5.1)	(-) 2.7 (7.6)	0.207	38.5 (6.3)	33.3 (7.5)	(-) 5.1 (8.4)	0.041

Generally, there was no recognizable pattern attained from the pre-exposure and post-exposure to both familiar and unfamiliar music across all three subjects, whereby each of them exhibited variable performances in speech measures.

All three subjects did however, show significant positive responses towards unfamiliar music. Both subjects, subject B and C (moderate AD), showed improvement in speech rate, $p < 0.001$. This indicates that exposure to unfamiliar music increased their speech rates which is indicated by an increase in the number of uttered words per minute. Subject B showed values of (M = 73.3, SD = 43.1 words/minute) for pre-exposure and post-exposure (M = 144.6, SD = 26.7 words/minute) while subject C showed values (M = 99.7, SD = 15.7 words/minute) for pre-exposure and (M = 120.2, SD = 11.9) for post-exposure. Meanwhile, subject A (severe AD), exhibited improvement in F0 ranges, with having a wider variation in pitch frequencies with pre (M = 211.7, SD = 24.1Hz) and post-exposure (M = 253.0, SD = 30.3 Hz) with $p < 0.001$.

[10] Speech intensity (decibel)

For exposure to both familiar music and audiobooks (control), no significant improvements for the speech parameters were detected.

Table 4: *Observations of the subject based on different forms of stimuli*

Areas of speech	Subject	Stimuli		
		Unfamiliar	***Familiar***	***Control***
Topic of conversation	***A***	Romantic, past, family, current	Husband, Family, when love songs, talks about romance, current	Storybooks, current, past, family
	B	Family, church	Family (son), church	Family, church
	C	Current, Family, Past	Current, family, talks about love life	Current, family, past
Sense of enjoyment	***A***	Yes	Yes	No
	B	Yes	Yes	No
	C	Yes	Yes	Neutral
Reaction to music	***A***	Respond with foot tapping, or finger tap	Responds by singing the lyrics. Occasionally bops the head vertically following the music beat	Showed fear Occasionally decline to join session
	B	Did some finger tapping Smile while listening to music	Sang loudly to music. Smiled a lot	Could not comprehend, thought was scolded Mumbled to herself, while looking down
	C	Sits and smile while listening to music	Sits and smile while listening to music	Sits quietly while listening Occasionally falls asleep

Results showed that subjects exhibited improvement when exposed to unfamiliar music. However, these results did not necessary indicate their level of preference or enjoyment towards the type of music listened to.

Observations when the stimuli were given to the subjects and feedbacks of their enjoyment were recorded at the end of each session showed a sense of enjoyment towards music stimuli (both familiar and unfamiliar) over audiobooks. This was perceived via happiness in their facial expression which was also seen in a study by (Bouhuys et. al., 1995 in Juslin and Vastfjall, 2008). However, their responses towards the type of music given were different. When exposed to familiar music, subjects would either hum or sing along to the songs played. On the other hand, when subjects showed responses during exposure to unfamiliar music, they would either tap their fingers on the table or tap the tip of their foot slightly.

Exposure to audiobooks however, resulted in a different form of response; when exposed to audiobooks, subject B and C would occasionally fall asleep, which was almost never observed when exposed to music stimuli. Subject C showed a neutral response towards the audiobooks, whereby she would just listen to the stimuli quietly. Subject A (severe AD) did not respond well when given audiobooks, as she would continually mutter to herself while looking down, having a disturbed expression. During the post-exposure to audiobooks, subject A expressed feelings of discomfort as she felt that the narration in the audiobooks were directed at her. Subject B (moderate AD) showed slight aversion towards the audiobooks, as there were times when she would form excuses in order to decline her participation in that particular session. Once we reverted back to music in the last phase, she did not exhibit any more difficulty in participating in the sessions. This was also seen in a previous study (Wood et al., 1990 in Juslin and Vastfjall, 2008), whereby music increased the willingness of one to participate in social activities.

For all sessions, the topics of conversation during pre-exposure and post-exposure were mostly of the same content for each subject respectively throughout the whole study. In general, the topics of discussion were mostly centered on their families, their childhood, romantic life, personal interests, and current everyday life. These topics seemed to interest the subjects, allowing them to be more engaged in the conversation. They showed the most amount of engagement when discussing about their loved ones. However, the subjects' moods during each session did affect the engagement in the conversations. When subjects experienced mood swings, they tend to withdraw themselves from engagement in conversations, which was frequently observed in subject B. This may be an indication of the association between language, mood and behavior (Potkins et al., 2003 in Bourgeois and Hickey, 2009, p. 64)

When exposed to familiar music (especially romantic songs, for example Love Me Tender by Elvis Presley or Can't Help Falling in Love with you by Nat King Cole), subjects tended to discuss more about their love life when they were young. Exposure to familiar music tend to sway the conversations more into topics of their past, such as their childhood (Stevens, 2015). A study (Davidson and Garrido, 2014 in Stevens, 2015) mentions that music is able to trigger nostalgia, being a catalyst for remembering particular events, people, emotions and places. When exposed to unfamiliar music, we were able to tap into questions regarding their personal interests as well as their current everyday life. However, most of the time, the topics of conversation would eventually revert back to family topics.

The mood of the subjects seems to affect the measures of speech; SPL range, F0 ranges and speech rate of the subject. This is supported by previous studies (Gobl and Chasaide, 2003, Ellgring and Scherer, 1996), stating the way different moods and emotions affect the changes in voice quality. When subjects were excited (for example, angry or happy), they tend to exhibit larger area of speech, higher F0 ranges, SPL range and speech rate. When the subject showed fear or discomfort (which were observed in subject A and B), they tend to exhibit smaller area of speech, lower F0 ranges, SPL range and speech rate (Markel, Bain and Phillis, 1973 in Ellgring and Scherer, 1996).

The results show more significance on a session to session level, rather than the accumulative sessions in the phase as a whole. This may indicate that there is no long-term effect of the stimuli on the speech production of the subjects. However, difference in effect of stimuli can be weighed from pre to post session.

5. Conclusion

All three subjects showed variable performances without specific or well defined trend in the speech measures and agreed with previous studies (Cohen and Masse, 1993 in Haneishi, 2001) which stated that patients with neurodegenerative disease cannot be interpreted similarly those with non-degenerative disease. The results also suggest that unfamiliar music may have significant effect on the speech rate of subjects with AD, however, it is difficult to gauge the long term effect of music on speech production of these Alzheimer's disease patients. Instead, the results indicated that there may be more to understand how familiar and novel stimuli influence speech production in Alzheimer's disease patients.

Future studies should include active music therapy with video recordings of facial expressions and a scale to measure the improvement of quality of life (QOL).

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