Comparison on the Effectiveness of "Face-it" Application versus Mirror Therapy as part of Home Exercise Program in Addressing Facial Paresis for People with Acute Stroke: A Pilot Study

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Abstract *– There are currently few available strategies available to address facial disability, including mirror therapy (MT). MT lacks a definite protocol, has limited interactivity, and poses risk of injury. Digital games have been used successfully in limb rehabilitation due to their interactiveness and sufficient feedback information. "Face-it" (FI) is a novel mobile application developed to provide interactive theory-based rehabilitation. This pilot study compared the effectiveness of FI and MT in improving facial paresis and physical and social function among community-dwelling people with acute stroke, and the adherence of participants in both programs. House-Brackmann facial nerve grading system (HB) and Facial disability index (FDI) were used to assess functional improvement. Ten people from Region IV-A were randomly placed in either MT or FI group after baseline measurement, and were repeatedly assessed after receiving the assigned treatments. Pearson correlation and Chi-square statistic were used to compare baseline measurements, T-test for within- and between-group measurements, and the tally of completed sessions for participant adherence. Within-group t-test results showed that both MT and FI groups have significantly reduced facial paresis and improved physical (HB p=.03 and .03, PF p=.03 and .01 respectively) function after 14 days. Between-group t-test showed no significant difference for both groups, except for social function where FI group improved significantly after 5 days (p=.00) and 10 days (p=.01). All participants completed the assigned interventions without adverse effects. More research involving larger sample size is recommended as FI is potentially a safe, engaging alternative for improving facial function.*

Keywords *– Stroke, Facial paresis, Mirror therapy, Face it, mobile application*

INTRODUCTION

In the Philippines, stroke is a leading cause of disability, and has a higher rate of prevalence than myocardial infarction [1]. Stroke is described as a vascular pathology that injures the brain, resulting to spasticity and/or paresis on the contralateral part of the involved brain side [2]. Aside from functional limitations, people with stroke also experience a decline in personal confidence as a direct effect of facial asymmetry and paresis which results to failure in expressing and responding with emotions through facial expressions and verbal communication. Motor recovery post-stroke typically peaks in its early phases, primarily within the first three months and slowed between 3 and 6 months [3]. Any intervention designed to promote motor recovery must take advantage of this short timeframe to maximize the rapid neuroplastic changes occurring during this period.

There are currently few available strategies in the physical rehabilitation of facial disability for people with stroke, and one of these is mirror therapy. In a study conducted by Azuma et al [4] for 10 months, they concluded that facial biofeedback rehabilitation with the use of mirror combined with botulinum toxin has beneficial effects for addressing facial paresis and especially for the prevention of facial synkinesis. However, there is no definite protocol for its implementation, and there is a potential risk for breakage, which may cause injury. In addition, there has been no follow-up study concerning the use of mirror therapy for the rehabilitation of patients with stroke experiencing facial paresis.

Several studies have focused on using mobile applications and interactive video games in addressing problems of upper and lower extremity. The study of Chen et al [5] reported that digital games for upper extremity functions increased treatment motivation and were effective for patients with stroke undergoing

rehabilitation because of easy usage, interactiveness and sufficient feedback information. Creation of certain games and applications that target specific stroke impairments are continuously rising as goal-oriented tasks are used in neurological rehabilitation. However, many studies involving digital applications and other computerized based treatment are limited to the rehabilitation of the extremities only [5-7].

Integrating the concept of motor learning is important in the design of treatment strategies to promote motor recovery. Motor learning is described as a change in movement patterns as a result of the interplay of practice, experience and feedback [8]. Treatment strategies that incorporate motor learning concepts in its protocol improved functional outcomes of people with stroke [9]. This research utilized blocked-order practice in the design of both intervention as it is the best choice to address impairments of patients who are under initial stage of learning [10].

Mobile applications have been used in some studies to improve the motor functions of the upper extremities of people with stroke [5]-[6] Despite the availability of numerous applications involving facial movements online, no research has been conducted about the utility of such applications for facial paralysis of people with stroke. Hence, the researchers designed "Face-it" (FI) a mobile application designed recovery of facial motor function of people with stroke. This study sought to identify the effect of FI application on facial paralysis among acute stroke survivors and to monitor patients' adherence to home exercise with the aid of interactive video game.

MATERIALS AND METHODS

Research Design

Multiple Time Series design was used to compare the effects of FI and mirror therapy for people with acute stroke. The researchers used three follow up periods to compare the outcomes for both mirror therapy and Face-it application groups, at five-day interval, for the first two assessment points and four-day interval for the last assessment point.

Participants

The researchers conducted the study in Region IV-A (CALABARZON Region). Adults with stroke of the middle cerebral artery (MCA) for 3 months at most [11] and with facial paresis were recruited via consecutive sampling and were then evaluated for inclusion in this study. The researchers included people undergoing physical therapy rehabilitation for as long as there is no management for facial paralysis. The participants were then screened if they have the following: a grade of II-IV in House-Brackmann Facial Nerve Grading System, a mobile phone (with front facing camera and able to operate the application) and knowledge in the use of the device and similar mobile applications. Participants with global or receptive aphasia, visual [7] and hearing problem, unstable angina [12] cognitive impairment, and recurrence of stroke at any point during the research period were excluded from the study.

Screening Tool

To aid the researchers in selecting the participants in this study, the initial scores coming from this outcome measure were utilized:

I. House-Brackmann Facial Nerve Grading System (HB).

House-Brackmann facial nerve grading system is used to measure patient's facial function, assess the course of recovery and the effects of treatment [13]. It is also a good indicator of prognosis among patients with facial palsy [14].

II. Facial Disability Index (FDI).

FDI is a tool that measures social disability of patients with stroke [15]. It is a patient-reported outcome measure that has good internal consistency with Cronbach's alpha values between 0.667 and 0.907[16].

Assessment Tools

To determine the changes in facial function and physical and social disability among the participants of this study, the researchers used the following outcome measures:

I. House-Brackmann Facial Nerve Grading System.

The same assessment tool was used in assessing the effects of treatment in facial function. Previous studies such as that of Kang et al., [7] and [15] have used this to monitor improvement in facial function among participants with central facial paresis. In addition, Reitzen et al., [13] discussed House-Brackmann can fully describe facial function when used in regional assessment of the face. Was also shown to have an acceptability when

used at the midface (ρ=0.85, p<0.001) and mouth (ρ =0.76, p<0.001) [13].

II. Facial Disability Index.

FDI is a 10-item, self-administered questionnaire used to assess disabilities of people with facial nerve disorders. Its first five items assess the physical function of patients with facial palsy, and the remaining five items measures social function [16]. It has evidence for construct validity and internal consistency (physical function subscale θ=.88; social/ well-being subscale θ=.83) [16].

Device

Hand-held mirror and mobile phone with installed application installed were used in the study.

Face-it application (see Figure 1) was specifically designed to address facial paresis for acute stroke patients. A total of 12 facial expressions are displayed for each of the three levels, which correspond to the practice types in motor learning. Level 1 incorporated blocked practice wherein the participant has to imitate individual facial expressions displayed on the screen within 5 seconds for 5 repetitions. Level 2 incorporated serial practice wherein a set consists of six facial expressions displayed for 5 seconds each and organized in a consistent sequence. To be able to complete the twelve facial expressions, the remaining six facial expressions were placed in the second set, and each expression were also displayed for 5 seconds. These two sets were displayed alternately for 12 times. In the last level, 12 facial expressions were displayed in a random manner for 5 seconds each until the song ends.

For the first two levels, a point is awarded when four correct repetitions are completed cumulatively within each set. However, a point is automatically awarded when the participant is successful in mimicking a facial expression. The second and third levels are initially locked and were only unlocked if the participant is able to score six points cumulatively in the preceding level.

Safety and Feedback

Untoward events such as accidents or adverse effects were logged by a therapist on stand-by to monitor the safety of the application. The participants were interviewed by the therapist about some possible problems with therapy period to obtain feedback concerning their adherence.

Figure 1. Main page of Face-it application

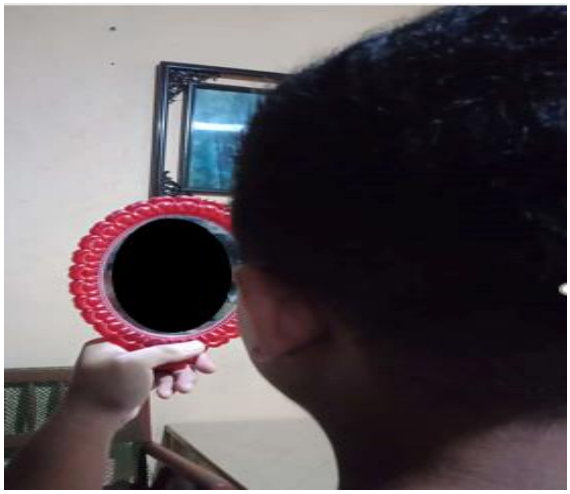

Figure 2. Demonstration of facial mirror therapy procedure

Procedure

Participants were placed on either mirror therapy (see Figure 2) or face-it application group using draw lots method performed by a clinician not involved in the research. The control group received mirror therapy and the experimental group received "face-it" application as part of their home exercise program.

Both groups received their respective treatment while sitting, twice daily with a minimum duration of 15 mins and 30 mins rest interval for 14 days, in accordance with the parameters set by another study on mirror therapy [7].

A physical therapist (PT) with experience in treating patients with stroke was recruited to conduct MT. A large, flat mirror was provided by the researchers and was positioned 12 inches from the patient's face.

Another PT was recruited to supervise the use of FI. The PT's role was limited only to monitoring potential adverse effects of the treatment such as exercise-induced hypertension. They were trained to avoid giving any feedback to the participants while using the application. The distance of the mobile phone from the face was kept at about 12 inches in order to detect the participants' face fully. The application gave an option for the participant to save their performance in video format to the gallery of his/her phone to ensure that the participant was compliant with the treatment. The implementors of the study also asked for feedback regarding both interventions. A logbook was also provided in order to record the date and time of treatment, blood pressure and patient's performance during the treatment session.

Statistical Analysis

Data was analyzed using IBM Statistical Package for Social Sciences (SPSS) version 23 ®. The baseline values were collected and analyzed using Levene's test. Parametric measures were used to analyze the ordinal data (House-Brackmann), paired t-test (age), and chi-square for the non-parametric data (gender and MCA affectation). Pre-test and post-test of HB, FDI Physical and Social were compared using independent t-test.

Ethical Consideration

This research was approved by the Ethical Review Committee of Lyceum of the Philippines University – Batangas. Eligible participants who consented to take part in this study were included.

RESULTS AND DISCUSSION

The baseline data of ten (10) participants of this study are summarized in Table 1. Both groups are similar in all demographic variables except for the laterality of stroke, as all participants belonging to mirror therapy group have left-sided stroke.

Table 1 Baseline Values

VARIABLES	Mirror therapy N=5	Face it N=5	P
Age	57.20±5.63	56.60±3.85	0.27
Time elapse since stroke (weeks)	7±3.16	7.80 ±2.86	0.64
Gender n(%) female	4(80)	3 (60)	0.49
MCA Affectation n (%) right	0 (0)	2 (40)	1.00
Pre HB	2.80±0.84	3±0.71	0.46
Pre FDI PF	64.90±9.04	75.90±6.03	0.84
Pre FDI SF	35.20±10.35	69.60±8.30	0.17

Pre=Pretest, MCA=Midde Cerebral Artery, HB=House Brackmann, FDI=Facial Disability index, PF= Physical Function, SF= Social Function

This is in contrast with the baseline values of outcome measures, of which only HB scores were similar for both groups. Even though the MT group registered lower mean score than FI group in the physical function (PF) section of FDI (MT=64.9±8.2, FI=75.9±6.02), the former has exceptionally better mean score in the social function (SF) section (MT=35.2±10.4, FI=69.6±8.3). It is possible that the baseline values of FDI did not become homogenous due to the number of participants included in this pilot study. In addition, this study might have been affected by interviewer bias, as the assessors were not monitored by the researchers in the actual administration of the outcome measures. FDI and other patient-reported outcome measures are prone to alteration of participant responses as a result of the presence of the interviewer [17].

Table 2
Relationship of Participants Profile to Outcome Measures

Outcome	Age		Time elapse since stroke (weeks)	
	r	P	r	P
Pre HB	-0.33	0.35	0.73	0.84
Pre FDI PF	-0.00	0.99	0.32	0.37
Pre FDI SF	-0.13	0.73	-0.13	0.71

Pre=Pretest, HB=House Brackmann, FDI=Facial Disability index, PF= Physical Function, SF= Social Function

Table 2 presents the relationship between the demographic data of all participants and the baseline scores of HB and FDI. It shows that all outcome measures are not significantly related to the participants' age and the time elapsed since their stroke. This result can be attributed to small sample size or can also mean that the outcome measures are not affected by these variables.

MT group showed significant within-group improvement in facial function as shown by one-point reduction in HB values (p=0.03), which was recorded on the third assessment period (Table 3). Despite this apparent difference, Table 4 shows that the groups still did not have statistically significant different post-test HB values (14 days: p=0.37). It is possible that the improvement of both groups, especially FI, was not magnified due to the limited number of participants for both groups.

Table 3
Comparison within Group

	Mean±SD			
	Mirror		Face it App	
Duration	Mean	P	Mean	P
HB Pre	2.8±0.84		3±0.71	
5 days	3±1	0.70	2.20±0.45	0.09
10 days	2.40±0.55	0.30	2.20±0.45	0.09
14 days	2.20±0.45	0.07	2±0.00	0.03
FDI PF Pre	64.90±9.04		75.90±6.03	
5 days	64.90±8.16	1	77±6.7	0.37
10 days	86.9±4.60	0.02	74.8±11.40	0.88
14 days	79.20±15.85	0.03	94.60±4.60	0.01
FDI SF Pre	35.20±10.35		69.60±8.30	
5 days	36.80±9.55	0.47	63.20±7.16	0.08
10 days	47.20±7.69	0.52	32.80±5.93	0.00
14 days	30.40±6.69	0.18	36±5.66	0.00

Pre=Pretest, MCA=Midde Cerebral Artery, HB=House Brackmann, FDI=Facial Disability index, PF= Physical Function, SF= Social Function

As for physical function, both groups showed within-group improvement in FDI-PF values (Table 3). In addition, MT group displayed a 22-point increase of FDI-PF mean score after 10 days (p=0.02). FI group registered significant improvement of FDI-PF mean value at 18-points after 14 days (p=0.01). Despite the difference of FDI-PF mean value for these groups, between group analysis (Table 4) showed that this is not statistically significant (10 days p=0.08: 14 days p = 0.10). The results show that both FI and MT can improve facial physical function, but the small sample size makes this finding inconclusive. It is also possible that the result was also affected by the protocol as most of the participants belonging to FI group reached level 2at the ninth day of training, while the MT group may have received more exercise volume and variation in the same amount of time. Future research must include a clearer description of MT parameters to improve the robustness of comparison between groups.

Facial social function for both groups, as measured by FDI-SF, cannot be compared due to 34-point difference in baseline mean values. The excessively low FDI-SF baseline value registered by the FI group could have contributed to the lack of improvement of those that received MT (Table 3). On the other hand, the same table showed that those receiving MT showed significant improvement in FDI-SF, starting with a 36-point decrease at the 10th day (p=0.00) and maintaining a 33-point decrease at the 14th day (p=0.00). Despite the small sample size, these results show that FI is potentially effective in improving facial social function.

Table 4
Comparison between Groups

	Mean±SD		
Duration	Mirror	Face It	P
HB			
5 days	3±1	2.20±0.45	0.74
10 days	2.40±0.55	2.20±0.45	0.25
14 days	2.20±0.45	2±0.00	0.37
FDI PF			
5 days	64.9±8.16	77±6.7	0.68
10 days	86.9±4.6	74.8±11.40	*0.08
14 days	79.2±15.85	94.6±4.6	*0.10
FDI SF			
5 days	36.8±9.55	63.2±7.16	0.55
10 days	47.2±7.69	32.8±5.9	0.64
14 days	30.40±6.69	36±5.66	0.46

Pre=Pretest, HB=House Brackmann, FDI=Facial Disability index, PF= Physical Function, SF= Social Function,
*Equal variances not assumed

Based on the overall data, FI appears to be comparable to MT in improving the physical function of people with facial disability as a result of stroke. However, the result is inconclusive due to small sample size.

The facial motor and physical function outcomes achieved by the FI and MT groups can be attributed to real-time feedback offered by both interventions. This feedback approach can provide positive reinforcement which further improves execution of movement [12]. The better physical function scores of FI group can be further attributed to multiple sensory feedback provided by the screen and

point system of the mobile application, as compared to pure visual feedback delivered by MT.

In addition, the inclusion criteria may also have affected the outcomes as patients with some motor function have potential for significant functional improvement [18]. Repetition of tasks can also be a factor for the observed results, though this is present in both interventions. Repetition has been associated with effective motor training among people with stroke [19].

This study is the first to report about the effect of a mobile application in facial motor and function of people with stroke. Given that this is a pilot study, the number of participants were limited. It is recommended that future studies involve a larger sample size to ascertain the observed trends. In addition, the effect of similar applications on other conditions causing facial paresis may be conducted to determine if the effects can be generalized. Longer time frames can also be employed to verify if the effects can be sustained through time.

Also, the use of Face-it application is feasible and safe for people with stroke as shown by full adherence of all participants to the treatment program, and the absence of adverse effects. It is possible that the within-group scores for FDI-SF of the FI group are related to their level of satisfaction to the treatment modality, as digital game scan increase treatment motivation through regular tracking Chen et al [5] and playful aspect of training (Jang et al as cited in Hatem et al., 2016). However, the level of satisfaction between groups cannot be divided objectively due to absence of standardized measures. Thus, the development and use of such measures can help determine the role of FI's design in improving FDI-SF.

Despite being used for other conditions affecting the face [20]; [16], FDI appears to be responsive as well in detecting improvement in facial physical and social function. Future researches concerning the use of FDI on monitoring facial function among people with stroke is warranted to further validate its use for this purpose.

CONCLUSION

Face-it application is a potentially safe and effective alternative to mirror therapy in improving physical function among people with facial paresis secondary to acute stroke. However, strong conclusions cannot be drawn due to small sample size and limitations in the description of treatment parameters. Further research about this and similar applications are recommended to provide a stronger basis for their use in improving the functional ability of people with stroke.

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