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The Effectiveness of HRV-Biofeedback Technology and Heart Rate Variability on Intercultural Communication Competence among Postgraduate Students from Different Nationalities

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Abstract:
Communication competence is an essential factor for all individuals, especially for those professionals who are deeply bounded into the collaborative settings of work and professions. Thus, it is important to assess the potential factors that could influence communication competence of individuals from various backgrounds. However, the available works on communication were mostly conducted based on the self-reported answers of individuals. Thus, this study has applied the heart rate variability (HRV)-biofeedback technology to extend the findings. This study was conducted by the participation of 60 postgraduate students of a public university, and the participants were from 17 different countries. This study was carried out through the application of a mixed methods research design, which included the quantitative and the HRV data sets. Based on the results, there were some significant correlations between the levels of HRV and the main attributes of intercultural communication competence of the participants. The results also confirmed the effectiveness of the use of HRV training and HRV-biofeedback technology on the increase of communication competence among individuals from various backgrounds. Based on the results, individuals with good levels of HRV possess good intercultural communication competence as well. The results from this study may open a new window on the relationship between HRV-biofeedback and intercultural communication competence in the field of communication.

Keywords: intercultural communication, intercultural communication competence, heart rate variability, biofeedback technology, quick coherent technique

1. Introduction

Communication is one of the main achievements of human-beings that shapes their environments and helps them to establish their relationships. Communication among people from various cultures and nationalities helps them to share their experiences, values and knowledge. According to Kim and McKay-Semmler (2013), communication is considered as the main means of social and cultural relationships among people. Thus, communication competence is an important factor for all human beings, especially for those individuals who study and work in the fields and professions that require high levels of collaboration and teamwork. Kim (1991) defined communication competence as "the cognitive, affective, and operational adaptability of an individual's internal system in all communication contexts."

Moreover, intercultural communication competence is the way that individuals interact with other people in effectual and correct manners. Communication competence also refers to the combination of some components such as abilities, skills, attitudes, and patterns of the personality (Dusi et al., 2014; Matsudair et al., 2008).

The ever-growing multicultural environments and multicultural organizations require high levels of contacts and collaboration among staff and individuals. As argued by Sinicrope et al. (2007), in the new era of globalization, the abilities to be related and connected to people from different backgrounds is an important competence for individuals to overcome the environmental challenges in the national and international levels. Furthermore, interactions among individuals from various backgrounds may affect their social and professional lives. As pointed out by Lin (2011), communication is among the critical and essential elements to learn, to understand one another, and to be linked into the modern societies. Interactions among individuals may also help institutions to gain their projected goals easily. According to Pikhart (2014), daily communication among individuals in a multicultural organization establishes and enhances trust and teamwork among them.

Factors that construct communication competence of individuals and may influence their daily interactions are both internal and external skills and abilities (Kim, 1991; Heider, 1958; Jandt, 1973). The Attribution Theory of Heider (1958) asks researchers to focus

on the relationship between internal and external abilities of individuals and their external and internal attributes that may affect their daily actions and reactions. Kim (1991) also believes that the main part of communication competence is meta-competence, and competence mostly belongs to the cognitive and internal property of individuals. There are some shared information requirements for both internal and external communication (Welch, 2013). Thus, it is essential to evaluate the relationships between the internal and external abilities of people that may affect their daily interactions.

One of the main measurable inner factors which may affect intercultural communication competence of individuals is their heart rate variability (HRV)-biofeedback. According to Jandt (1973), biofeedback has several applications and suggestions for studies in intrapersonal activities and interpersonal communication, and human beings have an ability to control their bodily functioning which indicates quite unique appearance of their internal communicative procedure. Assessment of the self-reported answers of participants through a technology-mediated study of their inner competence and intelligence, especially evaluation of the levels of their HRV frequency ranges, may deepen the information and reinforce the outcomes. According to McCraty (2003) the emerging studies on complex contacts and balance between cognitive, emotional and psychological conditions of communicators have led to the improvement of some technologies on human function and performance. McCraty and Shaffer (2015) argued that the heart rate variability which refers to the time interval changes between the adjacent heartbeats is an emergent property of mutually-dependent regulatory mechanisms that works on different proportions of time to become habituated to emotional and environmental challenges.

Good HRV frequency ranges are connected with well-performance, psychological flexibility, intrinsic self-regulatory abilities, adaptability of individuals, and their creativity and abilities to overcome the affective, cognitive and physiological stresses (Lagos et al., 2008; McCraty & Shaffer, 2015). According to Quintana et al. (2012), higher HRV indicates a psychophysiological situation which is friendly and well-matched with social connections and public communication. Low HRV frequency range however is associated with anxiety, stress, and depressions, and individuals with low HRV scores may have more stress and anxiety and their stress and anxiety may cause them to have a high degree of negative perspective about their personal and social actions and reactions (Nubli-Wahab et al., 2011; Senik et al., 2013). Based on the HRV power spectrum, the HRV frequency bands are categorized under the three ranges as: very low frequency (VLF) which indicates the range of $0.003 \ H_Z$ to $0.04 \ H_Z$, low frequency (LF) which includes the frequency range of $0.04 \ H_Z$ to $0.17 \ H_Z$, and high frequency (HF) which indicates the range of $0.15 \ H_Z$ to $0.4 \ H_Z$. A desirable HRV frequency range which indicates the coherent heart is under the LF and HF ranges of $0.04 \ H_Z$ to $0.26 \ H_Z$ (McCraty & Shaffer, 2015).

However, most of the previous works on communication were conducted in the western context of communication. Works on the western perspectives may not answer the questions in the Asian context of communication because of their fundamental differences in the social, cultural and educational norms. According to Kim (2007b) and Kim (2012), communication science belongs to the Euro-American venture and it reflexes and refers to the cultural setting which belongs to the mentioned enterprise; thus, it is simple to understand that the object of studies in the west is their own people. If other people like to study their own communication practices in their own environments, they are most welcome. Westerns are busy enough to think wisely about their own cultural norms (Kim, 2007b; Kim, 2012).

Furthermore, previous researchers mostly conducted their studies on communication competence based on self-reported answers of individuals, and the results from the quantitative surveys may not cover the overall competence of individuals. According to Deardorff (2004), even though researchers use different methods to evaluate communication competence, including observation, interviews, and portfolio, but based on the reviewed literature, assessments mostly were done based on self-reported questionnaires. Thus, this study aims to compare the results from the self-reported answers of the participants for the quantitative questionnaires with the results from a technology mediated study of their HRV as an important internal factor. This study aims also to assess and describe the effectiveness of the use of HRV-biofeedback technology on the development of heart rate variability, and the probable effects of the use of HRV-biofeedback technology on the increase of intercultural communication competence among postgraduate students from different cultural backgrounds in a Malaysian public university.

1.1. Conceptual Support

According to Kim (2010), interests in the basic parts and micro levels of interface of people across societies maintain the main domain for theories and studies of intercultural communication. Kim's (1991) hypothetical conceptualization of communication competence focuses on the active and interactive conditions of interactions between at least two communicators. As she pointed out, communication competence as the overall capacity and capability of individual that facilitates the process of communication between communicators who belong to different backgrounds and also contributes in assisting communication outcomes (Kim, 1991). Moreover, Sarwari's (2017) the Contact and Cohesion Theory focuses on Contact Initiation, Negotiation, Cognition, and Cohesion as the four steps for conducting proper interactions among individuals from different backgrounds in Asian context of communication. The Contact and Cohesion Theory also introduces seven pre-conditions for conducting successful interactions among individuals from various backgrounds in Asian context of communication. The proposed preconditions are: Coherent Competence, Coherent Heart, Self-knowledge, Purposefulness, Respect Differences, Shared Interests, and Flexibility (Sarwari, 2017).

The Attribution Theory of Heider (1958) focuses on the relationship between the internal and external abilities and attributes that affect individuals' action and reaction. According to this theory, the procedure of assigning the reason for individuals' behaviour is some internal characteristics rather than the only external elements or forces. Thus, the explanation of performance of individuals related to the internal attributes of their personality and traits (Heider, 1958). HRV-biofeedback is among assessable internal factors that could affect daily interactions among communicators. Jandt (1973) introduced biofeedback as intrapersonal communication, and based on the results of a study under the title of (Biofeedback as Interpersonal communication) argued that humans have an ability to control functions of their body which were considered to be construable through the automatic nervous system which is a unique form

of intrapersonal communication. Moreover, good HRV is connected with creativity, harmony, well-performance, self-control, reduction of psychological anxieties, and personal skills of individuals to deal with the cognitive and affective stresses and anxieties (Lagos et al., 2008; McCraty et al., 2000; McCraty & Shaffer, 2015; Tiller et al., 1996). Thus, assessment of the effectiveness of HRV-biofeedback on intercultural communication competence may help researchers to highlight its probable effects on the process of interactions among individuals from different backgrounds.

2. Literature Review

According to Beamer (1992), intercultural communication is not just a goal, but a continuing process. Communication competence is the main component in performance across different fields of human progress such as psychological, academic, relational and occupational developments (Paulk, 2008). Through their stay and study in a multicultural university campus, students from different nationalities may find the opportunity to have interactions with individuals from various backgrounds. Reed (2008) argued that, universities are the productive environments for reducing anxiety and also for the development of communication competence of individuals. Thus, interactions among postgraduate students from different backgrounds may enable them to improve their communication competence and have more collaboration with their peers from various backgrounds. Based on the results from two experiments, Cohen, Wildschut and Insko (2010) argued that, task related interactions increase collaboration in diversified environment.

Their personal competence and demands for the contacts and collaboration in a collegiate environment may empower individuals from different nationalities to have more interactions and improve their intercultural communication competence. The abilities to establish and continue good relationships with other students and preventing destructive conflicts with peers are the main indicators for the improvement of intercultural communication competence among students (Luthar & Burack, 2000; Cairns & Cairns, 1994; Sarwari & Wahab, 2016; Sarwari & Abdul Wahab, 2017; Sarwari, Ibrahim & NorAshikin, 2016). The development of communication competence among students from various backgrounds increases their professional achievements (Mahoney et al., 2003). According to Marrone (2005), communication competence as the ability of conducting peaceful intercultural interactions helps individuals communicate in a multicultural setting.

Communication competence belongs to both of internal and external abilities of individuals that affect their daily interactions (Kim, 1991; Heider, 1958; Sarwari & Abdul Wahab, 2017). Assessment of heart rate variability as an important internal factor may help researchers to find out the relationship between internal and external attributes that construct communication competence. The HRV-biofeedback technology enables researchers to assess and compare the results from the self-reported answers of individuals with the levels of their HRV. Studies on HRV- biofeedback and focus on the emotional self-regulations have shown helpful results in the educational, workplace and clinical settings (Tanis, 2008). According to Jandt (1973), biofeedback deals with the automatic physiological process and intensely related to internal process of communication in the human body. According to Jacob (2010), heart rate variability (HRV) refers to the term which indicates the beat-to-beat changes of the heart rate. Heart rate variability (HRV), which is the time intermissions between nearby heartbeats, is a developing property of inter-reliant regulatory-systems which functions on various time ranges to adapt the psychological and environmental challenges (McCraty & Shaffer, 2015). As stated by McCraty and Shaffer (2015), a good HRV frequency band of a healthy person reflects well-function and an inherent and natural self regulatory ability, adaptability, or flexibility.

The results of studies on the use of HRV biofeedback by the previous researchers have demonstrated the efficiency of this technology on improvement of human performance, especially in the educational issues (McCraty et al., 2000). Moreover, based on the results of a study on the relationships between heart and brain, Thayer (2007) argued that, HRV associated with executive and nonexecutive function tasks, and physical detraining affects HRV. Thus, description of the effectiveness of the application of HRV-biofeedback technology and techniques on the increase of good HRV intercultural communication competence may bring more interesting results.

3. Methodology

3.1. Participants
The participants of this study were 60 postgraduate students in a Malaysian public university, who belonged to 17 different Asian and African countries. From all participants, 47 (78.3%) of them were males and 13 (21.7%) others were female students. From all participants, 29 (48.3%) of them were master students and 31 (51.7%) others were PhD students. From all participants 27 (45%) of them were under the age category of 22-27, 19 (31.7%) of them under the age category of 28-33, 8 (13.3 %) of them under the age category of 34-39, and 6 (10%) of them under the age category of 40 and above.

3.2. Instruments
The revised version of Intercultural Competence Questionnaire (ICQ) of Matveev (2002) which has 24 items was adopted and used to assess intercultural communication competence of the participants. The ICQ was developed by Matveev (2002) under the guidance of the Intercultural Abilities Model of Abe and Wiseman (1983), and Intercultural Effectiveness concept of Cui and Awa (1992). The ICQ was used in this study because all attributes of this instrument which are interpersonal skills, team effectiveness, cultural uncertainty, and cultural empathy (Matveev, 2002) could have some connections with creativity, harmony, psychological flexibility, well-performance and self-control, which are the main outcomes of good HRV (McCraty & Shaffer, 2015; McCraty et al., 2000). The revised version of ICQ measures the level of intercultural communication competence based on the Likert Scale with five options per

item. The quantitative instruments were checked through the reliability test of SPSS and the Cronbach alpha score for all items together was .796.

For the HRV data collection, the emWave PC biofeedback (1.0) software and device which were developed by the Hearth Math Institute for the heart rhythm variations were used and the data were collected separately from the volunteer participants. According to Reyes (2014), the emWave is a portable device and help individuals to monitor HRV, and to rehearsal biofeedback techniques. The emWave product of HeartMath Institute is developed to be used for biofeedback treatment and publicly applicable through worldwide web (Whited et al., 2014), and the biofeedback through the use of emWave device focuses on the initiation of positive emotions (McCraty et al., 2006). The emWave device was used to collect the HRV data from the participants to compare the results from their self-reported answers for the quantitative questionnaire with the results from the technology mediated data from their internal abilities. Before the HRV data collection sessions, the letter of consent which included the information about HRV data collection procedure, time and sessions was given to the volunteer participants to be read carefully.

Porges (2007) argued that, the aptitude of observation, conceptualization and understanding of HRV is associated with the technologies that monitor the heart rhythm, the methods that measure changes in the heart rate, and the knowledge and information of basic neural mechanisms and systems mediating the beat-to-beat changes in the heart rhythm. According to Ross (2011) the use of emWave for HRV assessment under the HeartMath process is unquestionable and quantitatively effective, as the HeartMath Institute through conducting of various studies has provided evidences for the effective role of our hearts on our wellbeing and balanced lives. The emWave device and other biofeedback technologies, devices and techniques which developed by the HeartMath Institute are certified through scientific research on biofeedback, stress and emotions over 17 years, and emWave allows individuals to observe their heart rate variability (HeartMath.org, 2016).

3.3. Data Collection Procedure
Both of the quantitative and the clinical data were collected in different stages. The quantitative data was collected directly from the participants by distribution of the questionnaires. The clinical data collection procedure was applied under the guidance of the Quick Coherence Technique (QCT) which was developed by HeartMath Institute. The QCT suggests three steps for the HRV assessment process. The proposed steps are: 1) heart focus (which asks the volunteer to focus on surrounding areas of his or her heart), 2) heart breathing (which ask the volunteer to breathe regularly and at the same time focus on his or her heart), and 3) heart feeling (which asks the volunteer to gently bring forward a positive sentiment while focusing on his or her heart and breathing) (Childre et al., 2000; HeartMath.org, 2016).

For the clinical data collection procedure, all 60 participants of this study were divided into two groups as 30 for focus group and 30 for control group. A one-day extensive HRV-biofeedback training was held with the participation of 30 members of the focus group. During the workshop, all 30 members of the focus group were trained about the use of HRV-biofeedback technology and briefed about the probable effects of the use of this technology on their internal abilities, and also on the levels of their communication competence. By the end of the training, all of the 30 members of focus group reconfirmed their participation in the real data collection procedure. The HRV data collection procedures had four sessions for each group. The four data collection sessions for members of the focus group were: baseline, heart focus, heart breathing, and heart feeling. The data collection sessions for the members of the control group were: baseline, relaxation1, relaxation2, and relaxation3. The HRV data from members of focus group were collected under the intervention of the steps which included in the Quick Coherence Technique. Moreover, from members of the control group the HRV data were collected without the intervention of any training or technique.

The intercultural communication competence data were collected before and after the HRV-biofeedback training from both groups of the participants to compare their mean scores to assess the possible effects of the use of the HRV training and the use of HRV-biofeedback technology on the levels of intercultural communication competence among the participants. The clinical data collection procedure of this study took about two months, from early June up to late July, 2015.

3.4. Data Analysis Procedure
The quantitative and the clinical data sets were analyzed separately and the possible tests were applied based on the requirements of the data analyses procedure. To well answer the "right" questions, we must know which analyses are essential in the study (Bickman & Rog, 2009). The essential tests from SPSS were applied to analyze the quantitative and the clinical data sets. The received scores from the clinical data were analysed through the descriptive test of SPSS to find out the mean and standard deviations scores for each steps of the procedure. The bivariate correlation test was also applied to find out the probable correlations between the high scores for the different HRV-biofeedback sessions and the mean scores for each attributes of intercultural communication competence.

3.5. Findings
Based on the descriptive results, from all 60 participants of this study, 47 (78.3%) of them were male, and 13 (21.6%) others were female students with their M/SD scores of $M = 75.6$, $SD = 12.3$, and $M = 76.1$, $SD = 12.9$ respectively. From all participants, 29 (48.3%) of them were master students with their scores of $M = 76.9$, $SD = 13.1$, and 31 (51.6%) others were PhD students with their scores of $M = 81.4$, $SD = 13.7$. The given M/SD scores are from the results of the first stage of the quantitative data collection procedure for all participants together. As the quantitative instruments had 24 items and five options per item, thus the average mean score was 60. The given mean scores are above the average mean score and show that generally the level of intercultural communication competence of the participants was good.

For the clinical dataset, all 60 participants of this study were divided into two different groups, 30 participants for the focus group who participated in a short HRV-biofeedback training, and 30 other participants who did not participate in the training and were considered as the control group. Prior to the HRV-biofeedback technology training, the quantitative data were collected from the participants of both groups for communication competence. For the first stage of the qualitative data, the M/SD scores for the focus group were $M = 74.9$, $SD = 12.1$, and for the control group were $M = 75.2$, $SD = 13$. The HRV data collection procedure was continued for about two months. After the completion of the HRV data collection procedure, the quantitative data were collected again to compare the mean scores for both groups to find out the possible effects of the HRV-biofeedback training and the use of HRV-biofeedback technology on the increase of intercultural communication competence among the participants. For the second stage of the quantitative data collection, the M/SD scores of the focus group for communication competence were $M = 81.2$, $SD = 12.9$, and scores of the control group were $M = 76.7$, $SD = 12.6$. Table 1 illustrates the changes in the mean scores of both groups for the pre-training and post-training stages.

Groups	Frequency	Pre-test		Post-test	
		Mean	SD	Mean	SD
Focus group	30	74.9	12.1	81.2	12.9
Control group	30	75.2	13	76.7	12.6

Table 1: Shows the differences in mean scores between the pre-test and post-test

Based on the descriptive tests, participants who had participated in the HRV-biofeedback technology training had higher mean score rather than the participants who did not participate. The received mean scores for both groups after the use of HRV-biofeedback technology, and after almost two months period of time confirmed that the use of HRV-biofeedback technology had positive effects on the increase of communication competence, while the results showed that the period of time also had positive effects on the results for both groups. Prior to the use of HRV-biofeedback technology, the mean score for focus group was 74.9, and after that it was 81.2. Also, the mean score for control group for the first data collection stage was 75.2, and for the second stage it was 76.7. The significant changes in the mean scores confirmed the positive effects of the use of HRV-biofeedback technology, and the time factor also had an influence on the increase of intercultural communication competence among the participants.

The clinical data collection procedure had four sessions. Data for the primarily (baseline) session was collected from all participants of both focus group and control group without the intervention of any technique or particular program. Data from three other sessions were collected separately from members of both groups and under two different procedures. The three sessions for focus group were heart focus, heart breathing, and heart feeling with their particular techniques based on the regulations of the Quick Coherence Technique of HeartMath Institute (HeartMath.org). However, the three data collection sessions from members of control group were collected based on the simple relaxation and without intervention of any technique or training. The estimated time for each session of the HRV data collection procedure for both groups was two minutes.

According to the statistical findings from the clinical data, for the first stage which was baseline session, M/SD scores for both of the focus group and control group were 8.9/8.4 and 9.1/10.6 respectively. In this stage, the mean score for control group was higher than for the focus group. However, the results for three other sessions showed that members of the focus group had higher HRV scores for all three sessions and it showed the positive effects of the use of HRV-training and the use of the Quick Coherence Technique. The results for the relaxation1, relaxation2, and relaxation3 sessions from members of the control group also showed that the use of HRV-biofeedback technology had positive effects on their HRV scores, as their scores for two sessions from three sessions were higher than their score for the baseline session. Table 2 illustrates the results from HRV-biofeedback technology tests for both groups of the participants.

HRV session	Focus group, N = 30		Control group, N = 30	
	Mean	SD	Mean	SD
L-baseline	70.4	20.5	69.5	22.7
M-baseline	20.6	16.0	18.6	13.2
H-baseline	8.9	8.4	9.1	10.6
L-session2	54.9	25.5	68.4	17.9
M-session2	22.3	12.2	24.0	16.8
H-session2	22.6	21.6	7.5	7.4
L-session3	64.1	25.3	71.7	25.1
M-session3	18.4	11.9	16.2	13.2
H-session3	17.6	18.7	12.1	16.0
L-session4	52.7	21.8	67.3	21.9
M-session4	21.5	11.0	23.4	14.7
H-session4	24.3	20.8	9.3	10.7

Table 2: Shows the HRV scores for both of the focus group and control group

The bivariate correlation test was applied to find out the probable correlations between the high scores of all four stages of the clinical data and the main attributes of intercultural communication competence .Some significant correlations were found between the mentioned factors. Table 3 indicates the results for correlation between the main attributes of intercultural communication competence and HRV frequency bands.

	1	2	3	4	5	6	7	8	9
1- Interpersonal Skills									
2- Team effectiveness	.298								
3- Cultural Uncertainty		.324					.243		
4- Cultural Empathy	.355		.480						
5- High baseline	.359		.463	.612		.494			
6- Medium session 1	.551			.210				.341	
7- High Session 2			.369						
8- Medium session 2	.294	.243			.418				
9- High session 3				.266		.423		.374	
10- Medium session 4	.275	.421	.213						

Table 3: Illustrates correlations between attributes of ICC and HRV sessions

Based on the above mentioned results, the HRV training and the use of HRV-biofeedback technology helped the participants to focus on their internal abilities to increase their control on their emotional situation and improve the levels of their intercultural communication competence. The results from this study illustrate that the use of the Quick Coherence Technique and the application of HRV-biofeedback technology had positive effects on the increase of heart rate variability and intercultural communication competence of the participants. These findings are supportive of the existence of relationship between the HRV scores of individuals with the levels of their intercultural communication competence.

4. Discussion
This study was conducted to assess the effectiveness of heart rate variability (HRV) training and the use HRV-biofeedback technology on the increase of heart rate variability and intercultural communication competence among postgraduate students from diverse backgrounds. The study also used the Quick Coherence Technique of the HeartMath Institute to see whether it influence the levels of HRV scores and intercultural communication competence among the participants or not. The results from this study have confirmed the positive effects of the use of HRV training and HRV-biofeedback technology on the increase of HRV scores and intercultural communication competence among the participants. These findings are supportive of the arguments of Lagos et al. (2008), and McCraty and Shaffer (2015) on the effectiveness of use of HRV-biofeedback on well-performance, creativity, self-control and psychological flexibility of individuals.
Based on the results, the HRV training and the use of HRV-biofeedback technology improved the heart rate variability scores and intercultural communication competence among the participants. The results from this study also confirmed the existence of relationship between good levels of HRV and intercultural communication competence among the participants. According to the results, individuals with higher scores of heart rates variability were good in intercultural communication competence as well. As stated by McCraty et al. (2000), the results from various studies on the relationships between the use of HRV-biofeedback technology and the human performance indicated that the use of HRV-biofeedback technology is effective on the development of human performance. The results from this study are supportive of this argument.
The results from the correlation test illustrated that the main attributes of intercultural communication had significant positive correlations with the high HRV scores of the participants. It means that personal skills and abilities of individuals that help them to initiate interactions with different people, to have team effectiveness, and to have cultural empathy have connections with their heart rate variability. Their good HRV scores also affect the ways that individuals behave during their interactions with different people. These findings confirm the positive effects of good HRV scores on the daily personal and social lives of individuals.
As argued by Reed (2008), the university time is an important opportunity for individuals to increase their communication competence and social skills. Attention of students on the internal factors that may affect their daily interactions may help them to increase their communication competence and have more successful interactions with their peers. One of the ways that may help individuals to focus on their internal abilities, especially heart actions and reactions and heart rate variability, is HRV training through the use of HRV-biofeedback technology. Through the increase of their control on their internal abilities and their good HRV scores, individuals could increase their communication competence. Based on the results from this study, individuals with good HRV scores had higher scores in intercultural communication competence as well. These results are supportive of the theoretical assertions Heider (1958) and Kim (1991) on the relationship between the internal and external skills and abilities of individuals that affect their daily personal and social lives.
The results from the correlation tests showed the existence of significant correlations between the main attributes of intercultural communication competence and the high scores for each session of the HRV-biofeedback. These findings illustrate that both of the internal and external abilities of individuals and also the different steps of tseir communication competence have close relationships and help one another to function well. According to the results from this study, their gatherings and interactions, their participations in the projected trainings, and the use of some the probable technologies such as HRV-biofeedback help individuals from different

backgrounds to improve their internal and external abilities and be more successful in their personal and professional lives. The combinations of the internal and external abilities which affect personal and social skills of individuals are the main constructors of communication competence. According to Dusi et al. (2014) and Matsudair et al. (2008), communication competence is the combination of skills, attitudes, and personal behaviours and treats that help individuals to conduct successful interactions. Thus, their personal skills and abilities, their daily interactions and the well-managed relationship between their external and internal abilities help individuals to increase the levels of their communication competence to have successful interactions and establish social relationships through their contacts and communication.

McCraty et al. (2000), Lagos et al. (2008), and McCraty and Shaffer (2015) based on their studies in the Western parts of the world argued about the effectiveness of HRV-training and the use of HRV-biofeedback on the development of human performance, creativity and psychological flexibility. The results from this study also confirmed that HRV training and the use of HRV-biofeedback technology have positive effects on the increase human performance and creativity among individuals in an Asian country regarding their daily interactions. It means that the use of HRV-biofeedback technology has similar effects among individuals regardless of their social and cultural differences. The results from this study, especially the results from the use of HRV-biofeedback technology in the field of communication, are quite new and may help future researchers to deepen their findings through the evaluation of the internal and external skills and abilities of individuals in the improvement of their personal and social skills. The results may also help researchers and individuals to pay attention on the use of HRV-biofeedback technology, the relationships between the internal and external abilities of individuals, and the probable effects of their internal and external abilities on their social and professional lives and performances.

5. Conclusion

This study had examined the effectiveness of heart rate variability (HRV) training and the use of biofeedback technology on the increase of heart rate variability and communication competence among postgraduate students. This study is among the preliminary works on the relationship between HRV and communication competence. The results from this study have confirmed the positive impacts of HRV training, the use of HRV-biofeedback technology and the use of the Quick Coherence Technique on the development of heart rate variability and intercultural communication competence among the participants. The results also confirmed the existence of correlations between the levels of heart rate variability and intercultural communication competence of the participants. Based on the results, besides their involvements in direct communication with their peers from diverse backgrounds, HRV training and the use of HRV-biofeedback technology help individuals to focus on their internal abilities improve their good HRV scores. As good HRV scores are associated with development of human performance, creativity and psychological flexibility, good HRV scores help individuals to improve their intercultural communication competence.

Based on the correlation results, the main attributes of intercultural communication competence of the participants had connections with their heart rate variability. According to the cited works from the literature and according to the findings from this study, the use of HRV-biofeedback technology has similar outcomes among individuals under both Asian and Western social and cultural contexts. The ever-growing multicultural environments and multicultural organizations require teamwork and collaboration among professionals and team members. Thus, their good HRV scores and their good levels of intercultural communication competence may help postgraduate students, who are potential professionals and may work in multicultural organizations, to be more successful. The results from this study may encourage university students to focus on their internal abilities especially on their heart rate variability and its effects on their lives. The results may also help individuals on the development of their communication competence through their attention on the relationship between their internal and external abilities. The results from this study may encourage researchers in the future to use the HRV-biofeedback technology in the field of communication, and strengthen the results of their studies from the regular survey through the use of technology-mediated studies.

5.1. Pragmatic Implications

The evidence from prior work on the relationship between communication competence and HRV-biofeedback are rare. This work might be among the preliminary works on the relationship between HRV-biofeedback and communication competence among individuals from various backgrounds. The results from this study confirmed the effectiveness of the use of HRV-biofeedback technology and the Quick Coherence Technique on increase of heart rate variability and communication competence among individuals from different backgrounds. The results also confirmed the existence of relationship between HRV and communication competence of the participants. The emWave device and the Quick Coherence Technique of the HeartMath Institute are effective and easily applicable (Reyes, 2014; Whited et al., 2014; HeartMath.org, 2016), and good HRV is associated with creativity and well performance (McCraty & Shaffer, 2015). Thus, modern universities and multicultural organizations which host individuals from different backgrounds could improve the levels of good HRV and communication competence among their students and staff through the use of HRV-biofeedback tools and techniques, especially the emWave device and the Quick Coherence Technique, to enhance the levels of their creativity and productivity in the ever-growing combative markets. Researchers in the field of communication can use the HRV-biofeedback technology and techniques to strengthen their findings as well.

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