

Canonical Correlation Analysis of the Big Five Factors of Personality and Future Anxiety among Palestinian University Students

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Abstract: This study explores the relationship between the Big-Five factors of Personality, which are Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness, and four domains of Future Anxiety, which are General Anxiety, Social Anxiety, Political Anxiety and Economic Anxiety among the Palestinian university students in the Gaza strip via the Canonical Correlation Analysis (CCA). The sample consisted of 531 randomly selected students, from two non-private universities who were enrolled in the second semester of the academic year 2011-2012, and were in their first or fourth grade level. CCA is the suitable multivariate technique to assess the complicated relationship between the Big-Five factors of Personality and Future Anxiety compared to other statistical techniques. Furthermore, the study of correlation between two sets of multiple variables by using pairwise correlation coefficients does not enable us to assess the simultaneous relationship between them or to grasp the structure and key features of the data. After the verification of its assumptions, the CCA was conducted and interpreted, furthermore, a double cross-validation was performed to evaluate the obtained results. The results revealed that students with high level of Neuroticism and low level of Agreeableness had high levels of General and Social Anxiety.

Keywords: Multicollinearity, Multivariate, Variance inflation factor, Validation, Singularity

INTRODUCTION

Gaza strip has been suffering from special circumstances of occupation, siege and wars for a long time. Young people who were born and grown under these circumstances are particularly affected by this painful reality which affects their life, future and even personalities.

In psychology, especially in the Gaza Strip - most psychologists used to use univariate statistical analyses such as t-test, one-way ANOVA and the simple Pearson's correlation to analyze data that might better be analyzed using multivariate methods.

The use of multivariate methods in analyzing social and behavioral data is recommended, [1] reported that: "*Much of the early developmental work in multivariate analysis was motivated by problems from the social and behavioral sciences, especially education and psychology*". Not only in social and behavioral sciences, the majority of data sets collected by researchers in all disciplines are multivariate [2]. In order to fully grasp the structure and key features of the multivariate data; a simultaneous examination of relationships between variables is needed, and one or another method of multivariate analysis might be most helpful.

Several statistical techniques available for the analysis of multivariate data, like Multivariate Analysis of Variance (MANOVA), Discriminant Analysis, Factor Analysis, and our concerned method; the Canonical Correlation Analysis (CCA).

The five-factor model of personality is a hierarchical organization of personality traits in terms of five basic dimensions: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience [3]. According to [4] and [5] the five dimensions have the following attributes: *Neuroticism* is the tendency to be sensitive, emotional and to experience negative effects such as fear, sadness, embarrassment, anger, guilt and disgust. *Extraversion* is characterized by being outgoing and active, it includes traits such as sociability, assertiveness, activity and talkativeness. *Openness to Experience* is characterized by inclination for a diverse and broad range of new experiences; it includes

active imagination, aesthetic sensitivity, attentiveness to inner feelings and a preference for variety. *Agreeableness* is the tendency to be compassionate, good natured, and sympathetic to others and eager to help them, and in return believes that others will be equally helpful. *Conscientiousness* refers to a tendency to self-control and the active process of planning, persistence, organization, and motivation.

Future Anxiety can be defined as “a state of apprehension, uncertainty, fear, worry and concern of unfavorable changes in a more remote personal future” [6]. Factors that induce anxiety might be personal factors; when the individual has misperceptions or irrational ideas that make him construed reality, attitudes and events wrongly. Furthermore, it might be social factors, like environmental and cultural circumstances factors saturated fear and deprivation, loneliness, insecurity, or stressful of life situations, where the increase in burdens or the difficulties faced by the individual in life will make him more pessimistic. Pressures and traumatic situations to which the individual exposed, is considered an important determinant in feeling concerned about his future [7].

Several authors applied CCA in analyzing real data. [4] used CCA in investigating the relationship between statistics anxiety and the big five personality factors between psychology undergraduates students at James Cook University, Singapore. Results showed that Neuroticism was positively correlated with Worth of Statistics, Fear of Asking for Help, and Fear of Statistics Teachers, whereas Openness to Experience and Agreeableness was negatively correlated with those three variables. Extraversion was positively correlated with Interpretation Anxiety, Test and Class Anxiety, and Fear of Asking for Help. Conscientiousness was not correlated with statistics anxiety.

[8] used CCA to conduct a model for academic procrastination and learning strategies as predictor variables and statistics anxiety as explained variables. The study of [9] aimed to detect the preferred learning styles and dominant multiple intelligences of Yarmouk University, Jordan, students and their relationships by using CCA.

[10] used CCA to investigate the relationship between coping and personality traits at Marmara University in Istanbul, Turkey, The analysis showed that students with high conscientiousness level tend to use more self-confident, optimistic, and turning to religion coping strategies, and students with high extraversion level, tend to use self-confident and seeking of social support strategies in stressful situations. For more applications see [11].

In the light of available information to the authors, no published work in Palestine has been applied the CCA in the analysis of multivariate data. The importance of this study is raised from reducing statistical barriers of using multivariate methods, and formalizing, interpreting and evaluating a model for the Big Five Factors of Personality and the four fields of Future Anxiety; using CCA. In this study CCA is used to explore the simultaneous relationships between the personality factors and the future anxiety among university students in Gaza Strip.

The rest of this paper is organized as follows. Section 2 reviews the main concepts, assumptions and interpretation of the CCA, while a comparison between CCA and other multivariate procedures are presented in Section 3. Section 4 presents the description of the data. The modeling and validation of the CCA are discussed in Sections 5 and 6, respectively.

CANONICAL CORRELATION ANALYSIS (CCA)

CCA is a method that enables the assessment of the simultaneous relationship between two sets of multiple variables, and it is a way of making sense of cross-covariance matrices [12]. It explores the relationships between two multivariate sets of variables, all measured on the same items [13]. The main goal of CCA is to identify and analyze the relationships between two sets of multivariate variables measured on the same sampling units. It focuses on the correlation between two new "synthetic" variables; that called canonical variates, one is a linear combination of the variables of the first set, and the other is a linear combination of the variables of the second set. The first canonical correlation r_{c1} is the maximum correlation between the first pair of canonical variates

For a random sample of n observations on each of two sets $X = (x_1, \dots, x_p)'$ and $Y = (y_1, \dots, y_q)'$, the canonical correlations; r_{c1}, \dots, r_{cm} are the square roots of the eigenvalues of $S_{yy}^{-1} S_{yx} S_{xx}^{-1} S_{xy}$, where $m = \min(p, q)$, S_{yy} is the $(q \times q)$ sample covariance matrix of the y 's, S_{yx} is the $(p \times q)$ sample covariance matrix between the y 's and the x 's, and S_{xx} is the $(p \times p)$ sample covariance matrix of the x 's [13].

CCA has some essential assumptions that should be tested like normality, linearity, homoscedasticity and the absence of multicollinearity. Linearity is the most important assumption for CCA, if the relation between the two sets of

variables is curvilinear; CCA misses some or most of its interpretability [14]. Even though normality is not strictly required; interpretability of canonical solutions is improved if it is hold [12]. CCA is very sensitive for minor changes in any of the two data sets, so missing data and outliers and the way they are treated, would make a big changes in the results.

There is no assent among researchers on what coefficient should be used in interpreting canonical correlations and canonical variates. For instance, [2,13]; used only the *standardized coefficients (canonical weights)* in their interpretations, while [15] assumed that standardized coefficients and *canonical loadings (the simple correlations between the variables and their respective canonical variates)* [12], are necessary for understanding variable importance in CCA. [14] used the canonical loadings, *overlap variances*, and *redundancy "the average of variance the canonical variate from one set extract from the variables in the other set"* to interpret the canonical variates. [16] presented and interpreted seven different coefficients that were created as a result of CCA. Lastly, [12] recommended not to interpret the standardized coefficients or structure coefficients, and depend only on *canonical cross-loadings (the simple correlations between the individual variables in one variable set with the canonical variate in the other variable set)*.

In this study the authors have followed steps in [15], which are, first evaluate the full canonical model and each canonical function, by checking both; the statistical significance and the magnitude of the relationship to insure noteworthy relationship between considered variables, then study the standardized coefficients and canonical loadings, to decide which variables are contributing to this relationship. Lastly take a look on the canonical cross-loadings that [12] suggest.

Redundancy was not approved by [13,15 and 16] so it would not be used.

CCA, MANOVA AND MULTIVARIATE MULTIPLE REGRESSION

From many other statistical procedures that deal with multivariate data, Multivariate Analysis of Variance (MANOVA) and the Multivariate Multiple Regression are the most comparable to CCA. In MANOVA we compare the mean vectors of the (...) samples for significant differences [13], it is better to be used when the dependent variables are quantitative and the independent variables are categorical [17]. Multivariate Multiple Regression is used to interpret possible linear relationships between certain input and output variables [1], the dependent and independent variables should be quantitative [17].

CCA is often a useful complement to a multivariate regression analysis [13], in fact it is a generalization of MANOVA, and multivariate multiple regression as it can be considered as the General Linear Model (GLM) [18]. In CCA the relationship between sets of multiple dependent and multiple independent variables is detected, and it can use both quantitative and categorical data for either the dependent or independent variables [12].

DATA DESCRIPTION

The considered data in this study is a pre-analyzed data from a study by [7], where the data were analyzed using univariate methods (t-test, one-way ANOVA and the simple Pearson's correlation). The original data consists of 800 university students, were randomly selected from two non-private universities (400 from Al-Azhar University-Gaza and 400 from Al-Aqsa University) who were enrolled in the second semester of the academic year 2011-2012, and were in their first or fourth level of education. The study population consisted of all students in the first and fourth levels of education, who enrolled in the two considered universities, and totaling 12896 students, 5217 from Al-Azhar University – Gaza, and 7679 from Al-Aqsa University. A random sample of 531 students is randomly selected from the original sample. Table 1 presents the population and the sample distributions by university and the level of education. There are 50.1% of the sample are females, 52.4% are from literary colleges and most of the participants (63.1%) are city residents.

[7] used two instruments for collecting the data, *The Big Five Factors of Personality Inventory (NEU-FFI)*, was firstly prepared by [3] then translated into Arabic by Al-Ansari [19], the inventory in its initial form consists of 60 items spread on five factors: Neuroticism (*NEU*), Extraversion (*EXT*), Openness to Experience (*OPE*), Agreeableness (*AGR*), and Conscientiousness (*CON*), 12 items for each. And the *Future Anxiety Questionnaire*, was developed by [7]. In its initial form, it was consisted of 42 items distributed on four domains, 12 items for General Anxiety (*GA*), and 10 items for each of Social Anxiety (*SA*), Political Anxiety (*PA*), and Economic Anxiety (*EA*) domains. In both instruments the five-level Likert scale was used, the degrees for responses were 1 for Strongly Disagree, 2 for Disagree, 3 for Neutral, 4 for Agree and 5 for Strongly Agree. Validity and reliability of the study instruments were examined by [7] through a pilot study conducted on 140 randomly Palestinian university students. Four items were removed from the big five factors of personality model since their internal consistency was not significant at 0.05 significant level. Validity and reliability tests confirmed the eligibility of the instruments to measure the Big Five Factors of Personality and the Future Anxiety among the university students in the Gaza Strip.

Table.1: Distribution of population and sample by university and education level

	Level	Al-Azhar	Al-Aqsa	Total (%)	
Population*	First	2861	4861	7722	(59,9%)
	Fourth	2356	2818	5174	(40.1%)
	Total (%)	5217 (40.45%)	7679 (59.55%)	12896	(100%)
Sample	First	118	200	318	(59.9%)
	Fourth	97	116	213	(40.1%)
	Total (%)	215 (40.5%)	316 (59.5%)	531	(100%)

*[7]

Table 2 presents the descriptive statistics for the nine variables, *NEU*, *EXT*, *OPE*, *AGR*, and *CON* in the *PER* set and *GA*, *SA*, *PA* and *EA* in the *ANX* set. For *PER* set, among students *CON* has the highest effect (mean= 4.035), while *NEU* has the lowest effect (mean=2.983). For *ANX* set, the highest effect reeffers to the *EA* (mean=3.525), and the lowest effect is for *GA* (mean= 2.875). So the primary results show high levels of Conscientiousness and Economic Anxiety among university students in the Gaza Strip.

Table.2: Descriptive statistics for the variables in the *PER* and *ANX* sets (n=531)

Set	Variable	Mean	Std. Dev.	Min.	Max.
PER	<i>NEU</i>	2.983	0.553	1.27	4.91
	<i>EXT</i>	3.932	0.555	1.71	5.00
	<i>OPE</i>	3.366	0.501	1.67	4.83
	<i>AGR</i>	3.596	0.440	1.60	4.80
	<i>CON</i>	4.035	0.498	2.00	5.00
ANX	<i>GA</i>	2.875	0.761	1.00	4.88
	<i>SA</i>	3.016	0.734	1.25	5.00
	<i>PA</i>	3.512	0.743	1.14	5.00
	<i>EA</i>	3.525	0.704	1.22	5.00

As presented in Section 3 CCA is the most suitable multivariate procedure to analyze the considered data. The assumptions of the CCA are examined. The normality were examined via skewness and kurtosis and multivariate normality were examined by the Mahalanobis distance method [13] identified one observation as a multivariate outlier and it was removed, so the sample size becomes 530. A matrix scatter plots for the variables of each group were performed and the almost perfect oval-shaped scatters suggested no departure from linearity or homoscedasticity. The values of Variance inflation factor (VIF_k) was ranging between 1.070 and 1.361 which indicated there is no multicollinearity or singularity.

CANONICAL CORRELATION MODEL

The CCA was conducted using SPSS- MANOVA syntax, and "CCA" R-package. Since *PER* set has five variables ($p=5$), and *ANX* set has four variables ($q=4$), thus, four canonical functions were created ($m=\min(5,4)=4$). The full model is given in Fig.1 in terms of standardized original variables ($zNEU$, $zEXT$, $zOPE$, $zAGR$, $zCON$, zGA , zSA , zPA and zEA).

Function	Canonical correlations and canonical variates
1	$r_{c1} = 0.506$ $u_1 = 0.892 zNEU + 0.042 zEXT + 0.076 zOPE - 0.344 zAGR + 0.001 zCON$ $v_1 = 0.600 zGA + 0.520 zSA - 0.110 zPA + 0.100 zEA$
2	$r_{c2} = 0.262$ $u_2 = 0.450 zNEU + 0.433 zEXT + 0.047 zOPE + 0.423 zAGR + 0.533 zCON$ $v_2 = -0.575 zGA - 0.084 zSA + 0.794 zPA + 0.579 zEA$
3	$r_{c3} = 0.129$ $u_3 = 0.141 zNEU + 0.956 zEXT - 0.240 zOPE + 0.034 zAGR - 0.473 zCON$ $v_3 = -0.267 zGA - 0.351 zSA - 0.746 zPA - 1.19 zEA$
4	$r_{c4} = 0.044$ $u_4 = 0.181 zNEU - 0.316 zEXT + 0.726 zOPE + 0.627 zAGR - 0.472 zCON$ $v_4 = -1.121 zGA - 1.155 zSA + 0.273 zPA - 0.120 zEA$

Fig.1: The full canonical model

The results of the multivariate tests of significance are given in Table 3. Results prove that the full model was statistically significant with p -value < 0.001 of three tests Wilks, Hotelling and Pillai's, and a proportion of variance shared between the variable sets across all functions $R^2 = 1$ -Wilks $\lambda = 0.3196$ for the full model, and it is a moderate effect size [15], which implies that at least the first canonical correlation; r_{c1} ; is significantly different from zero.

After reviewing the canonical correlations and hierarchical significant tests for the four canonical functions in Table 4; we found that only the first function was reliable and to be interpreted with $r_{c1} = 0.505$ representing about 25.5% of the shared variance for the first canonical function. The second canonical function has a statistical significance, but it does not explain a reasonable amount of variance, only 7% of the shared variance which is less than 10%, so it is not warrant to interpretation [15], and the cumulative effect of functions 3 to 4 and function 4 was not statistically significant.

Table.3: Multivariate tests of significance for the full model

Test	Statistic	F	df1	df2	p-Value
Pillais	0.3428	9.824*	20	2096	0.000
Hotelling	0.4359	11.323*	20	2078	0.000
Wilks λ	0.6804	10.641*	20	1728.01	0.000

* Test is significant at the 0.01 level of significance

Table.4: Canonical correlations and hierarchical significant tests for the four canonical functions

Canonical Correlations and Canonical Roots			Hierarchical Significant Levels of Correlation Function		
Function	Can.Cor r_c	Can.Root r_c^2	Function	Wilks λ	p-Value for F
1	0.505	0.255	1 to 4	0.6804	0.000
2	0.262	0.070	2 to 4	0.9140	0.000
3	0.129	0.017	3 to 4	0.9814	0.134
4	0.044	0.002	4 to 4	0.9980	0.599

To assess the contribution of the variables in the first function, standardized coefficients, canonical loadings l , squared canonical loadings l^2 , and canonical cross-loading Δ , were obtained and given in Table 5. The standardized coefficients for the first variate shows that *NEU* and *AGR* had the highest relative contribution 0.892 and 0.344, respectively, but in a contrast directions, the other variables had low contribution to the variate. For the second variate, the highest relative contribution was for *GA* (0.600) then *SA* (0.520) in the same direction.

Table.5: Canonical solution for PER set predicting ANX set for the first function

Canonical Function 1						
	Variable	Stdz. Coef.	l	$l^2\%$	Δ	$\Delta^2\%$
PER	<i>NEU</i>	0.892	0.942	88.7	-0.476	22.6
	<i>EXT</i>	0.042	-0.278	7.7	0.140	1.9
	<i>OPE</i>	0.076	-0.029	0.1	0.015	0.02
	<i>AGR</i>	-0.344	-0.503	25.3	0.254	6.5
	<i>CON</i>	0.001	-0.167	2.9	0.084	8.4
ANX	<i>GA</i>	0.600	0.908	82.5	-0.459	21.1
	<i>SA</i>	0.520	0.882	77.8	-0.446	19.8
	<i>PA</i>	-0.110	0.283	8.0	-0.143	2.1
	<i>EA</i>	0.100	0.641	41.0	-0.323	10.5

The canonical loadings showed almost the same results. For the *PER* set; *NEU* had the highest loading, resulting 88.7% of the shared variance with the first canonical variate, then *AGR* with a moderate loading producing 25.3% of shared variance with the first variate. For the *ANX* set, *GA* and *SA* had the highest loadings with 82.5% and 77.8%, respectively, of shared variance with the second variate. For *EA* variable, even though it had very low contribution in the variate (standardized coefficient = 0.100), a moderate loading was noted representing 41% of shared variance with the second variate. The canonical cross-loading has almost the same pattern as canonical loadings. For *PER* set, *NEU* and *AGR* had the highest correlations with the second variate, that 22.6% and 6.5% of the variance in the two variables were explained by the first function. For the *ANX* set, the highest correlations with the first variate was recorded for *GA*, *SA* and *EA*, with 21.1% , 19.8% and 10.5%, respectively, of the variance in these variables explained by the first function.

The results indicate that the first canonical function is basically about the relationship between Neuroticism *NEU*, and Agreeableness *AGR* from the *PER* set- with opposite direction-, with General Anxious *GA* and Social Anxious *SA* for *ANX* set. We can conclude that students with high level of Neuroticism and low level of Agreeableness had a high level of General Anxious and Social Anxious.

VALIDATION OF CCA

Double Cross Validation was performed to confirm the generalizability of study results, following are the steps as given in [20]. First step, the sample was divided into two un-equal groups, at a ratio of 70% - 30%, and a CCA was conducted for each group. Second step, four "original" canonical variates were created, two for each group by applying the variables z-scores to its relative canonical variate. Third step Four cross-validated canonical variates were created, by multiplying the variables z-scores in one group, by the standardized coefficients of the variates from the other group. Fourth step, four Pearson's correlation coefficients; R_c , were computed, two for each group, first using the original pair of canonical variates and then using the cross-validated pairs.

Table.6: Canonical correlations and canonical roots for the two DCV groups

First group ($n_1=371$)			Second Group ($n_2=159$)		
Function	Can.Cor r_c	Can.Root r_c^2	Function	Can.Cor r_c	Can.Root r_c^2
1	0.508	0.258	1	0.523	0.273
2	0.259	0.067	2	0.318	0.101
3	0.179	0.032	3	0.179	0.032
4	0.086	0.001	4	0.007	0.007

Invariance Coefficient; IC , equals the difference between the squared correlation coefficients for the original variates and the cross-validated variates:

$$IC_1 = R_{10}^2 - R_{1CV}^2 = (0.508)^2 - (0.482)^2 = 0.020$$

$$IC_2 = R_{20}^2 - R_{2CV}^2 = (0.523)^2 - (0.590)^2 = -0.075$$

The *IC*'s are small for the two groups, about 0.02 and 0.08, these small values indicates the stability and explicability of the results [20].

CONCLUSIONS

The simultaneous relationship between the Big-Five Personality Factors and Future Anxiety among university students in the Gaza Strip is basically about Neuroticism and Agreeableness from personality set, and General Anxious and Social Anxious from Anxiety set. Students with high level of Neuroticism and low level of Agreeableness had a high levels of general and social anxious.

CCA is a suitable multivariate technique to assess the complicated relationships between sets of multiple dependent and multiple independent variables of both quantitative and categorical data. In order to achieve accurate results, assumptions of multivariate methods should be met, especially linearity. If one of the assumptions did not verified, then transformations for one or more variables are required.

In CCA Statistical significant of canonical correlation is not the only criterion to decide if a canonical function is reliable to be interpreted. The magnitude of the canonical correlation is also an important criterion. Canonical functions to be interpreted should have canonical correlation with both significant and acceptable magnitude. Double Cross-Validation is suitable method to confirm the generalizability and replicability of CCA results. In this study the small values of the Invariance Coefficient indicates the stability and reliability of the results.

The study of correlation between the Big-Five factors of Personality and Future Anxiety by using pairwise Pearson's correlation coefficient as treated by [7] do not enable us to assess the simultaneous relationship between them or to grasp the structure and key features of the data.

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