Title: Personality and aesthetic preferences in architecture: a review of the study approaches and assessment methods

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Abstract

It is often believed and expected that a clear relationship exists between human personality and human preferences in architecture. However, by reviewing the findings of previous studies, it is found out that such expectation is not necessarily true, as there is no consistency among previous findings. This study provides a critical review and overall classification of various research approaches and assessment methods used in previous studies. In addition, the theoretical and practical shortcomings of each approach have been introduced. Next, the psychological approach is recommended as a more feasible one, and the studies carried out using this approach are structurally analyzed. The theoretical frameworks, strategies and the execution tactics of these researches were critically reviewed. Finally, a systematic quadruple model was suggested for evaluating aesthetic experiences and judgments. After presenting the manifest and the hidden variables with this model, machine learning helped to discover the hidden patterns in the personality and human preferences.

Keywords: Aesthetic preferences, Architectural preferences, Personality, Visual aesthetics, Aesthetic response, Quadruple model

1. Introduction

Throughout the history, to take care of their needs, human beings have always tried to create changes in their surroundings or build things using the materials and the tools they have had at their disposal. To this end, the ideas and the forms of these man-made devices have not only been governed by the forces in their environment, but also by their personalities as one of the determiners of their minds' functions. Personality shows why individuals are the way they are, how and why they are different from each other and how they experience different behaviors regarding different biological processes of the brain (DeYoung & Gray, 2009). Nostro et al. (2017) claimed that there is no notable relation between personality traits and grey matter volume in general population. On the other hand, when population was split by gender, significant correlations were found in males but not in females. For example, positive correlations were reported between extraversion and grey matter volume of bilateral precuneus and parieto-occipital sulcus, bilateral thalamus, left mid FFG extending into the cerebellum and right cerebellum.

Therefore, personality and its related theories should not only be limited to a particular domain of information processing, but they must also be considered with respect to affection, cognition, and behavior. Moreover, the way these various areas interact and influence one's mind's functions must be taken into consideration as well (Gray, 2004; Gray, Braver, & Raichle, 2002). Consequently, it can be stated that humans, as subjects, manifest their minds' function in their surroundings as an object. In addition, the type of forming their surrounding or selection of the patterns and the preferences are influenced by what is in their minds. One's mind's function determines how he/she has felt about his/her environment (affection), how he/she has got to know it and assess it (cognition), what kind of relationship he/she has established with it (relationship), and how he/she has reacted to it or interacted with it (behavior). In architecture, each individual, with different personality traits, could have a different attitude in the way he/she uses material such as wood, in building or selecting a place as his/her residence. These differences exist because the type of affection (fear, excitement, and dependence on wood and its component such as the color and the texture), cognition (possible functions and usages for the wood), and relationship that a person has established with this material (subjective or non-subjective entity) are different from person to person. As the result, it could be assumed that these differences have affected the way an individual uses and utilizes these materials and create products and spaces with specific attributes (for example creation of an innovative and abstract model from wood or preserving

the organic structure and the texture of the wood in the final product). Therefore, it is, generally, expected that people with different personalities to adopt different preferred patterns or make different decisions with respect to avoiding or approaching an environment. Clarifying this relationship in the past, often, took place using either deductive paradigms and/or deterministic approaches in Philosophy, Geography, and Medicine (Little, 1987). However, the main issue, in the past few decades, has been finding a relationship between the predictors, the components of human personality, and the components of the preferred surrounding. For instance, what forms and environmental attributes does a novelty seeking individual with high affection and low cognition who is non-subjective in his relationship with his environment and has high level of impulsivity (Cloninger & Svrakic, 2016) prefers or likes? It seems that proving this relationship and determining its dimensions is not a simple task (Swami & Furnham, 2014; Lang, 1987; Mikellides, 1980) and faces scientific and methodological complexities.

The most essential issue of the research is predicting the architectural preferences and the related factors based on the personality structures of the mankind that can have comprehensive effects on their behavior, mental health, and well-being. Therefore, in the first phase, a review of the methods to achieve a conceptual model in studying the relationship between the personality and the architectural preferences is considered. This study includes the results of the review of the methods and describes the selected model for research.

2. Method

To carry out this study, over 100 papers and several PhD theses were compiled on the preferences and the environmental aesthetics. Extensive literature searches were carried out employing the Google Scholar database. The following key terms associated with aesthetic preferences: “visual aesthetics”, “personality traits”, “architectural preferences”, “art preferences”, and “aesthetic judgments” were entered. To check the quality of the published literature, Web of Science was used. The only journals included in the review process were the ones published in English language. These studies were, first, categorized in four groups based on their methodological approaches and then were assessed briefly with regard to their degree of success and generalizability. Finally, due to having lower implementation limitations and higher theoretical background, the group containing the psychological responses were structurally analyzed from the methodological and execution aspects so that a conceptual model could be developed to be used in the future researches.

3. An overview of the research methodologies on the relationship between the personality and the environmental aesthetics

In an overall approach and proportionate to the received responses in facing the environmental stimuli from the participants in the reviewed researches, all of the studies could be categorized and, even, predicted in four groups of Physiological, Neurobiological, Practical, and Psychological responses.

3.1. Physiological research

Part of the research on the relationship between the personality and the environmental preferences lead to receiving Physiological responses and/or activities in facing the stimuli and various situations. Therefore, a series of experiments have been conducted in which the conditions are controlled by the researcher and an individual is exposed to environmental stimuli (light, noise, photo, etc.). Then the person's level of arousal to each stimulus is measured based on the physiological changes his/her body undergoes. Utilizing different methods in personality psychology in a comprehensive domain study, biological basis of personality has been studied and the results have been categorized based on genetic, psychophysical, biochemical, neuropsychological, and neurobiological aspects (Strelau, 2006; Zuckerman, 2005). The part of the research that is carried out with the aim of identifying the causal relationship between personality traits and body's physiological parameters are called psychophysiological studies. Blood pressure (BP), Pulse (P), Heart Rate (HR), Cardiovascular Activity (CVA), Eye-blink activity (EB), Electromyography (EMG), Respiratory Sinus Arrhythmia (RSA), Electro Dermal activity (EDA) or Galvanic Skin Response (GSR), and Eye-tracking (ET) are just a few of these physiological parameters. Measurements of these parameters, up to certain limit, are influenced by the individual personality characteristics of each person. This leads to different unconscious physiological responses displayed by different individuals when exposed to the same environmental stimuli. For instance, in psychophysiology of Extraversion (De Pascalis, 2004), the studies show that where EDA is used as an indicator for orienting reflex, the orienting reaction expressed in the amplitude of EDA is lower for the Extraverted individuals. Moreover, along with the habituation of an individual to novel stimuli, this parameter is lowered. This decline in the parameters takes place for the extraverted individuals faster than the introverted ones (Stelmack & Geen, 1992; Eysenck, 1990; Stelmack, 1990, 1981; O'Gorman, 1977).

Even though the physiological researches are mostly designed to answer questions in the field of psychology, they could be used in a research that focuses on the aesthetic experiences

of art and architecture (Krupinski & Locher, 1988; Locher & Nodine, 1987; Berlyne, Craw, Salapatek, & Lewis, 1963). Overall, this group of researches suffer from numerous executory limitations. For instance, medical illnesses, environmental situations, psychological, and physical conditions of the participants during the administration of these tests affect the results. Moreover, to carry out the tests, using simple variables and stimuli are required.

3.2. Neurobiological research

Another group of the analyzed research, called Neuroaesthetics, dealt with the neurobiological mechanisms of the participants when facing environmental stimuli and aesthetic experiences. Neuroscientific investigations have approached this area using imaging and neurophysiological techniques, such as functional magnetic resonance (fMRI), magneto encephalography (MEG), electroencephalography (EEG) and positron emission tomography (PET) (Cinzia & Vittorio, 2009). In this newly established field, observing the brain and neurobiological functions in aesthetic experiences has led to numerous interesting findings (e.g., Coburn, Vartanian, & Chatterjee, 2017; Vartanian, Navarrete, Chatterjee, Fich, Gonzalez-Mora, Leder, Modroño, Nadal, Rostrup, & Skov, 2015; Chatterjee & Vartanian, 2014; Vartanian, Navarrete, Chatterjee, Fich, Leder, Modroño, Nadal, Rostrup, & Skov, 2013; Cinzia & Vittorio, 2009; Jacobsen, Schubotz, Hofel, & Cramon, 2006). These findings also led to better understanding of how aesthetic perception is done and which areas of the brain are involved in processing different aspects of visual experiences. A meta-analysis study done by Skov et al. suggested that diffuse regions of brain such as posterior cingulate cortex, anterior insula and occipital lobes are involved when it comes to analyzing a picture or painting (Vartanian & Skov, 2014; Kirk, Skov, & Nygaard, 2009). Another meta-analysis commissioned by Boccia et al. (2016) revealed that a wide number of 27 brain regions are linked to the aesthetic perception. In this study, it was also recommended that different visual stimulants can stimulate distinct brain areas. For instance, Fusiform area is mostly activated when eyes are focused on a portrait picture, whereas Parahippocampal gyrus is mostly responsible for natural landscapes visual processing. Vartanian et al. (2015) studied the effect of ceiling height and perceived enclosure on aesthetic judgment and approach-avoidance decisions in architecture. In this study, fMRI was used to look for the nerve-related mechanisms in the brain. The findings of this research showed that "the rooms with higher ceilings are perceived as more beautiful, and the activated structures involved in visuospatial exploration and attention are located in the dorsal stream" (Vartanian et al., 2015, 10). In addition, it was found out that "open rooms are perceived as more beautiful and activated structures that underlies perceived visual motion. Furthermore, the enclosed rooms were

found to more likely elicit exit decisions and activated the anterior midcingulate cortex (aMCC) — the region within the cingulate gyrus with direct projections from the amygdala" (Vartanian et al., 2015, 10). Another related study, which investigated the impact of contour in architecture, reported that "the participants were more likely to judge spaces as beautiful if they were curvilinear rather than rectilinear. Neuroanatomically, when contemplating beauty, curvilinear contour activated the anterior cingulate cortex, a region strongly responsive to the reward properties and emotional salience of objects, exclusively" (Vartanian et al., 2013, 10446).

Due to the complexity of the subject and the dynamic influences of the personality on various parts of the brain, no outstanding research has been carried out to understand the relationship between the personality and the preferred environment. However, it is possible that the research in this field could clarify some related facts. Overall, before starting a study in Neuroaesthetics and using the customary test, any researcher should establish very strong theories by utilizing the required psychological tests. These theories related to the subject of personality and environmental preferences do not benefit from a clear-cut form.

3.3. Practical research

In the third category of researches, the practical or action research, the participants are asked to take part in a practical test. This test could be designing a house, deciding the arrangement of the furniture, coloring an object or any other activity proportionate to the subject of the research (Matthews, Hill, Case, & Allisma, 2010; Rosenbloom, 2006; Osborn, 1988; Duffy, Bailey, Beck, & Barker, 1986). Ultimately, by assessing the actions of each person in relation to his/her personality traits, some results could be obtained. For example, to examine the relationship between color preferences and sensation seeking, some students were asked to color the human figure's clothing using paints (Rosenbloom, 2006). The results suggested that sensation seekers would prefer to make more complex images and choose red (as a hot and arousing color). In another study, Matthews et al. (2010) reported the relationships between Myers-Briggs Type Indicator (MBTI) and three-dimensional form in design choices (design form decisions, ordering principles, and pattern languages). In this study, 91 interior design students were asked to design a personal home environment. Significant differences were found to have occurred between design choices among all personality types.

Moreover, Practical research can be done differently by making a checklist by observing the living environment of an individual that has been designed and arranged based on his/her interests and attitudes. This is one way to go about predicting his/her personality (Meagher,

2016; Graham, Sandy, & Gosling, 2011; Gosling, Craik, Martin, & Pryor, 2005; Gosling, Ko, Mannarelli, & Morris, 2002; McElroy, Morrow, & Ackerman, 1983). Selection of action research approach always faces limitations in execution and assessment of the relationships. In this group of research, the participants must have a certain level of skills needed to perform the practical activity (i.e., designing a house). The skill requirement criterion, automatically, eliminates many members of the society from becoming a participant in such studies. In addition, the life world and professional experiences of the participants is an influencing factor in the study that the action research approach could not control.

3.4. Psychological research

Psychological research is the most common and diverse type of research used to understand and clarify the relationship between the personality and the environmental preferences and benefit from a long history in environmental aesthetic studies (Swami & Furnham, 2014). In such researches, the environmental stimuli are introduced via various tactics and are followed by gathering the participants' psychological responses and analyzing them. The findings of this group of research are not focused (Nadal, 2007), some researchers have obtained significant results (e.g., Jankowski, Francuz, Oleś, & Chmielnicka-Kuter, 2018; Swami & Furnham, 2012; Chamorro-Premuzic, Burke, Hsu, & Swami, 2010; Chamorro-Premuzic, Reimers, Hsu, & Ahmetoglu, 2009; Feist & Brady, 2004; Rawlings, 2003; Furnham & Walker, 2001a, 2001b; Furnham & Avison, 1997; Furnham & Bunyan, 1988); whereas some others have not been able to get any meaningful results (e.g., Pietras & Czernecka, 2018; Palmer & Griscom, 2013; McManus, Cook, & Hunt, 2010; Griscom & Palmer, 2010; Furnham & Chamorro-Premuzic, 2004; Zuckerman, Ulrich, & McLaughlin, 1993). This lack of focus could be seen in visual preferences in most of the architecture studies as well (e.g., Cleridou & Furnham, 2014; Dębek & Janda-Dębek, 2012; Cook & Furnham, 2012; Ibrahim, Abu-Obeid, & Al-Simadi, 2002; Stamps & Nasar, 1997) as an art with a multisensory nature. Generally, the findings of the studies on the relationship between the personality and the aesthetic preferences is too scattered and have not been verified, especially in architectural preferences. To be more precise, when the research variables are personality and architecture, the result of the decisions and selections of the individuals become more unpredictable than ever. However, the question that arises is, which one of these four groups of research category with their executory shortcomings and the existing theories is more suitable to be used in the field of architecture? As the result of having stronger theoretical foundations, more focused researches, and ease of execution, it seems that the psychological research is

more feasible when dealing with architecture and one could use a fresh perspective and create some structural and technical changes. To this end, the studies with psychological responses were chosen for further analysis.

4. The systematic quadruple model of aesthetic responses

Basically, any systematic research designed and carried out in the field of environmental aesthetics should utilize certain variables in a coordinated format in order to get the responses. These variables manifest themselves in three different aspects: environment and environmental stimuli, the person who is exposed to the stimuli, and the situation. Thus, a quadruple conceptual model is obtained that consists of the following components: 'the aesthetic variable and the environmental stimulus', 'the variables or the human characteristics associated with the participants in the study', 'the contexts and the situations in which the test is administered', and 'the responses' (Figure 1). Even though this model has been recommended in the study of musical preferences (Hargreaves, Miell, & MacDonald, 2012), the structures and the processes of the researches point to generalizability of this model to all four groups of environmental aesthetics studies. This model assumes that the factors associated with all three broad variables are in an interactive relationship with the other two variables. Therefore, all of the three variables and their factors interact with one another to give rise to a response. In addition, the systematic quadruple model can be used as a framework for organizing numerous researches in the field of aesthetic preferences. Using a similar model to this by some researchers in organizing studies in Neuroaesthetics (Chatterjee & Vartanian, 2014) and Neuroaesthetics in architecture (Coburn et al., 2017) is a prime example. Respectively, they have reviewed the studies based on a triad model in which the three variables of 'environmental stimuli', 'personal characteristics, and situation', and 'responses' are considered in relation to the brain and the nervous system. According to this model, three large-scale systems generate aesthetic experiences: sensory-motor, knowledge-meaning, and emotion-valuation systems. In the sensory-motor scale, the focus is on the type of the visual and non-visual stimuli or navigation through the built spaces; and how the sensory and motor systems get involved in different parts of the brain. In the knowledge-meaning scale, personal experiences, education, culture, and the context in which objects are encountered and appraised are considered. The emotion-valuation scale, concentrates on the aesthetic responses from the affective and cognitive aspects engaged by the environmental stimuli and the brain mechanisms associated with them (Coburn et al., 2017; Chatterjee & Vartanian, 2014; Leder, Belke, Oeberst, & Augustin, 2004).

5. Quadruple model and the structure of the Psychological research

According to the introduced model in environmental aesthetics, to carry out a research with psychological responses, four separate stages should be completed. This could be done by placing a group of participants in a certain context and situation and exposing them to pre-measured environmental stimuli. The final stage is gathering and analyzing their responses from the cognitive, affective and perceptual aspects.

5.1. Environmental stimulus

In the first stage, it is necessary to select a few aesthetic variables and prepare the photos or other visual stimuli for displaying in the questionnaire. Thus, in reality, the first stage can be summarized in three steps: selection of the environmental attributes/aesthetic variables, selection and measurement of environmental stimuli, and the mode of presentation in the questionnaire (Nasar, 2008).

5.1.1. Selection of the environmental attributes/aesthetic variables

The selection of aesthetic variables is based on the theoretical foundation of the research and the research questions and is carried out using various approaches (e.g., Gifford, Hine, Muller-Clemm, Reynolds, & Shaw, 2000; Nasar, 1994). One examines the formal aesthetic variables. The second approach considers variables that are more abstract than the formal ones mentioned. In the third approach, the type and the style of the building or an art piece are considered as the symbolic aesthetic variables (Table 1).

5.1.2. Selection and measurement of the stimuli for the test

After the aesthetic variable is determined, in the second step, selection of the stimuli to be used in the test, the rating and coding of the stimuli, and determination of the sample size are considered. The test stimuli can be selected using the following formats: graphic representation (Madani Nejad, 2007; Heath et al., 2000; Imamoglu, 2000), oral description, black and white and color photos (Nasar & Devlin, 2006; Nasar & Kang, 1999; Stamps & Nasar, 1997; Devlin & Nasar, 1989; Shafer & Richards, 1973), video (Zhang et al., 2006; Nasar 1984), virtual reality or being exposed to the actual context or the real life situation (Meyers-Levy & Zhu, 2007). Selection of each one of these formats benefits from certain strengths and suffers from certain weaknesses in the way they measure, rate, control the experiment setting, and the degree of realism (Nasar, 2008; Taylor, Zube, & Sell, 1987).

Moreover, the selection creates different capabilities with respect to the number of the participants. In the rating phase, a few judges measure the test stimuli based on the aesthetic variables and the factors related to them using the Likert scale. The rating could take place based on various policies with respect to the level of the judges' expertise or whether they are rating stimuli individually or in a panel format. In addition, it is possible for a study not to have the rating phase and the researcher may use a software to create a different spectrum of the environmental stimuli to eliminate the possible errors (Dębek & Janda-Dębek, 2012; Madani Nejad, 2007). Regardless of the choice the researcher makes, the product of the second step is a final sample that consists of some pre-determined coded environmental stimuli that are prepared to be used in the questionnaire. All the actions taking place in selection and measurement of the environmental stimuli must be done in a way that they lead to the least possible degree of bias. Therefore, the validity and the reliability of the research depends, greatly, on the selection process, the choices and the judgments that take place in this step.

5.1.3. The presentation mode in the questionnaire

The last step in the first stage is the way the researcher introduces the stimuli in the questionnaire. This decision is always done through interaction among the steps. The subject and the theoretical foundation of the research, the number of the participants, the format of the coded stimuli, the received responses, the instrumentation, the context, and the situations are the factors affecting the presentation mode in the questionnaire. Using a software or hardware format for the questionnaire, administration of the test in a controlled environment or in an online format, the number of the stimuli and the trials that are to be displayed for each participant, the duration of the display, the reaction time, and some other technical details are some of the issues determined in this step.

5.2. Participants

The second stage in execution of the study depends on the participants in the test and their human characteristics. Up to this date, various studies have been analyzed in the researches on the environmental preferences such as identity, biological, and socio-cultural factors, familiarity with the environment, and expertise (Table 2).

Contexts and situations

In the third stage of the conceptual model, attention is focused on the contexts and situations. Even though in this stage the results of the responses are anticipated not have any direct impact, some studies show that these factors can affect the result of the studies. In general,

four groups of factors associated with this stage are identified in the visual preferences: the location of the test, the time of the test, the type of the assessment (private/public), and the alternate preferences. For instance, in a short period of time, while the research is ongoing, dissatisfaction and lack of interest towards a specific form and color is created, or a participant is informed that his preferences and assessments are to be judged by a panel (Zhang et al., 2006). Another situation could be that the participants are asked about their color preferences in architecture based on the function and the interior/exterior of the building (Dębek & Janda-Dębek, 2012).

5.3. The response

The response stage is the final stage in the conceptual model where different responses are elicited from the participants using various instruments and the received responses are statistically analyzed. In the response section of the study, an individual can provide the researcher with three types of perceptual, affective and cognitive responses when exposed to the stimuli. Sensing the stimulus takes place in less than a second (Victor, Ropper, & Adams, 2001) and the person can respond perceptually whether the stimulus is light or dark, simple or complex, open or closed. Affective responses point to the inner state of the participant and originate and depend on how he/she feels toward the environment. The emotional responses are applied in four aspects of pleasure, excitement, arousal, and calmness (Nasar, 2008). In the cognitive responses, the environmental stimuli can be assessed from different aspects such as whether it is stable or unstable, safe or unsafe, modern or traditional. Overall, the type of the responses (emotional responses versus aesthetic judgments) largely depends on the theoretical framework of the research, the fundamental theories in psychology, and the affective and cognitive mechanisms of perception and aesthetics. In this regard, different psychological and Neuroscientific models of perceptual mechanisms have been introduced in aesthetic judgments and experiences (Bakker, Voordt, Vink, & Boon, 2014a; Skov, 2009; Chatterjee, 2004; Leder et al., 2004; Nasar, 1994; Cloninger, 1994). Understanding these models can have a great impact on more accurately designing various stages of the research and the received responses.

After determining the types of the received responses, the instruments are selected. Selection of the instruments takes place in interaction with the type of the received responses and the mode of presentation of the stimuli in the questionnaire (step three of the first stage). Sorting, selecting from among the members of a group, using the Likert scale rating, comparison of the choices, open and closed questionnaires and combination of these are some

of the instruments used to elicit preference stimuli. This part of the process, as far as the reaction time is concerned (e.g., McManus et al., 2010; Smith, Bousquet, Chang, & Smith, 2006; McWhinnie, 1993), and the forced-choice blocks and the Likert-type items can be modified.

At the end of this section, the responses are gathered as the data and are from the study. In addition, by utilizing various statistical methods and models the data is analyzed. Overall, in most of the recent studies, correlation and regression analysis are carried out in investigation of the relationship between the variables of the study and the aesthetic responses.

To achieve the goals of the study, determining the relationship between personality and architectural preferences, the methodology of preferences studies of 20 recent research on visual art and architecture were reviewed and the results were tabulated in table 3. The framework used in the review process of these researches was based on the components and the factors of the quadruple model. Moreover, in the result column of the table, the meaningfulness of the relationship between the personality and aesthetic variables were displayed (Table 3).

6. Limitations and future directions

Having the goal of establishing a much better relationship between the human beings and architecture, studying architecture, while taking individual and personal characteristics of the clients, is of great importance. Therefore, discovering the preferred patterns for each person and taking them into consideration by the designers and builders could, ultimately, create conditions that result in the satisfaction of that person. In this review study, the methodological structure of the environmental preferences research with psychological approach was further analyzed. The review showed that there are two sets of reasons why the researches on the relationship between personality and aesthetics in architecture have not born clear and meaningful results. The first group of the reasons are fundamental and relate to the nature of the aesthetics and both of the variables in this study, personality and architecture. Architecture is defined as a multisensory art that a thorough understanding of it becomes possible only by directly experiencing it; and personality is considered as a dynamic organization of psychobiological systems (Cloninger & Svrakic, 2016; Allport, 1961). These factors have born no results using the traditional methods and quantitative paradigms.

The other set of reasons could lead to achieving positive results through changing and reviewing the theoretical orientation, the structure, and the execution tactics. To this end, the literature was reviewed from methodological aspect.

By studying the researches on visual aesthetics, a systematic quadruple model along with a series of the model's components and factors were obtained. Dealing with this model and its components in action, to a great extent, depends on the subject, aims, and the theoretical framework of the study (Figure 2).

In the study and analysis of the relationship between personality and aesthetic variables in architecture based on the quadruple model, a projective model or a concept map was created. This map benefits from a core concept (the relationship between personality profile and architectural preferences profile). In the projective model, all of the relationships between the variables are present and are placed at the control of the researcher, like a neural network. By utilizing this neural network, assessing and determination of the weight of all of the relationship and prediction of the architectural preferences patterns for each personality becomes possible (Figure 3). In this case, for sophisticated statistical analysis, extracting the hidden information or obvious patterns and relationships in a large volume of data and their interrelations, there is a need for data mining (Fayyad, Piatetsky-Shapiro, & Smyth, 1996). Data mining, which takes place using tools such as statistical models, mathematical algorithms, and machine learning methods, leads to analysis of the data and prediction of the results (e.g., prediction of patterns of architectural preferences) (Piatetsky-Shapiro & Parker, 2011). In the past studies, simple statistical models have usually been used to analyze the data. This approach to data analysis has led to not discovering the correlation between personality and preferences. For instance, it is possible for only a part of a set of data related to personality profile to be associated with part of a set of data regarding the architectural preferences profile in a dataset originating from an experiment. A simple statistical analysis method often neglects such an intricate and complex relationship between two sets of data.

Another part of the changes in the methodology relates to the execution tactics. As it was previously mentioned, the researcher must understand the theoretical framework of the study in relation to the process and the mechanism of perception and aesthetic preferences (Hardiman & Zernich, 1977). For instance, a researcher could adjust the theoretical orientation of his study based on the Neuroaesthetics Chatterjee's model who believes "the viewer experiences pleasure without obvious utilitarian consequences of this pleasure" (Chatterjee, 2004,55). Chatterjee divided visual processing into three dimensions of early, intermediate and late visions. In his model, Forento-parietal circuits and occipital cortex are mostly responsible for early and intermediate visions (processing features such as color, shape, location and motion of the objects) while late vision including visual cognition and visual attention are significantly derived from interaction between insula, temporal pole and

orbito-forental regions (Leder & Nadal, 2014; Chatterjee, 2004; Chatterjee & Vartanian, 2016).

Chatterjee's model is in contrast with Leder and colleagues model who believe the aesthetic experience takes place when "exposure to art provides the perceiver with a challenging situation to be classify, understand, and cognitively master the artwork successfully" (Leder et al., 2004, 493). Many of the decision-theorists believe that human beings, when deciding on their preferences, often act in less than a second according to their intuition process (Dijksterhuis, 2004; Dijksterhuis, Bos, Nordgren, & Baaren, 2006; Zajonc, 1980); and the role of logic and cognitive process is not very dominant. In the study of the relationship between personality and architecture, most of the researches have involved the cognitive process in the aesthetic preferences by making the observation and the selection time of the visual stimuli unlimited. The lack of time limitation, here, provides the participants, with different experiences and memories, with opportunity to come up with different assessments of the stimuli; whereas, the assessed characteristic may have not been part of the intended aesthetic variables (Bakker, Voordt, Vink, & Boon, 2014b). In such a situation, controlling the research and the relationships involved will be affected by the intervening variables that have not been predicted in the research framework. Lack of attention to this issue could, perhaps, be one of the reasons for the fact that the studies on the relationship between personality and architecture have not born any meaningful results. Therefore, selection and dealing with the affective and cognitive processes that are involved in the aesthetic preferences have a direct impact on the theoretical orientation and the executory tactics; and could create changes, such as the selection of the aesthetic variables, the presentation mode of the stimuli, the received responses, the instrumentation, the reaction time, and the methods and models of statistical analysis in the components of the quadruple model.

7. Conclusion

This review offers a suitable methodological approach for studying the relationship between personality and architectural preferences. It could be used to aid researchers in designing a sophisticated study in this domain and enabling them to perform complex analyses. To this end, two general recommendations were made for future studies. First, use of the quadruple model that adopts a systematic approach to the issues and makes it possible to collect all the data impacting the results of a study and to knowledge discovery by the use of machine learning; and the second being selection of a perceptual model in aesthetic preferences that

has a direct impact on the quadruple model and the process of execution of the research. To this end, Chatterjee ‘s model was the best model among others as the role of cognition in aesthetic preference is notably limited in it. In this model, visualization process was divided into three dimensions including early, intermediate, and late visions. According to what Chatterjee has claimed, it seems that early vision is responsible for understanding morphological features at first glance, while spatial status is mainly processed by intermediate vision. memory-related contents are apprehended by late vision.

Based on these two recommendations, a focused and step by step research could be designed to solve the problem, identifying the preferred patterns in art and architecture. The quadruple model is like a framework in which all of the variables from various parts (environmental variables, subject variables, contexts and situations, and responses) and the existing relationships between them are present. In addition, this model offers certain tools for analyzing the data, has the capability of adapting to the theoretical foundations (i.e., foundations of visual perception) and being affected by them.

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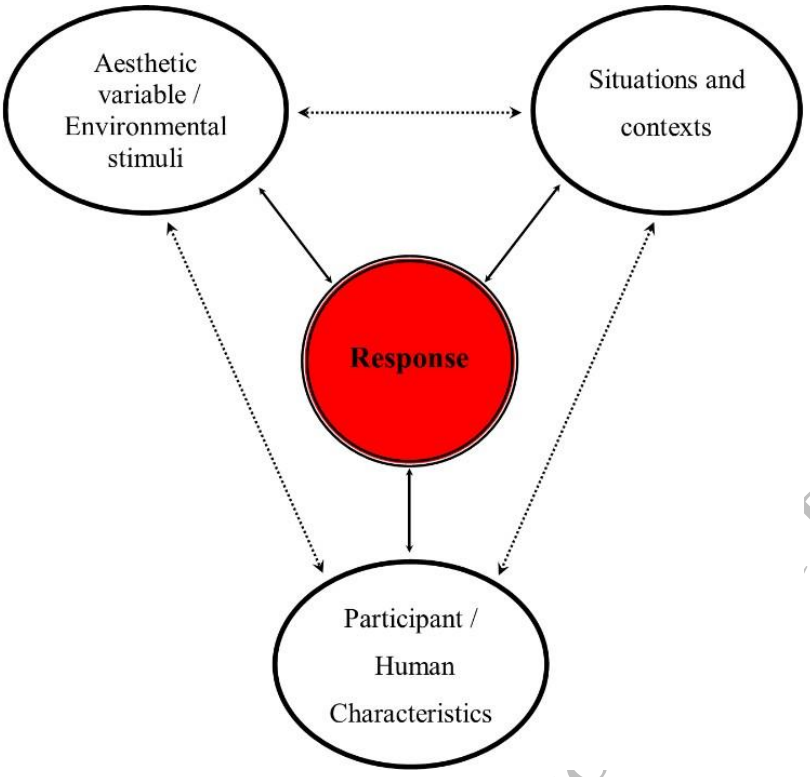


Figure 1- The Quadruple model of aesthetic responses

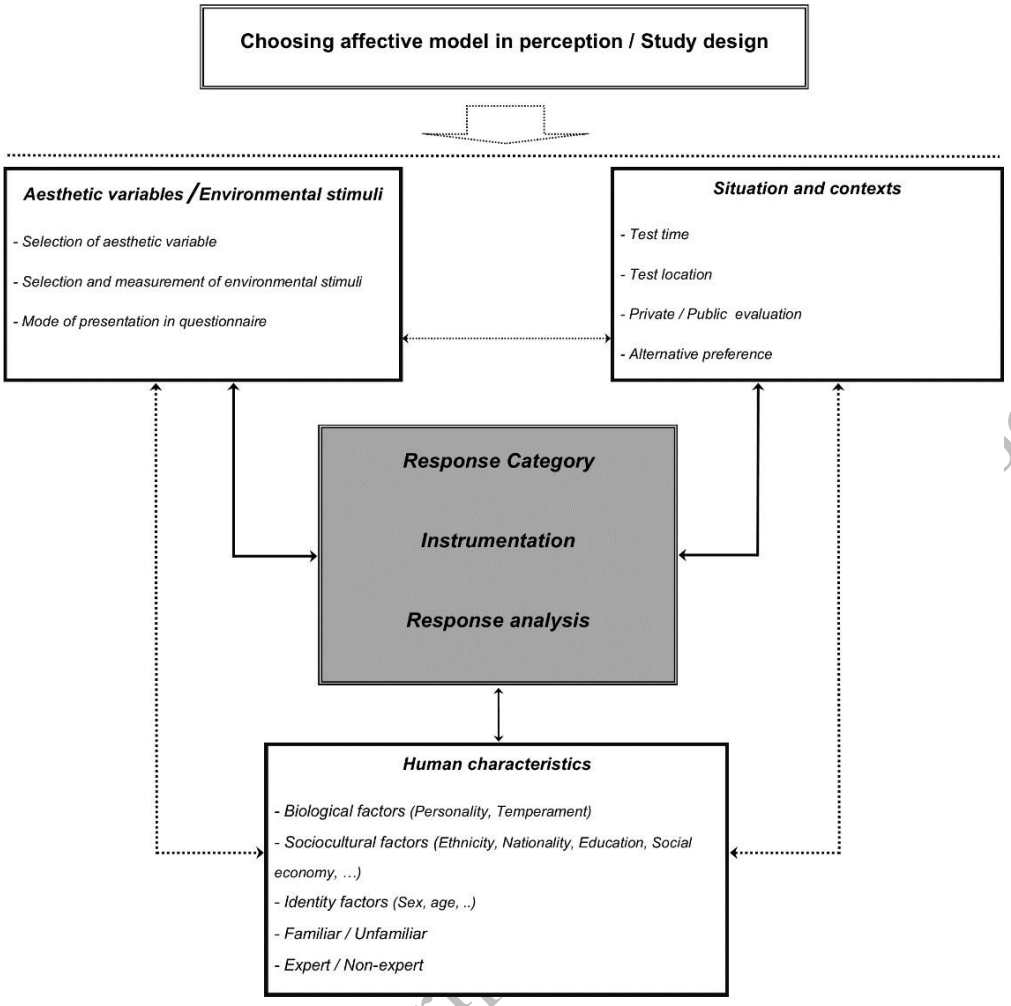
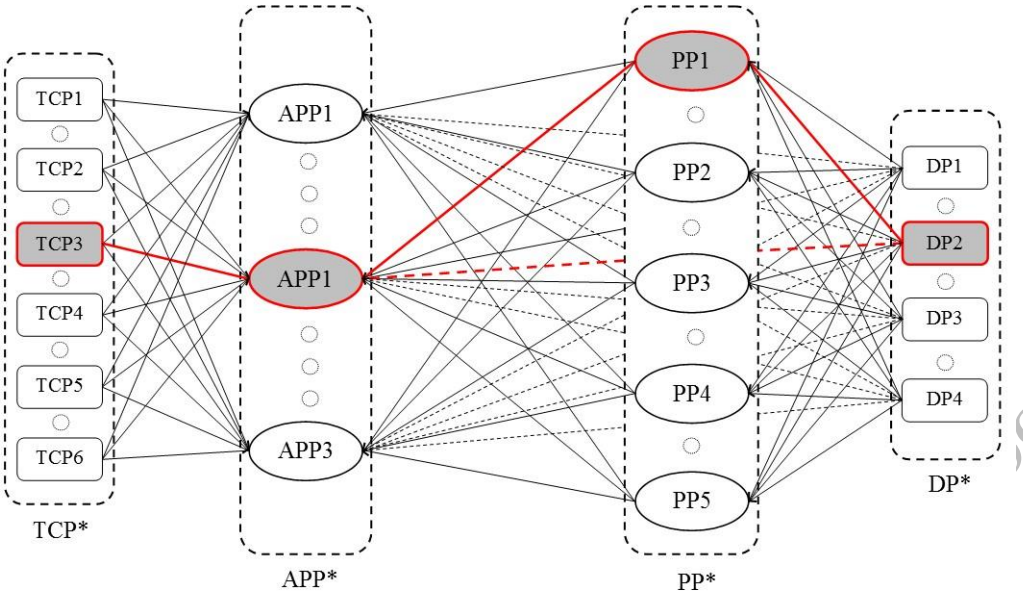


Figure 2- The Quadruple model of psychological responses in preference architecture



Note: *APP (Architectural Preference Profile); PP (Personality Profile); DP (Demographic Profile); TCP (Test Condition Profile)

Figure 3-A neural network model in the study and analysis of the relationship between personality and architecture

Table 1 – Aesthetic variables

Type	Variable	Examples of studies
Formal variable	Angular vs rounded shapes, size, aspect ratio, height of the ceiling, symmetry, color, and etc.	Jankowski et al., 2018; Swami & Furnham, 2012; Hidayetoglu, Yildirim, & Akalin, 2012; Dębek & Janda-Dębek, 2012; He, Zhang, Zhu, Xu, Yu, Chen, Liu, & Wang, 2011; McManus et al., 2010; Nasar & Stamps 2009; Madani Nejad, 2007; Meyers-Levy & Zhu, 2007; Bar & Neta, 2006; Zhang, Feick, & Price, 2006; etc.
Abstract variable	Complexity/simplicity, representation/abstractness, clarity/ambiguity, harmony, and etc.	Palmer & Griscom, 2013; Chamorro-Premuzic et al., 2010; Griscom & Palmer, 2010; Nadal, 2007; Imamoglu, 2000; Heath, Smith, & Lim, 2000; Herzog, 1992; Zuckerman et al., 1993; Furnham & Bunyan, 1988; etc.
Symbolic variable	Art and architectural styles/types	Carl, Richards, & Heath, 2018; Cleridou & Furnham, 2014; Cook & Furnham, 2012; Chamorro-Premuzic et al., 2009; Rawlings, 2003; Cela-Conde, Marty, Munar, Nadal, & Burges, 2002; Furnham & Walker, 2001a, 2001b; Nasar & Kang, 1999; Stamps & Nasar, 1997; Furnham & Avison, 1997; Stamps, 1993; Purcell & Nasar, 1992; Devlin & Nasar, 1989; etc.

Table 2 – Participant variables

Participant	Variable	Examples of studies
Identity factors	Sex, age, etc.	Most studies have examined the identity variables such as age and sex.
Psychobiological factors	Temperament, personality traits, schizotypy, and etc.	Jankowski et al., 2018; Pietras & Czernecka, 2018; Cleridou & Furnham, 2014; Palmer & Griscom, 2013; Cook & Furnham, 2012; Dębek & Janda-Dębek, 2012; Swami & Furnham, 2012; McManus et al., 2010; Chamorro-Premuzic et al.,2010; Chamorro-Premuzic et al., 2009; etc.
Sociocultural factors	Religion, ethnicity, education, race, major, political orientation, and etc.	Nasar & Devlin, 2006; Feist & Brady, 2004; Imamoglu, 2000; Nasar & Kang, 1999; Nasar, 1984; etc.
Expert / Non-expert	Background and training in art / architecture, artistic experience, aesthetic activities, and etc.	Pietras & Czernecka, 2018; Miu, Pițur, & Szentágotai-Tătar, 2016; Cela-Conde et al., 2002; Ibrahim et al., 2002; Locher, Smith , & Smith, 2001; Devlin & Nasar,1989; etc.
Familiarity with the environment	Familiar / Unfamiliar	Furnham & Walker, 2001; Ibrahim et al., 2002; Imamoglu, 2000; etc.

Table 3 – The review of the methods and the results of preferences studies for visual art and architecture stimuli

Study	Environmental stimulus			Participants			CO & SI	The responses			Domain & Results
	Variables	Stimuli	Presentation	Subjects	PT	Variables	Variables	Response category	Instrumentation	Statistical analysis	
Cleridou & Furnham, 2014	5 artistic styles	30 images of paintings / buildings	Online task Software	148 F, 44 M Age: 18-30	IPIP	Sex, Ethnicity, Artistic experience	No variables	Affective: like / dislike	Rating, 9 point Likert-scale	Correlation, Factor Analysis, Regression	For ARCH: N For art: C, N,O
Palmer & Griscom, 2013	Harmony	Color stimuli: 56 colored pairs Dot patterns: 22 five-dot images Circle-in-a-frame images: 35 images	Software, Response time (2000-ms) interval (500-ms)	90 students Mean age: 21.4	BFI SSS	Background & training in visual art and color	No variables	Affective: like / dislike Cognitive: harmonious/ disharmonious for color pairs, simple/complex for dot patterns, good fit/bad fit for circle-in-a-frame	Rating: continuous rating scale (−100 to + 100)	Correlation, chi-square, SEM, Factor analysis	For harmony: non-significant
Cook & Furnham, 2012	6 British styles	24 photographs of British buildings	In a large lecture theater	74 F, 10 M Age: 18-25	NEO-FFI	Familiarity	No variables	Affective: attractiveness Cognitive: familiarity	Rating in 10 seconds	Bonferroni correction, Regression, PCA	For ARCH: E, N, A
Dębek & Janda-Dębek, 2012	Color, Form, & Shape	12 architectural models	Software questionnaire	290 F, 144 M	FCZ-KT	Sex, Age, Residence	Alternative preferences	Emotional,	Rating, 5 point Likert-scale	GLM, LSD	For ARCH: non-significant
Swami & Furnham, 2012	Symmetry / asymmetry	57 colored images of paintings by Piet Mondrian	In a large lecture theater	83 F, 75 M Age: 18-39	SSS-V TIPI	Sex, Age, WPT, ToA, AA, NRT, Religion, Ethnicity, Education	No variables	Affective: like / dislike	Rating, 7 point Likert-scale	ANOVA, Correlation, Regression	For Mondrian's original painting: O
McManus et al., 2010	Aspect ratio square/rectangle Golden Section	210 pairs of 21 different rectangles	Computer presentation, Response time	54 F, 25 M Age: 18-25	BFI-2-the 30-item	Sex, Age, AA, , ToA, Need for cognition, Schizotypy, Vocational types	No variables	Affective: attractiveness & nice	Paired comparison	Q-Mode Factor Analysis, Correlation	For rectangle preferences: non-significant
Chamorro-Premuzic et al., 2010	Complexity / simplicity	20 paintings of 4 distinct visual art genres	Online task Software	2253 F, 1001 M Age: Under 20-70	B5S	Sex, Age, Education, Unconventionality, Visits to museums	No variables	Preferential: hate/love Emotional: sad/happy Cognitive:	Rating, 5 point Likert-scale	SEM, Correlation	For visual art preferences & complexity: O, E,

								simple/complex			N, C
Chamorro-Premuzic et al., 2009	4 painting styles	24 images of paintings	Online task Software	91692 (M & F) Age: 13-90	IPIP	Sex, Age, Education, Artist vs. scientist	No variables	Affective: like / dislike	Rating, 7 point Likert-scale	Descriptive statistics Correlation, SEM	For art: A,C, O, E
Feist & Brady, 2004	Ambiguity, Abstractness / representation	45 works of art	With a projector in a classroom	Low O: 32 F, 16 M High O: 36 F, 19 M	SSS-V NEO-FFI	Sex, Age, Tolerance of substance use, Race, Major, Political orientation	No variables	Affective: like / dislike	Rating, 9 point Likert-scale	ANOVA	For abstract art: O
Furnham & Chamorro-Premuzic, 2004	Basic principles of aesthetic	The Maitland Graves Design Judgment, 90 slides	In a large lecture theater	46 F, 28 M Age: 18-24	NEO-FFI	Income, Sex, Age, Political idea, Art interests, activities & knowledge	No variables	Art judgment: preference (selecting better design in a slide)	Correct response from paired or triple images	Multiple regression	For art judgement: E, C
Rawlings, 2003	Abstractness / representation, Pleasant / unpleasant	18 unpleasant/ 18 pleasant photographs 44 slides of 4 painting styles (PR, UR, PA, UA)	Slideshow, Session1: in a lecture theater, Session2: in a small classroom	188 M & F Mean age: 21.97	IPIP SSS-V EPQ-R	Sex, Age, Schizotypy (UE). Expert / non-expert	No variables	Affective: like / dislike	Rating, 5 point Likert-scale	Pearson correlation, PCA, Regression	For art & photograph: SS, UE, P, O, N
Furnham & Rao, 2002	Original vs. facsimile	100 slides of 2 modern abstract painters & sketches	Slideshow	77 F, 52 M Age: 16-19	NEO-FFI	Sex, Age, Ethnicity, Level of education	No variables	Affective , Cognitive	Rating, Paired comparison task	Correlation, Multiple regression	For preference ratings: C
Ibrahim et al., 2002	Non-familiar/ Familiar ARCH	familiar ARCH: 6 exterior, 4 interior/ Non-familiar ARCH: 7 exterior, 3 interior	In a laboratory Presented on a white surface table	- 30 expert, 30 non-expert - 24 expert, 28 non-expert	16PF	Sex, Familiarity, Expert/non-expert, Level of study	No variables	Perceptual: 7 items Affective: 10 items Cognitive: 15 items	Rating, 7 point Likert-scale	Factor analysis, Correlation	For ARCH: non-significant
Furnham & Walker, 2001a	4 painting styles Japanese traditional, pop-	40 slides of paintings (10 paintings for each style)	Slideshow In a room	101 M & F Age: 16-18	SSS-VI NEO-FFI WPAI	Sex, Age, Occupation, Nationality, Ethnicity, Home location,	No variables	Affective: like / dislike Cognitive: familiarity, pay for the painting,	Rating, 11 point Likert-scale	Correlation, Multiple regression, Curve analysis,	For art styles preferences: CON, SS, O, C

	art, abstract, & representational					Experience of art, interest in art, Visits to galleries		artist talent			
Furnham & Walker, 2001b	3 painting styles Pop art, realistic & abstract art	24 slides of paintings (8 paintings for each style)	Slideshow In a room	45 M, 76 F Age: 16-58	SSS-VI NEO-FFI	Sex, Age, Occupation, Home location, Art level studied, Visits to galleries	No variables	Affective: like / dislike	Rating, 11 point Likert-scale	Factor analysis, Correlation	For art styles preferences: SS, A, O, N, C
Rawlings et al., 1998	Complexity	24 polygons	Hardware, Presented on A4 paper	- 33 M, 82 F Mean age:19.7	EPQ-R SSS-V STA	Sex, Age, Background & interest in art	No variables	Affective & cognitive: 8 rating scales (or 8 items)	Rating, 7 point Likert-scale	Correlation, T-test, Regression, CCA	For complexity: SSS-V, STA
Stamps & Nasar, 1997	High style vs. popular style in ARCH	35 photographs of houses' scenes	Hardware, Photos mounted the boards	45 F, 37 M Age: Under 20- over 40	SSS-ES	Sex, Age, Education, Ethnicity, City, Political idea, Income, Occupation, Major activity last week	No variables	Affective: pleasant / unpleasant	Rating, 7 point Likert-scale	ANOVA	For high style / popular style: non-significant
Furnham & Avison, 1997	Paintings styles: representation / surreal, Variety of elements	20 slides of paintings (5 RM, 5 RF, 5 SM, 5 SF)	Slideshow	32 M, 30 F Age: 18-34	SSS-V NEO-FFI	Sex, Age, ToA	No variables	Affective: like / dislike	Rating, 11 point Likert-scale	Correlation, Factor analysis, Multiple regression	Preferences for art: SS strong effect / E, A, O weak effect
Zuckerman et al., 1993	Complexity, Tension, Style	52 slides of nature paintings	Slideshow	- 84 M, 135 F - 62 M, 91 F	SSS-V	Sex	No variables	Affective: like / dislike	Rating, 5 point Likert-scale	MANOVA, Factor analysis, Correlation	For complexity: non-significant
Furnham & Bunyan, 1988	Complexity/ simplicity, Abstractness/ representation	20 paintings (5 CA, 5 SA, 5 CR, 5 SR)	Slideshow	25 M, 35 F Age: 18-27	SSS-V	Sex, Age	No variables	Affective: like / dislike	Rating, 7 point Likert-scale	Correlation	For complexity: SS

Note. CO = contexts. SI = situations. PT = personality test. RM = representational painting with more elements, RF = representational painting with fewer elements, SM = surreal painting with more elements, and SF = surreal painting with fewer elements. CA = complex/abstract, SA = simple/abstract, CR = complex/representational, and SR = simple/ representational. PR = pleasant representational, UR = unpleasant representational, Pa = pleasant abstract, and UA = unpleasant abstract. M = male. F = female. ARCH = architecture. NEO-PI-R = Revised NEO Personality

Inventory. FCZ-KT = Formal Characteristics of Behavior-Temperament Questionnaire. IPIP = International Personality Item Pool. SSS-V = Sensation Seeking Scale Form V. BFI-2-the 30-item = The 30-item Forms of the Big Five Inventory–2. TIPI = Ten Item Personality Inventory. B5S = Big 5-Short Inventory. 16PF = Cattell's 16 Personality Factors Test. SSS-ES = Experience Seeking Scale. EPQ-R = Eysenck Personality Questionnaire-Revised. STA = Schizotypal Personality Scale. SSS-VI = Sensation Seeking Scale Form VI. WPAI = Wilson-Patterson Attitude Inventory. BFI = Big Five Index. SSS = Sensation Seeking Scale. AA = aesthetic activities. ToA = Tolerance of Ambiguity. NRT = Numerical Reasoning Test. WPT = Wonderlic Personnel Test. SEM = Structural Equation Model. PCA = Principal Component Analysis. GLM = General Linear Model. LSD = Least Significant Difference. ANOVA = Analysis of Variance. MANOVA = Multivariate Analysis of Variance. CCA = canonical-correlation analysis. C = Conscientiousness. N = Neuroticism. O = Openness to Experience. A = Agreeableness. E = Extraversion. SS = Sensation Seeking. CON = conservatism. P = Psychoticism. UE = Unusual Experience (Schizotypy).