

Personality Psychology using Heart Responses to Color Stimulus

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Abstract

The Lüscher Color Psychology Test measures a person's psychophysical state, his ability to withstand stress, perform, and communicate. This test is based on color selection in four levels of preference.

In this paper, we try to use heart response and particularly time domain features of heart rate variability to find the colors preferences without asking the subjects directly. For this purpose, we used four main colors in psychology, blue, yellow, green, and red, as a visual stimulus while the lead II of ECG was recorded from 16 girls as subjects during the stimuli. Then we used time domain features of HRV's to classify four different levels of performances. The results show that these features such as NN50 and RMSSD are able to distinguish between different performances levels by $p < 1E-3$.

This method cancels the possibility of making mistake in color selection by subjects and suggests the automatic system for personality psychology without their consciousness.

1. Introduction

Personality can be defined as a dynamic and organized set of characteristics possessed by a person that uniquely influences his cognitions, motivations, and behaviors in various situations [1].

Personality psychology is concerned to enduring patterns of behavior, thought, and emotion in individuals [2]. It is a branch of psychology that studies personality and individual differences. Its areas of focus include: constructing a coherent picture of the individual and his or her major psychological processes, investigating individual differences, and investigating human nature.

Psychology includes social interaction, child development, mental illness and information processing [3]. Physiology considers the organization of the brain, heart and body of mammals and humans, from the molecular level to the organism as a whole.

The body of the humans is in direct relation with his

personality and these are inseparable that each of them has effects on the other [1]). So it is important to understand the role of mental functions in individual and social behavior, while also exploring the physiological and biological processes that underlie certain functions and behaviors.

The Color Test is an effective tool that attempts to throw light on significant aspects of the human personality [3]. This test is based on the lifetime research conducted by Dr. Max Lüscher, and successfully draws attention to areas of psychological and physiological stress in an individual's personality.

The Lüscher Color Psychology Test is one of the famous tests which are using in psychology for distinguishing personality conditions. This test measures a person's psychophysical state, his ability to withstand stress, perform, and communicate [4]. It uncovers the cause of psychological stress, which can lead to physical symptoms. The color test is based on color selection in four levels of preference and one of the most disadvantages of this test is that this pickup determines the results of the test. The problem is that the subject with limited knowledge about the colors and their meanings can easily influence in results and with awareness selection change the correct conclusion. This test is explained in details in section 4.

So, in this paper, with the use of colors as stimulation, we try to overcome this limitation and propose the automatic system which makes color selection using heart responses without subjects' consciousness. First we find the level of preferred selections using HRV signal processing and then use the preferential features for automatic personality recognition system.

2. Electrocardiography (ECG) and heart rate variability (HRV)

The electrocardiogram signal represents the human heart operation [5]. The surface ECG is the recorded potential difference between two electrodes placed on the surface of the skin at pre-defined points [6]. The largest

amplitude of a single cycle of the normal ECG is referred to as the R-wave manifesting the depolarization process of the ventricle [7]. The time between successive R-waves is referred to as an RR-interval. The variability in a series of RR intervals has been widely used as a measure of heart function which helps to identify patients at risk for a cardiovascular event or death [8]. Analysis of variations in this time series is known as heart rate variability (HRV) analysis.

Heart rate variability (HRV) is a reliable reflection of the many physiological factors modulating the normal rhythm of the heart [9]. In fact, it provides a powerful means of observing the interaction between the sympathetic and parasympathetic nervous systems. Hence, HR variation analysis has become a popular noninvasive tool for assessing the activities of the autonomic nervous system. Furthermore, the human observer may not directly monitor these disease's indicators. So computer based analytical tools for in-depth study of data over daylong intervals can be very useful in diagnostics. Therefore, the HRV signal parameters, extracted and analyzed using computers, are highly useful in diagnostics [1].

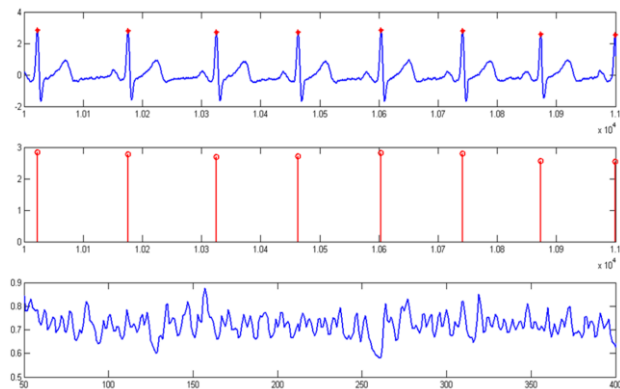


Figure 1. ECG of a normal subject with R detection and derived HRV

3. Time domain analysis methods

The time-domain methods are the simplest to perform since they are applied straight to the series of successive RR interval values [10]. With a finite number of intervals, consider RR intervals as RR_i with $i = 1, 2, \dots, N$ where RR_i denotes the value of i 'th RR interval and N is the total number of successive intervals.

The most evident of linear indexes of HRV is the mean value of RR intervals (RR) or correspondingly, the mean Heart Rate (HR). In addition, several variables that measure the variability within the RR series exist [11].

The standard deviation of RR intervals (SDRR) reflects the overall (both short-term and long-term) variation within the RR interval series which is defined as:

$$SDRR = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (RR_i - \overline{RR})^2} \quad (1)$$

in which the mean RR interval is shown by $\overline{RR} = E\{RR_i\}$.

The standard deviation of successive RR interval differences (SDSD) can be used as a measure of the short-term variability.

$$SDSD = \sqrt{E\{\Delta RR_i^2\} - E\{\Delta RR_i\}^2} \quad (2)$$

For stationary RR series, SDSD equals the root mean square of successive differences (RMSSD) given by [11]:

$$RMSSD = \sqrt{\frac{1}{N-1} \sum_{i=1}^{N-1} (RR_{i+1} - RR_i)^2} \quad (3)$$

Another feature which is calculated from successive RR interval differences is the NN50 which is the number of successive intervals differing more than 50 ms:

$$pNN50 = \frac{NN50}{N-1} \times 100\% \quad (4)$$

The HRV triangular index is obtained as the integral of the RR interval histogram (i.e. total number of RR intervals) divided by the height of the histogram which depends on the selected bin width. In order to obtain comparable results, a bin width of 1/128 seconds is recommended [12].

Another geometric measure is the TINN which is the baseline width of the RR histogram evaluated through triangular interpolation [12].

4. Lüscher Color Psychology Test

Different colors signify different traits of our personality [1]. Color Test is a very accurate personality tool. Colors represent our changing moods and hidden desires, which will help us to understand our present situation. The Color Test based on Dr. Max Lüscher is one of the most precise tools of all times. According to Dr. Max Lüscher, the originator of this test, each of the colors has a definite significance. The purpose of this simple, interactive test is to provide an analysis of our present situation and also help us pinpoint our actual problems in life, which might enable you to undertake suitable remedial measures [4].

The ordinary Lüscher test is carried out by placing the eight cards of different colors in front of the participant of the test [4]. The subject is asked to choose the color which he likes best and take this card off. Then he chooses among the remaining cards the color, which he now likes best, and thus he continues, until all the cards have been taken. In case of doubt the psychologist will emphasize the second time, because it is considered to be more impulsive [13]. So all the cards are placed on the table again, and the whole procedure is repeated. In automatic personality recognition system, this problem is

Table 1. Colors meaning in Luscher test

Colors	Affective Aspects
Blue	depth of feeling, concentric, passive, incorporative, heteronomous, sensitive, perceptive, unifying, tranquility, contentment, tenderness, love, affection
Green	elasticity of will, concentric, passive, defensive, autonomous, retentive, possessive, immutable, persistence, self-assertion, obstinacy, self-esteem
Red	force of will, ex-centric, active, offensive-aggressive, autonomous, competitive, operative, desire, excitability, domination, sexuality
Yellow	spontaneity, ex-centric, active, projective, heteronomous, expansive, aspiring, investigatory, variability, expectancy, originality, exhilaration

solved.

The Lüscher test distinguishes between basic colors and auxiliary colors. The basic colors represent mainly good personal features, while the auxiliary colors represent less good personality features [4]. The basic colors are blue, green, red and yellow, while the auxiliary colors are grey, violet, brown and black.

If a test person does not have the four basic colors among his five first choices, it will indicate some psychological problems [4]. According to Lüscher, a person who is healthy, normal balanced and free of conflicts and repressions, necessarily must have the four basic colors among his first five choices [4].

The test subject must not be influenced by the colors of clothes, which he thinks would suit him, or what color of car he prefers [4]. He must only consider the colors that lie in front of him. But the problem with the test is probably that in general it is not possible for test subjects to abstract completely from the colors of their favorite clothes, cars and furniture and colors that represent their dreams and aspirations. So another advantage of automatic personality recognition system is cancelling this effect. Because in this system, color selection is based on heart response to colors and so the subject is not aware of his choice. So this problem is solved too.

As mentioned before, the basic colors represent mainly good personal features, while the auxiliary colors represent less good personality features. So the most important part of this test is based on the basic colors. Therefore, in this experiment, we focused on good

personal features and used basic colors blue, red, green and yellow in our stimulus.

When taking the test, the subject decides which color he likes most and places the remaining in descending order. By looking at this order, the particular function a color represents can be determined, because the placement of the colors is from greatest to least sympathy. With the colors in order of preference, the following functions can be used for their placements [4]:

- *1st Position* - This is the most-liked color; it represents a "turning towards". It shows the essential method of the person choosing it, the means which he turns to or adopts to enable him to achieve his objective.
- *2nd Position* - This color shows the actual state of affairs, the situation in which he actually feels himself to be, or the manner in which his existing circumstances require him to act.
- *3rd Positions* - Color in this area shows that their characteristics are not being rejected, but simply set aside and not currently in use; they could be brought into use at any time if need be.
- *4th Positions* - This color represents a turning away from. These are the colors that are most disliked and represent a need which is suppressed out of necessity.

In Lüscher test, each color in each position has special meaning and effective aspects which are shown in Table 1 for using four colors. Then based on color meanings and their positions, the brief explanation of their

Table 2. *p*-Value Results for time domain Features of HRV in response to color stimuli

Features	Positions						
	1 st & 2 nd	1 st & 3 rd	1 st & 4 th	2 nd & 3 rd	2 nd & 4 th	3 rd & 4 th	Total
HRV_tri_ind	0.5464	0.7630	0.0382	0.4510	0.0159	0.0765	0.0648
Mean_HRV	0.3860	0.9100	0.7063	0.4287	0.6242	0.8505	0.8217
Mean_RR	0.3860	0.9399	0.7919	0.4510	0.4287	1	0.7972
NN50	0.0269	0.0191	0.0041	0.0057	0.0046	0.0285	0.0012
pNN50	0.1809	0.0570	0.0302	0.5591	0.4623	0.7774	0.1317
RMSSD	0.0022	0.0008	0.0288	0.0049	0.0177	0.0039	4E-4
Std_HRV	0.7919	0.5718	0.2136	0.6511	0.2582	0.0418	0.2856
Std_RR	0.9399	0.8211	0.2278	0.9699	0.1871	0.1051	0.3981
TINN	0.9099	0.8950	0.4853	0.8801	0.3962	0.4395	0.8169
SDRR	0.9699	0.7063	0.3271	0.6785	0.2427	0.1223	0.4673

personality can be presented. More details about this test are found in [4].

5. Color stimulation

Sixteen female students, without earlier experience of laboratory experiments, with the age between 23 and 27 participated in the study (24.75 ± 1.43). The participants were seated on a chair and the lead II of ECG was recorded from them during the stimuli.

For color stimuli we used the laptop screen which was placed one meter far from the subjects and each color of red, yellow, green and blue were presented on it for five minutes separately. Between each color stimuli there was a resting time for canceling the effects of previous stimulation (10 minute).

For comparing the heart response and personality test, before the experience we want each subject to sort using four colors in preferred order. So at last, we used these data to determine which heart's features can define preferential level perfectly.

6. Results

In this study, we have used Kruskal-Wallis test to define the level of significance of our measured features.

Kruskal-Wallis test is a nonparametric version of the classical one-way ANOVA, and an extension of the Wilcoxon rank sum test to more than two groups. The assumption behind this test is that the measurements come from a continuous distribution, but not necessarily a normal distribution. The test is based on an analysis of variance using the ranks of the data values, not the data values themselves.

The p values obtained from Kruskal-Wallis analysis are shown in Table 1 for features which are obtained by time analyzing of HRV. In case of $p < 0.05$ to be considered as significant, we can see that time domain features of HRV would show the significant difference between groups which p values are shown in Table 2. The results show that these features especially $NN50$ and $RMSSD$ are able to distinguish between different performances levels by $p < 1E-3$.

7. Discussion

In this paper, we try to use heart response and particularly time domain features of heart rate variability to find the colors preferences without asking the subjects directly. This method cancels the possibility of making mistake in color selection by subjects and suggests the automatic system for personality psychology without their consciousness.

Taking the Color Test can help an individual gauge his problems in life and where he stands and also what action

needs to be taken to get out of it. So the results help us to use these time domain features of HRV as an indexes of automatic personality recognition system which can solved the Lüscher color test limitations and make it possible to recognize personality from the physiological responses especially heart responses to color stimuli.

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