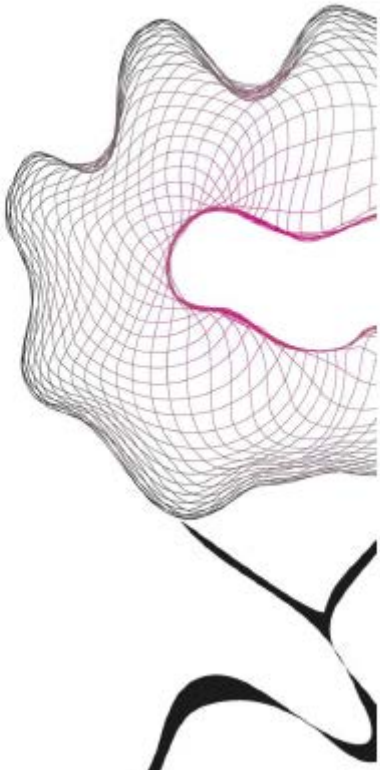

Bachelorthesis

The relation between conscientiousness and skin conductance in the Sing-a-Song Stress Test (SSST)

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12-01-2015

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Abstract

To understand why stress can differ in individuals many research on the relation between stress and personality has been carried out. Mainly the relation between the Big Five personality traits and stress often has been studied in psychological research. Conscientiousness, one of the personality traits in the Big Five, has often been linked to stress. High Conscientiousness often is related to lower stress. Nevertheless there still are inconsistencies about the relation between conscientiousness and psychophysiological reactions to stress, mainly skin conductance, which is why further research on the relation between stress and skin conductance has to be carried out. To examine the relation between skin conductance and conscientiousness we made use of the Sing-A-Song-Stress test (SSST), a newly designed paradigm which has been proven to induce stress in individuals. Based on this test, we developed an alternate version, including changes in phases and duration. Furthermore we made use of the NEO-FFI, a questionnaire designed to obtain information about the Big Five Personality traits. In the alternate SSST stress is elicited by letting the participants sing in company of the researcher and a confederate. The test consists of different phases including a baseline phases, exposition to neutral stimuli, the anticipation of the singing and a singing phase. Throughout the SSST, heart rate and skin conductance were measured as physiological variables of stress. We expected our version of the SSST to elicit higher skin conductance response during the anticipation and the singing phase than during the baseline. Also, our expectation was that participants scoring high on conscientiousness showed fewer levels of stress and fewer stress response than participants scoring low on conscientiousness. Independent of conscientiousness, all participants showed significantly higher SCR during the Anticipation and the Singing phase than during the baseline. This makes our version of the SSST suitable for further research concerning the theoretical framework of stress. Regarding the relation between SCR and conscientiousness, we found significant differences during the Anticipation phase between two groups of the five groups of conscientiousness. There were no significant differences between the other groups, neither did we find significant differences in the baseline or the singing phase.

Samenvatting

Om te begrijpen waarom stress bij mensen kan verschillen werd de relatie tussen stress en persoonlijkheid door wetenschappers onderzoekt. Vooral de relatie tussen de Big Five persoonlijkheidstrekken en stress werd vaak bestudeerd in psychologisch onderzoek. Conscientieusheid, een van de persoonlijkheidstrekken in de Big Five, werd vaak gerelateerd aan stress. Hoge consciëntieusheid is vaak gerelateerd aan lage stress. Echter zijn er steeds tegenstrijdigheden over de relatie tussen consciëntieusheid en psychofysiologische reacties, vooral huidgeleiding. Meer onderzoek met betrekking tot deze relatie moet worden uitgevoerd. Om de relatie tussen huidgeleiding en consciëntieusheid te onderzoeken hebben wij de Sing-A-Song stress taak (SSST) gebruikt. Deze taak is een recent ontwikkelde paradigma om stress in individuen te induceren. Op basis van deze test hebben wij een alternatieve versie ontwikkeld, welke verandering in fasen en duur inhoudt. Bovendien gebruiken wij de NEO-FFI, een vragenlijst om de Big Five persoonlijkheidstrekken te meten. In de alternatieve SSST werd stress geïnduceerd doordat wij de participanten laten zingen terwijl de onderzoekers aanwezig zijn. De test houdt verschillen fasen waaronder een baseline fase, de confrontatie met neutrale stimuli, de anticipatie van het zingen en de zing-fase, in. Tijdens de SSST werden hartslag en huidgeleiding, twee fysiologische variabelen van stress, gemeten. Wij verwachten dat onze versie van de SSST hoger huidgeleiding tijdens de anticipatie en het zingen opwekt dan tijdens de baseline. Ook verwachten wij dat participanten die hoog op consciëntieusheid scoren een lager stresslevel vertonen dan de participanten die laag op consciëntieusheid scoren. Onafhankelijk van consciëntieusheid hebben alle participanten significant hoger huidgeleiding tijdens de anticipatie en het zingen dan tijdens de baseline fase laten zien. Dit maakt onze versie van de SSST bruikbaar voor verder onderzoek in het kader van stress. Wij vonden verder significante verschillen tijdens de anticipatie tussen twee van de five groepen van consciëntieusheid. Verder zijn er geen significante verschillen tussen de andere groepen geweest.

Introduction

The term stress is commonly used in our everyday language and nearly everyone has an association to what it means. But do all people have the same states of stress? Does it depend on the physiology or even the personality of an individual how he reacts to certain stressors? Research led by Lee-Baggley, Preece and Delongis (2005) implies that we must not underestimate the role of our personality on our ability to cope with stress. A persons reaction to stress and their ability and way to cope with it can differ widely, dependent on their personality (Kahn & Byosiere, 1992). Mainly the relation between the personality trait of conscientiousness and stress has often been mentioned (Komulainen et al., 2014). The main aim of this study is to determine whether an individual's psychophysiological measurements of stress, such as skin conductance can differ dependent on their conscientiousness. This relation is thought to be found out by implementing an alternate version of a newly developed stress paradigm, the Sing-a-Song Stress Test (Brouwer & Hogerforst, 2014). The focus during this research will be on the stress measurements in individuals during different time periods of the task, while comparing individuals low on conscientiousness with their higher counterparts.

Conscientiousness

In his work "Dimensions of Personality", Eysenck (1950) names two dimensions of human personality: Extroversion and Neuroticism. This distinction of different personalities led to the development of the Big-Five Personality Scale published by Costa and McCrae (1985). This scale distinguishes between five different personality traits: Conscientiousness, Agreeableness, Neuroticism, Openness to experience and extraversion. While all five personality traits will be measured in this study, the focus will be set on the personality of conscientiousness. Being part of different personality inventories such as the Neo-PI-R (McCrae & Costa, 2008) or the Interpersonal style inventory (Lorr, 1986), conscientiousness often is found to be an indicator of order (Lorr, 1986), will power and responsibility (Murray & Koucklohn, 1953). Individuals with high levels of conscientiousness are linked to a stronger inhibition of urges and impulses (McCrae & Costa, 1985) and logical and foresighted reasoning (McCrae, 1990). High scores of Conscientiousness predict a tendency for organized and planned instead of spontaneous behavior and the ability to regulate and redirect impulses (McCrae & Costa, 1992). In a more practical sense, research indicates, that Conscientiousness is a predictor on job success (Vinchur, Schippmann, Switzer, and Roth (1998), longevity and resistance to substance abuse (Bogg & Roberts, 2004; Friedman et al., 1995).

Conscientiousness and Stress

While research indicates, that there is a relation between stress and the other personality traits such as extraversion (Fowles, Roberts & Nagel, 1977; Glen, 1984 ; Hinton & Craske, 1977) or neuroticism (Burdick, van Dyck & Bargen, 1982; Houtman & Bakker, 1991) this research will focus on the relation between stress and conscientiousness. A relation between stress and conscientiousness has been found in several studies (Gramstad, Gjestad & Haver, 2013). Research led by Besser and Shackelford (2007) found that conscientiousness is related to an increase in stress management, stress tolerance and the ability to avoid stress through careful planning before a potential stressor occurs, giving the individuals more time and ressources to deal effectively with stress. Also high conscientiousness is believed to reduce stress by modifying the effects of daily stressors (Gartland, O'Connor Lawton & Ferguson, 2014). Research further indicates that higher conscientiousness predicts lower reactivity to daily stressors and can serve as a predictor for lower nervousness, which in turn can result in a lower stress level (Komulainen et al., 2014). Concerning physiological indicators of stress, there is evidence that conscientiousness is related to reduced daily concentration of cortisol, a steroid hormone that indicates stress (Nater, Hoppmann & Klumb, 2010). Furthermore, Brouwer and colleagues (2014) found a negative correlation between conscientiousness and heart rate during a period of induced stress.

Stress

Selye (1976) describes Stress as "the nonspecific response of the body to any demand" whereas the behavioral view describes stress as "the perception of threat, with resulting anxiety discomfort, emotional tension, and difficulty in adjustment" (Huther & Henry, 1991). Although those views might differ on how stress is exactly caused they both share the argument that stress triggers a physical response in the human body, which "is not something to be avoided" (Selye, 1975). One of the main effects of stress on the human body is the activation of the sympathetic nervous system, which is responsible for changes in skin conductance, heart rate, blood pressure and respiration (Custer & Van den Berg, 2010). Besides its effects on the nervous system, stress may also trigger the endocrine system, which on the other hand is responsible for the regulation and distribution of cortisol and adrenaline, (Dickerson & Kemeny, 2004). The stressors relevant for psychological stress can be categorized into symbolic and physical stressors. While physical stressors describe direct physical effects of energy on the organism, symbolic stressors describe stimuli that have an

aversive nature, meaning that people often connect them with unpleasantness (Teichner, 1968).

Measurement of Stress

Physiological stress responses have been determined by measuring blood pressure (Fibiger and Singer, 1984a), chemical stress indicators such as adrenaline of cortisol (Fibinger et al. 1984b) or electro-dermal activity (EDA) (Storm, 2000). Several researches indicate that EDA measurements provide a reliable and straightforward method to measure arousal induced by mental and physical stress factors (Kilpatrick, 1972). During this research, we have chosen to make use of Skin Conductance, which can be parted into two different measurements, namely tonic skin conductance level (SCL) and phasic skin conductance response (SCR) (Dawson et al, 2007). Boucsein described (2012) the tonic skin conductance level as the level of skin conductance in phases where no external stimuli are presented. The phasic skin conductance response on the other hand describes the rapid augmentation of the skin conductance, triggered by an external stimulus. It is mostly triggered by a specific event or external stimulation. (Boucsein, 2012). Skin Conductance is a measurement for the activity of the autonomic nervous system. This activity is mainly determined by the sympathetic branch, a predominant factor for stress (Boucsein, 2012). Furthermore SC can be seen as a reliable measurement. Several researches indicated, that SC increases in a reliable fashion under threatening or stressful conditions (Katin, 1975; Zeiner and Smith, 1979). In the course of this research, we have chosen to focus on the skin conductance response. Although mostly event-triggered, SCR can also be measured in a tonic, non-specific fashion. In our case this means, that instead of measuring event related responses in Skin Conductance, we measure the number of spikes during a specific period of time.

Inducing Stress

To test which effects stress can have on an individual, research makes use of stress paradigms. Those paradigms are mostly designed to elicit emotional stress in participants “in an easy, controlled and efficient manner, while respecting ethical standards with regard to experimental participants” (Brouwer & Hogerforst, 2014, p.1). To do so, a wide variety of paradigms and stress test can be used such as the Trier Social Stress Test (TSST) (Kirschbaum et al., 1993), in which the participants take part in a job interview. The tests consists of an anticipation phase, where the participants prepare themselves for a job interview in front of a jury, an interview and a recovery period. The interview starts with a

presentation hold by the participant followed an arithmetic task in which the participants counts backwards from 1022 in steps of 13. If he or she makes a mistake he is asked to start from the beginning. After the interview, the recovery period takes place. Apart from this test, other test can be used, which require less resources, such as the Socially Evaluative Cold Pressor Task (SEPCT) (Duncko et al., 2009; Schoofs, Wolf & Smeets, 2009) or the Computerized Mental Arithmetic task (MAT) (Hamada et al., 2006) which can be used to asses several participants at the same time. A recently developed paradigm is the Sing-a-Song Stress Test (SSST) which was developed by Brouwer and Hogerforst (2014). Based on the TSST (Kirschbaum et al., 1993), the SSST was developed to serve as a new stress paradigm which is less resource intensive, flexible in terms of usage possibilities and effectively inducing mental stress in the participants (Brouwer & Hogerforst, 2014). In this paradigm, the participants were placed behind a screen and given the instruction to silently read the appearing messages, while reducing their movement to a minimum. During the reading, the participant's skin conductance and heart rate was measured via electrodes. Also, a vital signs camera was used as a non-contact method of measuring heart rate. The appearing messages on the screen included neutral stimuli, in this case extracts from the Wikipedia article about vacuum cleaners and always appeared for sixty seconds (indicated by a counter descending from 60 to 0). After being exposed to nine neutral sentences, the tenth last sentence included the request for the participant to sing a song out loud. During the whole process a 'confederate' was present, who the participant believed to be another participant. Prior to the procedure, the participant were not told, that they had to sing or that the research was about measuring stress. After the research was completed, the SSST has been shown to be an effective means of inducing stress in individuals. Based on this research our current study will make use of an alternative version of the SSST including the assessment of personality traits and changes in stimuli and duration.

Current study

One of the main changes of our version in comparison with the former SSST is the choice of stimuli. While the former version used two different stimuli, the neutral sentences about vacuum cleaner and the request to sing, our version consists of four different stimuli including mildly mentally challenging tasks such as the silent recital of different sports, periods of full relaxation (the baseline), a period of stress-anticipation and a period of stress similar to the period in the former SSST. In this study, we are primarily interested in the skin conductance

measurements during the baseline, the anticipation and the period of stress (the singing phase).

Since skin conductance seems to be correlate positively correlated with mental workload (Verwey & Veltman, 1996), we have chosen to compare the baseline, instead of the neutral stimuli with the singing and anticipation phase. Based on the former version of the SSST, where the request to sing resulted in an increase in stress and the former named relation between stress and skin conductance response, we expect the mean number of skin conductance responses during the singing to be significantly higher than during the baseline phase. We further expect the stress level of a participant to rise during the anticipation of stress resulting in an increase of mean Skin Conductance. This lets us hypothesize that we expect a higher number of mean SCR during the Singing and the Anticipation phase than during the baseline phase of the Sing-a-Song Stress Test among all participants.

Another important change, which is implemented in our study, is the inclusion of the assessment in personality traits, mainly conscientiousness. This has two main reasons. First, there is not yet a clear relation between conscientiousness and SCR. Although other psychophysiological measurements such as heart rate seem to be strongly related to conscientiousness (Brouwer et al., 2014), the relation between conscientiousness and skin conductance has yet to be found out. Considering that high conscientiousness mostly predicts less stress and the relation between SCR and stress is strongly underlined, we expect high conscientiousness to correlate negatively with skin conductance. Secondly, most research on the relation between conscientiousness and stress relies on daily or chronic stress. Our intention is to clarify the relation between acute stress and conscientiousness. The SSST has been proven to be a means to induce sudden stress in an individual (Brouwer & Hogerforst, 2014.) Since former research indicated that overall stress correlates mostly negatively with conscientiousness, we expect the same trend to happen with acute stress. Applying those expectation to our paradigm we can hypothesize that we expect a higher number of mean SCR during the Baseline, Anticipation and Singing phase for the low conscientiousness individuals compared to the highly conscientiousness individuals.

Method

Participants

Participants are recruited via the Sona-Systems web based application provided and run by the University of Twente as well as personally recruited by the researchers. 65 participants took part. Due to either technical complications or inconclusive data, the data of 13 participants was not used for the further analysis, which leaves a total number of 52 participants. Of those participants 21 were male and 31 were female with an age ranging from 18 to 55 with a mean age of 22.07 and a standard deviation of 5.016 .The participants where either Dutch (n=30) or German (n=22). Participants received no monetary reward, but earned a point for a mandatory segment in their study, if needed. All participants signed an informed consent form (Appendix A) prior to taking part and received the means to form an official complaint against the researcher (Appendix B). The ethics commissioner allowed this research if participants were aware they could stop at any time without penalty. Participants were led to believe they took part in a study researching personality factors and their level of fitness. This deception is necessary to ensure no pre-selection from the potential participants occurs. The SSST relies on surprise and mentioning the singing aspect could deter certain individuals or give them ample time to prepare. We chose fitness level since the physiological measurements sensors have to be made public and fitness level could fit with heart rate and skin conductance measures.

Materials

Computers

Screen Instructions were shown on a windows operated personal computer functioning in lean mode. Lean mode is a special research mode that disables background services such as updating and internet functionality in general. The display was a 1280x720 60Hz flat screen monitor at approximately 60 cm from the participant. The assignments were shown by a script written in PsychoPy by Dr. M. Noordzij (available on request).

Screen Instructions

There are eight instructions that the participants are shown on the computer screen during the experiment. The instructions are displayed for five seconds and are followed by a timer counting down. Except for the first and the last instruction, the timer counts down from 30 to 1 with a speed of one step per second. After the first and the last instruction, the counter counts down from 120. The first instruction is for the participant to be as calm as possible and focus on their respiration. The next four instructions ask the participants to think of certain

items or subjects in a special category, without telling them out loud. The sixth instruction asks the participant to think of a song to sing out loud during the next instruction. The following seventh instruction is for the participant to sing a song out loud while the timer goes down. The last instruction is a repetition of the first one and ends the experiment. A full list of the instructions can be found in the attachments (Appendix C).

Questionnaires

The two questionnaires are presented on a windows operated laptop in the same room standing in a 90 degree angle from the windows operated personal computer. The two questionnaires are given in separate Tabs of the program Google Chrome. Both questionnaires are completely written in Dutch. The University of Twente has, due to its proximity to Germany and interesting psychology program, a large population of German speaking students. It was not feasible to offer translated versions of these questionnaires. It must be noted that German students have to pass the "Netherlands NT2" test prior to the start of their study. This is a standardized procedure to grant people who are not native Dutch speakers the possibility to work and study in the Netherlands. To accommodate these German students a wordlist with translated words was provided. In case, that this wordlist did not cover all of the unknown words the participants also where allowed either to ask questions to the researcher or look up the word on the internet.

NEO-FFI/IRS.

The Neo-FFI and IRS questionnaire was provided by the 'Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek' (TNO). It is a two-part questionnaire. While the first part is the NEO-FFI developed by Costa and McCrae (1992) to asses data about the five personality traits conscientiousness, extraversion, neuroticism, openness for experience and agreeableness (the "Big Five"), the second part of the questionnaire is the IRS questionnaire to asses data about the general life stress and stress coping of a participant. All the questions in this questionnaire are statements followed by a 5-point-Likert-scale. This scale ranges from 1 (totally agree) to 5 (totally disagree).

Demographic Questionnaire.

The demographic questionnaire was constructed by the researchers to gather additional data from the participants. In this questionnaire, the participants gave demographic information regarding age, gender, nationality and occupation. Also, they are asked several questions about their habits regarding smoking, drinking, medication or the use of other substances,

their sporting habits and their experience with singing. The full questionnaire can be found in the attachments (Appendix D).

Subjective Stress Measurements.

The subjective stress measurement is a measurement which takes place two times during the actual experiment. Each time, the participant has to indicate how stressed he is on a scale from 1 to 9. The assessment takes place at two different times. First the participant has to indicate how stressed he is “at the moment” prior to the first instruction. After completing all the instructions in the experiment, the participant has to indicate how stressed he felt “directly before the singing”, “during the singing” and “after the singing”. This provides us with a total of five measurements.

Sensors

Heart rate and skin conductance measurement equipment are part of the Biograph infiniti package. This equipment consists of the sensors further mentioned below, a voltage isolator with several measurement ports, an amplifier and the cable's to attach everything to a computer via USB. Python software was used to allow the serial port to function as a timer indicator when connected to the voltage isolator. The voltage isolator provides several channels with different measuring frequencies. The voltage isolator was connected to a secondary laptop running on windows to measure the Voltage Isolator pulses, SCR and HRV signals. These were plotted using Biograph infiniti™ software. Voltage isolator pulses corresponded with the assignments on the computer providing accurate starting times and consequently the time-frames later used for analysis.

SCR.

Skin conductance was measured using the SCR package from bio finite consisting of two wearable skin conductance sensors as well as the EDA wrist sensor. The skin conductance sensors are normally connected to fingers or toes with a strap while the conductive sensors are placed towards the skin. The wrist sensor was synchronized with the computer to be able to later match the startup time with the assignment windows since it is not a part of the Biofinity package.

EKG.

Heart rate was measuring using the EKG package from Biograph infiniti. This package consists of three sensors, each having a silver/silver-chloride electrode that need to be attached to the subject using reusable medical-grade, non-latex rubber tourniquets.

The SCR and HR sensors converge in two cables that are inserted in the amplifier (c) in port C (SCR) and port E (HR). The voltage isolator is inserted in port (H). The ports of the amplifier measure in different frequencies. In this case all the measurements are taken with a frequency of 256 Hz. The amplifier is connected via the voltage isolator to the computer and all the input is connected to the laptop via the TT USB transformer via a short optic fiberglass cable. The TT USB computer is plugged in the designated laptop running the Biograph infiniti software with a purposefully build channel and screen set, designed for ease of use. The screen shows real time heart rate and skin conductance levels, and the small peaks from the voltage isolator when an instruction is shown to the participant on the instruction computer. Sensors were attached to each participant as symbolically indicated in figure 1.

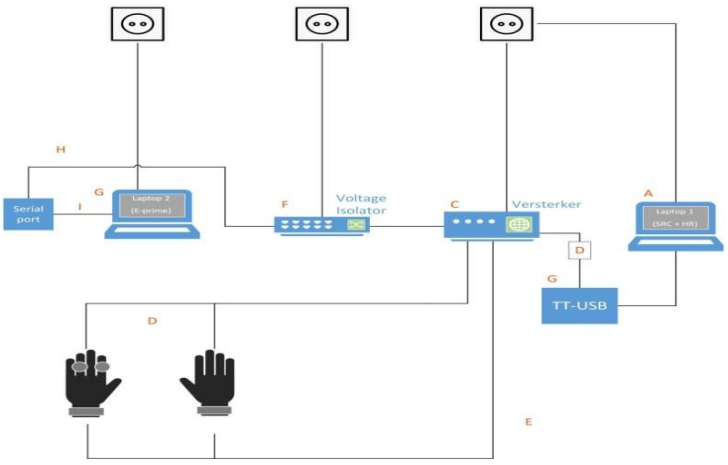

Figure 1: Schematic representation of the sensors and computers. A) Infiniti laptop, B) Fibre optic cable, C) Amplifier + 4 LR6A(1.5V) batteries, D) Finger sensors + cable, E) Heart rate sensors + cable, F) Voltage Isolator, G) TT-USB cable/Python PC, H) Custom db15 to serial port cable, I) Serial port cable

Procedure

Participants were instructed to make their way to the research lab located on the University premise. The research lab consists of a hallway with several smaller rooms to either side. The actual experiment took place in one of those small rooms. Prior to the start of the experiment the researcher explained the experiment briefly. Researcher and participant then both signed the informed consent. For the rest of the experiment the participant is provided with a number which he or she can use during the questionnaires to ensure anonymity. The participant is

asked to take place behind the computer for the IRS/NEO-FFI and demographic questionnaires and fill them both out. If the participant is of non-Dutch nationality he or she is further provided with a word list. The researcher then ensures the participant that he will be outside in case of questions and leaves the room. He asks the participant to knock if he or she completed both questionnaires.

After the participant finished the questionnaires, the research leader invites the confederate in the room as a second participant that gets his or her turn on the other computer later. To further strengthen the deception the confederate uses excuses such as being too early and/or greeting the participant by giving out a false name. Given the opportunity the researcher and the confederate improvise to ensure that the confederate is seen as another participant. The confederate is placed behind the infiniti laptop while the participant is relocated to the computer. This provides the illusion that the confederate is filling in the same questionnaires as the participant. After being asked to remove all jewelry and watches on both hands, the participant is attached to the sensors by the research leader as followed. The skin conductance sensors are placed on the middle phalanx of the index- and ring finger of the left hand. The researcher ensures, that the sensors are placed towards the skin of the fingers before closing the straps. The researcher also attached the EDA wrist sensor and the EKG sensors, but those measurements are beyond the scope of this research. While attaching the sensors on the participant the researchers explains each sensor and its functionality. After having placed all the sensors the researcher asks the participant if he has any further questions and answers them if necessary. Then the researcher asks the participant to reduce his movement to a minimum to ensure correct measurements and to get in a position where he or she can sit comfortably for eight to ten minutes. The recording function of the Biograph infiniti program is then started by either the researcher or the confederate before the instructions are started. The researcher further asks the confederate not to disturb or ask questions during the instructions.

During the experiment the researcher sits behind the participant. During the seventh instruction (the singing) the researcher may encourage the participant to sing, if he or she hesitates. He also reminds the participant to reduce his or her movement to a minimum. After the final sentence the researcher permits the participant to move again and he or she is asked to note their stress levels before, during and directly after the stressor took place. The measurements are stopped on the designated laptop and the experiment leader thanks the participant for his participation and the sensors are removed. The data is stored under the participant’s assigned number for later analysis and the link with their scores on the big five

and IRS test completed prior to this section. The participant is then informed about the deception and the true reason for the experiment and the SSST paradigm. Furthermore they are shown their results From the SCR and heart rate measurements. The researcher and the confederate explain the measurements to the participants if requested. Participants are asked if they believed the confederate was another participant or a researcher. The researchers also notes additional information. This information contains if the participant has really sung, if he started too soon or too early or if there were any additional complications during the experiment such as movement of the participant or technical difficulties with the sensors. The participants are asked by the researchers not to give any information about the research to other potential participants to ensure the authenticity of the measurement. Lastly, the participants are given contact information of all three researchers if they want to complain about the research, they also can leave behind contact information if they want to know more about the outcome of the research when completed.

Data Analysis

The following data analysis will be performed by using MATLAB and IBM SPSS Statistics Version 22. Per participant we will take the measurements of the number of Skin Conductance Responses during three measuring moments. The Baseline, the Anticipation (sixth instruction) and the singing (seventh instruction). Those will serve as dependent variables. Since the baseline phase is in total 2 minutes long, while the other phases are only 30 seconds long, we cannot take the measurement of the whole baseline. The baseline is split into four parts of respectively 30 seconds. We have chosen to take the second baseline interval for measurement. While the first interval of the baseline can still be biased by movement of the participant, the other baselines seem to be a better indicator. Due to the relatively long duration of the baseline, the participants could get nervous or distracted in the third and fourth interval of the baseline, which could result in an increase in skin conductance. We have chosen for the second interval of the baseline since we think that the participants are the most relaxed during this period. All preprocessing for calculating the mean number of responses per interval were performed with MATLAB by the instructor of this bachelor thesis (scripts available on request).

As independent variable we have chosen to use the conscientiousness score of each participant. Concerning the Conscientiousness score the participants were split into different independent groups based on research by McCrae and Costa Jr. (2004). In this revised version of the Neo-FFI questionnaire, 1492 participants filled in the questionnaire and had a mean

score of 33.48 on the Conscientiousness trait with a standard deviation of 6.36. To classify our participants, we chose to label the participants within one SD of the Mean as “Average”, those who score higher than one SD above the mean as “High” and those score two SD higher than the mean as “Very High”. The persons who score lower than one SD than the mean are labeled as “low” and those who score more than two SD lower than the mean are labeled as “Very Low”. This is further represented in Table 1.

Table 1

Labels of Conscientiousness including the score on conscientiousness in the NEO-FFI the number of participants in each group of Conscientiousness

Label	*NEO-FFI C-Score*	*N of participants*
Very Low	<20	0
Low	21-27	0
Average	28-39	16
High	40-46	22
Very High	>47	14

In this research 16 participants scored „Average“, 22 participants scored „High“ and 14 participants scored „Very High“ on Conscientiousness as seen in Table 1. There were no participants scoring “Low” or “Very Low”.

Prior to the analysis, we performed a Saphiro Wilk test to control for normal distribution among all the gathered data. The data for the baseline in the “very High” group and the data for the Anticipation in the “very High” group are not normally distributed with p=0,010 and p=0,007 respectively (Appendix E, Table E1). Since the data cannot be computed into being normally distributed by the means of a logarithmical transformation, we have chosen to use non-parametric methods of measurement in the following analysis. Also, since the data is not normally distributed and we make use of non-parametric methods, instead of the mean we will use the median (M), which is typically used with non-parametric tests (Pappas & Depuy, 2004).

For further analysis concerning the mean Skin Conductance response, we will define two sorts of effects. The “Anticipation-Stress-effect” and the “Singing-Stress-effect”. The “Anticipation-stress-effect” will be defined as a significant difference in skin conductance responses per measuring moment between the baseline and the anticipation. The Singing-Stress-effect will be defined as a significant difference in skin conductance responses per

measuring moment between the baseline and the singing. To see whether these effects took place, a Wilcoxon Signed Rank test is performed, indicating significant differences between the mean number of SCR during the three phases.

To analyze the relation between the groups of conscientiousness and the SCR, we performed several Kruskal Wallis tests to see if there are significant differences between the groups of conscientiousness during each of the measuring moments. In case of a significant difference between the groups of conscientiousness during one of the measuring moments, a Mann-Whitney-U test was performed to see between which groups of conscientiousness the significant difference can be found.

Results

Based on the Wilcoxon Signed Ranks Test, we can see, that there are significant differences between all three measuring moments concerning the mean number of SCR in all three groups (See Table 2). This means that the mean number of SCR is highest in the Singing phase (M=4, SD=1.98), followed by the anticipation phase (M=3, SD=1.78) and lowest during the Baseline (M=1.5, SD=1.71) among all participants. A graphical representation can be found in figure 2.

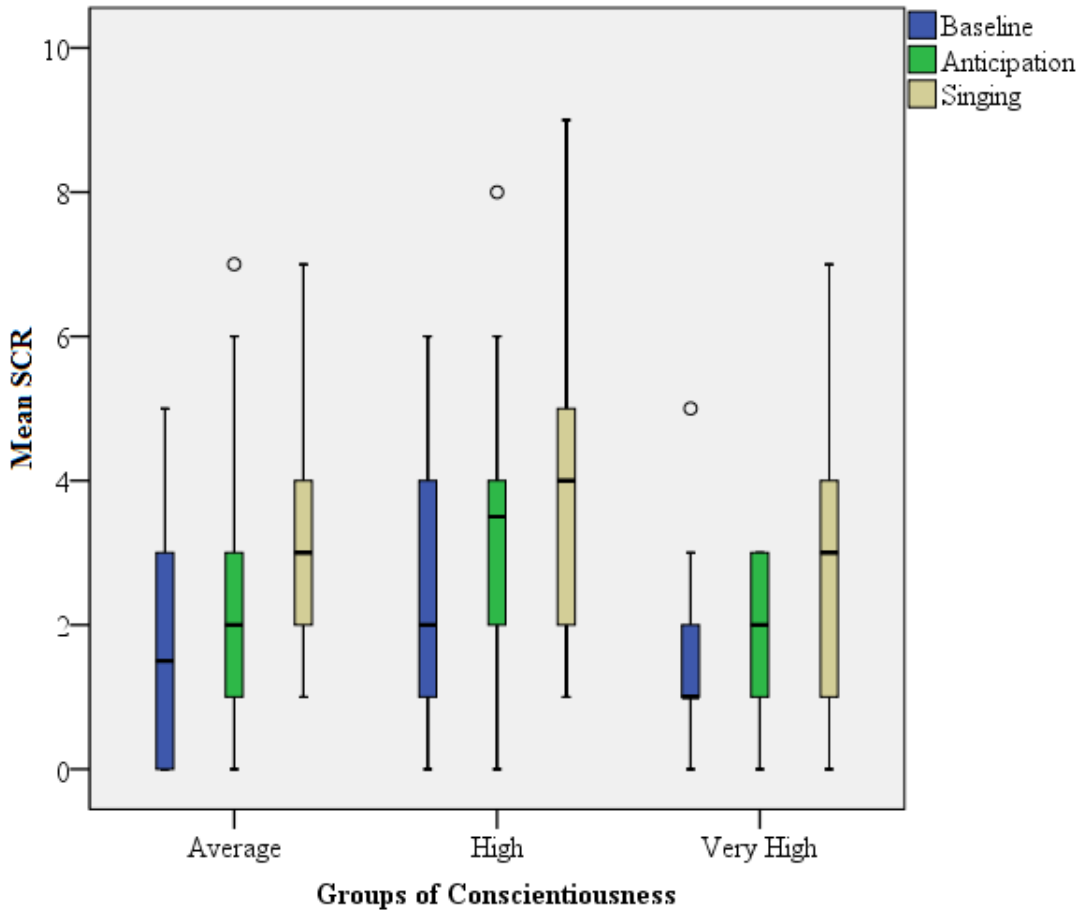

Figure 2: The number of SCR during Baseline, Anticipation and Singing for the three measuring moments in the three different groups of conscientiousness. The error bars represent the minimum and maximum SCR. The black lines indicate the median. The points above the plots represent outliers.

Table 2

Wilcoxon Signed Ranks Test of differences between the mean SCR during the three measuring moments in all individuals. A p value smaller than 0.05 indicates a significant difference

Source	*Z*	*p*
Anticipation – Baseline	-3.102	.002
Singing – Baseline	-4.749	<.001
Singing - Anticipation	-2.986	.003

By performing a Kruskal Wallis test, we can see, that there are significant differences between the groups of conscientiousness during the Anticipation phase (Chi-Square= 8.986, p=0.011). There are no significant differences of the groups during the measuring moments "Baseline" and "Singing" between the three groups. (Table 3).

Table 3

Kruskal Wallis test of the effect of the variable "Conscientiousness" on the three measuring moments A p value smaller than 0.05 indicates a significant difference between the groups of conscientiousness

Source	*Chi-Square*	*df*	*p*
	Three measuring moments		
Baseline	5.874	2	.53
Anticipation	8.986	2	.011
Singing	2.957	2	.228

To further investigate the differences of the groups during the anticipation, we performed several Mann-Whitney tests to test between which groups we can make out a significant difference. There is a significant difference between the "Very High" and the "High" group (z=-2.964, p=0.003). There is no further significant difference between the "Very High" and the "Average" group or the "High" and the "Average" group, but we should note that the difference between those two groups is not far from being significant. (Table 4).

Table 4

Mann-Whitney U test of the different groups of conscientiousness during the Anticipation phase. A p-value smaller than 0.05 indicates a significant difference between the two compared groups.

Source	Mann-Whitney U	Z	p
Very High – High	64.5	-2.964	.003
Very High – Average	92.5	-.837	.423
High – Average	115	-1.832	.073

Discussion

Based on the newly developed Sing-A-Song-Stress Test (SSST), a stress inducing paradigm to elicit social stress individuals (Brouwer & Hogerforst, 2014) we conducted research on the relation between the personality trait of conscientiousness and skin conductance. To do this, an alternate version of the SSST was developed and implicated in laboratory research with the addition of the NEO-FFI to assess personality traits in individuals. The aim of our study was twofold. On the one hand, we wanted to test whether our version of the SSST can elicit stress in a similar fashion than its predecessor. On the other hand, we wanted to clarify the relation between the skin conductance and conscientiousness.

Main Findings

One of the main objectives of this research was to test whether our version of the SSST fulfills the requirement of inducing stress in individuals. In terms of skin conductance, our version of the SSST has proven to be an effective means to do so. Considering the significant difference in mean skin conductance responses during the Anticipation and during the singing in comparison with the baseline we can say that the former named “Anticipation-Stress Effect” and the “Singing-Stress effect” took place in all participants, which supports our first hypothesis. The former version of the SSST already featured a variety of advantages in comparison to other paradigms such as the TSST. Those advantages involved shorter duration, the feature of a sudden, clear stressor, the possibility of investigating physiological response in a short time window and minimized equipment (Brouwer & Hogerforst, 2014). In addition to those advantages, our version of the SSST reduces the resource cost to one confederate. Furthermore our paradigm featured an additional baseline phase before and after the screen instructions. By this, the paradigm does not only feature neutral or stressful stimuli, but also periods of time where no additional external stimulation takes place.

Another objective of the study was to find out whether there was a difference in SCR between individuals depending on their score on conscientiousness. Although people in the “Very High” group had a significantly lower number of mean SCR during the anticipation phase, we did not find a similar relation during the other two phases. Neither did we find any significant differences between “Average” and “High” Conscientiousness or “Average” and “Very High” Conscientiousness. Prior to this research we hypothesized that stress in the individuals in our research will correlate negatively with their level of conscientiousness. This means that the higher the level of conscientiousness, the lower the expected stress. Our research cannot fully confirm this expectation. Since the measures of skin conductance clearly

indicated stress to be higher during the anticipation and the singing than in the baseline in all individuals, we can rule out a lack of stress as a problem for these unclear results. Research led by Brouwer and colleagues (2014) did in fact find a negative correlation between stress and conscientiousness measured by heart rate, but not in skin conductance. Unfortunately, the measurement of heart rate in the experiment was beyond the scope of this study so that no further explanations can be given. Still, the existing data set provides information for further examination of this relation. A possible explanation could be a lack of time for the individuals to prepare themselves. In research led by Besser and Shackelford (2007) high conscientiousness was related to high stress tolerance because the participants scoring high on conscientiousness where better organized, leaving them more time to effectively deal with stress. In our research the stressor was sudden and unexpected, which left the participants hardly any time to prepare themselves.

Limitations

In our study, we tried to classify our participants in five different groups of conscientiousness based on research by McCrae and Costa Jr. (2004). These groups ranged from “Very Low” to “Very High”. Unfortunately all of our participants were scoring in such a manner that they were classified “Average” or higher. In this case we do not have any participant in the groups “Very Low” and “Low”. Since we did not have any participants in the lower groups of conscientiousness trying to find an answer on the second hypothesis was limited. The second hypothesis we stated included the difference between high conscientiousness and low conscientiousness individuals. Since there were no participants that could clearly be defined as low conscientiousness (classified as “Very Low” or “Low”) it is difficult to release any clear statements about this hypothesis. The absence of two groups of conscientiousness can be a result of two different factors. On the one hand our sample of individuals can be exceptionally high on conscientiousness resulting in no persons in the lower two groups. On the other hand the norm scores we used to categorize the individuals may not be suitable for this research. A possible implication for further research and analysis could be the comparison with other norm scores and, if suitable, the replacement of the old ones. As possible other norm scores those proposed by Hoeksstra, Ormel and De Fruyt (1996) could be used. Also research led by Salter-Pedneault, Ruef and Orr (2010) proposed the use of Neo-Pi-R scoring software (Costa & McCrae, 1992) to calculate t-score profiles for each participant, which could be used to categorize them in terms of personality traits.

Future research

While the relation between conscientiousness and stress still remains unclear our version of the stress paradigm has been shown useful to induce stress under controlled laboratory conditions. Due to its flexibility and relatively low resource costs, the test is suitable for many further implications regarding stress.

Factors that are often related to stress are health and health related behavior (Quick, Murphy & Hurrell Jr., 1992). Individual differences in stress can be a result of sleep of food deprivation (Coenen & Van Luijtelaar, 1985) or the abuse of substances such as marijuana, alcohol or cigarettes (Taylor, 2004). Our version can be used to further clarify the relation between health behavior and Stress. It already contains two valid measurements for stress, skin conductance and heart rate and can easily be combined with health related questionnaires such as The Personal Experience Screening Questionnaire (PESQ) (Winters, 1992).

Future research can also be carried out in the field of stress and different coping mechanisms. The SSST can be used in combination with measurements of coping. By using general measurements of coping such as the coping style questionnaire (Roger, Jarvis & Najarian, 1993), we can further clarify the role coping styles and psychophysiological measurement. Hereby the effectiveness and impact of different coping styles can be further analyzed since this is a factor which needs further clarification (Oakland & Ostell, 1996). The paradigm can also be used to study coping flexibility as measured by the Flex (Schwartz and Daltroy, 1991) and a modification of the Ways of Coping Checklist (Folkman and Lazarus. 1980) in combination with Skin Conductance.

In addition further research can be carried out regarding the relation between the subjective experience of stress and psychophysiological measurement. Research indicates that stress also can be seen as a subjective experience which depends on the evaluation of the situation (Cooper, Dewe & O'Driscoll, 2001; Lazarus, 1993). It is also suggested that subjective stress and physiological measurements can have influence on each other (Bell et al., 2001). Further research can be carried out to further clarify this relation. The inclusion of the subjective stress measurement in our version of the SSST makes this paradigm suitable for research in this field.

Conclusion

In conclusion, our research has proven the point, that our version of the SSST increased stress in all participants. The expected Anticipation-Stress effect and Singing-Stress effect both took place. This means that our test can be put in line with other similar stress

inducing paradigms such as the TSST or the MAT. We could not confirm any differences between High- and low conscientiousness individuals in terms of mean SCR. This problem can be due to the main limitation, namely the missing comparison with low-conscientiousness, a problem that could be solved in future research via different norm scores. Furthermore we can agree with Brouwer and colleagues (2014) that the relation between conscientiousness and physiology still remains unclear and more research has to be carried out. Nevertheless has our version of the SSST proven the point to be an easy, low-resource means of inducing stress which makes it suitable for further research. This possible further research includes the extension of the theoretical framework about stress in relation with factors such as health or substance abuse, coping or the relation with subjective measurements of stress.

Acknowledgements

Thanks to the Nederlandse Organisatie voor toegepast-natuur-wetenschappelijk onderzoek (TNO) for providing the NEO-FFI and IRS questionnaires. Thanks to Ward Venrooij (TNO) for setting up the online-questionnaire processing the data of the participants. Thanks to the University of Twente for providing the hard- and software used to measure heart rate and skin conductance.

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Appendices

Appendix A
Informed Consent

Ik, …….. (*naam proefpersoon)*

Stem hiermee toe mee te doen aan een onderzoek dat uitgevoerd wordt door

Imke Silderhuis, Lars Nijboer en Sascha Jenderny

Ik ben me ervan bewust dat deelname aan dit onderzoek geheel vrijwillig is. Ik kan mijn medewerking op elk tijdstip stopzetten en de gegevens verkregen uit dit onderzoek terugkrijgen, laten verwijderen uit de database, of laten vernietigen tot 24 uur na het onderzoek.

De volgende punten zijn aan mij uitgelegd of anders zijnde duidelijk gemaakt:

1. Het doel van dit onderzoek is het onderzoeken van de samenhangen tussen persoonlijkheidskenmerken en niveau van fitness.
2. Er zal mij gevraagd worden vragenlijsten in te vullen en diverse taken gepresenteerd via een computer uit te voeren.
3. Ik ben mij ervan bewust dat tijdens een deel van het onderzoek mijn (HR) hartslag en SCR (Skin Conductance Response) worden gemeten. Ook ga ik ermee akkoord dat de apparatuur om dit te meten aan mij worden aangesloten door een van de onderzoekers.
4. Tijdens het onderzoek zal ik de instructies, die mij door de onderzoekers worden gegeven uitvoeren.
5. Het hele onderzoek zal ongeveer 60 minuten duren. Ongeveer 15 minuten hiervan bent u verbonden aan de meet-apparatuur. De resterende tijd bestaat uit het invullen van vragenlijsten. Aan het einde van het onderzoek zal de onderzoeker u een briefing geven over dit onderzoek.
6. De gegevens verkregen uit dit onderzoek zullen anoniem verwerkt worden en kunnen daarom niet bekend gemaakt worden op een individueel identificeerbare manier.
7. De onderzoeker zal alle verdere vragen over dit onderzoek beantwoorden, nu of gedurende het verdere verloop van het onderzoek.
8. Ik heb de mogelijkheid om de eindresultaten van het onderzoek in te zien, zodra ik dit wil en de onderzoekers mijn contactgegeven (E-Mail Adres) geef.
9. Deelnemers aangesloten via Sona-Systems krijgen 1 punt toegewezen na complete afloop van dit experiment, ongeacht de beslissing de persoonlijke data te laten vervallen.

Handtekening onderzoeker: …… Datum: ……..

Handtekening proefpersoon: …… Datum: ……..

Appendix B
Contact Information

Procedure wegens persoonlijk contact.

Gedurende dit experiment wordt u aangesloten op apparatuur om hartslag en huidgeleiding te meten. Deze apparatuur bestaat uit twee polsbanden met sensoren en twee sensoren voor de wijs en ringvinger van uw linkerhand. Daarnaast wordt er een EDA meter aangesloten. Deze worden door de onderzoeker bij u aangebracht. Hier hoort geen risico of ongemak uit voort te vloeien. De apparatuur draagt u ongeveer 15 minuten terwijl u instructies op een scherm opvolgt. Het gehele experiment duurt maximaal 1 uur.

Wegens persoonlijk contact is het gebruikelijk de gegevens van de onderzoekers mee te geven aan de deelnemers van het experiment. Tevens staan hieronder de gegevens vermeldt waar eventuele klachten kunnen worden ingediend waarover u van mening bent dat dit niet bij de onderzoekers achtergelaten dient te worden.

Het experiment wordt uitgevoerd door;

Naam onderzoeker	E-mail	Telefoonnummer	Adres
Lars Nijboer	xxxxxxxxxxx	(mob) 06xxxxx	xxxxxxxxxxx
Imke Silderhuis	xxxxxxxxxx	(mob) 06xxxxx	xxxxxxxxxxx
Sascha Jenderny	s.jenderny@student.utwente.nl	(mob) 06xxxxx	xxxxxxxxxxx

Bij klachten over de onderzoekers of over de procedure kunt u deze indienen bij de secretaris van de ethische commissie te bereiken op het mailadres; j.rademaker@utwente.nl toe behorend aan Drs. Janke Rademaker werkzaam bij de vakgroep BFD.

Appendix C
Full list of Screen Instructions during the SSST.
A full list of screen instruction given to the participant in the SSST. The time next to an instruction indicates the time, which the instruction rests on the screen. The onscreen

sentences are as followed, but translated into English. The original sentences are given in Dutch.

Screen instructions	**Time**
Sit calmly, relax and try to focus on your breathing	(2 min)
Think of as many animals starting with the letter P	(30 sec)
Think of stuff one can find in a kitchen	(30 sec)
Think of necessary items when organizing a wedding	(30 sec)
Think of as many team sports practised without a ball	(30 sec)
In the upcoming assignment, you will sing a song.	
Try to come up with songs to sing to your fellow students.	(30 sec)
Now sing your song for 30 seconds aloud! Try not to move.	
Keep singing.	(30 sec)
Sit calmly, relax and try to focus on your breathing	(2 min)

Appendix D
Demographic Questionnaire

In de volgende vragenlijst wordt u gevraagd om vragen over middelengebruik, gezondheid, zingervaring en algemene demografische gegeven te beantwoorden. In totaal bestaat de vragenlijst uit 28 vragen. Wij vragen u om deze vragenlijst zo volledig en zo waarheidsgetrouw mogelijk in te vullen. Tijdens het invullen is de onderzoeker voor eventuele vragen beschikbaar. De resultaten worden helemaal anoniem verwerkt.

Demografische Gegevens

Voer hier uw (Sona)-Proefpersoonnummer in :

_____

1. geslacht:

• Mannelijk

• Vrouwelijk

2. nationaliteit:

• Nederlands

• Duits

• anders, namelijk: _____

3. Hoe oud bent u?

___ jaar

4. U bent op dit moment

• Student

• Scholier

• werkend

• gepensioneerd

• werkloos

• anders, namelijk: _____

5. Hoe heeft u van dit onderzoek gehoord?

• -De Onderzoekers zelf

• -Sona-Systems

• -Vrienden

• -anders, namelijk: _____

Drugs- en middelengebruik

6. Rookt u?

• Ja

• Nee → verder na vraag 8.

• Nee, ik ben _____ maanden/jaren geleden gestopt → verder na vraag 8

7. Hoeveel sigaretten rookt u gemiddeld ongeveer per dag?

___ sigaretten per dag

Heeft u in de twee uur voorafgaand aan het onderzoek gerookt?

- Ja

- nee

8. Drinkt u wel eens alcoholhoudende dranken?

• Ja

• Nee → verder na vraag 11.

10. Hoeveel glazen alcohol drinkt u gemiddeld ’per week?

___ glazen

Heeft u in de twee uur voorafgaand aan het onderzoek alcohol gedronken?

- Ja

- nee

11. Gebruikt u regelmatig medicijnen?

• Ja

• Nee → verder na vraag 14.

12. Welke medicijnen gebruikt u? (Indien u dit niet wil delen, wilt u dat dan aangeven)

_____

13. Hoe vaak gebruikt u deze medicijnen per week?

___ dagen per week.

14. Drinkt u wel eens cafeïne houdende dranken?

• Ja

• Nee → verder na vraag 17

16. Hoeveel drinkt u gemiddeld?

___ kopjes per dag

Heeft u in de twee uur voorafgaand aan het onderzoek een cafeïne houdende drank gedronken?

- Ja

- nee

17. Rookt u wel eens Cannabis?

• Ja

• Nee → verder na vraag 20.

19. Hoe vaak rookt u gemiddeld Cannabis?

___ dagen per week

20. Gebruikt u nog andere middelen of Drugs (zoals cocaine, MDMA, Ecstasy, Speed, Amphetamine, etc.)?

• Ja

• Nee → verder na vraag 22

21. Indien ja, noem a.u.b. welke middelen u verder nog consumeert en hoe vaak u dit doet.

Middel Gemiddelde Dagen per week

Gezondheid

22. Leidt u onder ernstige klachten of chronische ziekte?

• Ja

• Nee → verder na vraag 24.

23. Indien ja, welke:

_____

24. Hoeveel dagen per week bent u gemiddeld aan het sporten?

___ dagen per week. (Indien u 0 dagen aan het sporten bent, sla de volgende vraag over)

25. Hoe veel uren bent u op zo'n dag gemiddeld aan het sporten?

___ uren per dag.

26. Hoe intensief sport u gemiddeld?

0 niet intensief 0 gemiddeld intensief 0 zeer intensief

Zingen

28. Zingt u wel eens?

- vaak

- soms

- (bijna) nooit

29. Zingt u wel eens in de aanwezigheid van anderen (bijvoorbeeld huisgenoten)?

- ja

- nee

27. Heeft u ervaring met zingen in het openbaar (koor, band, musical, professionele zanglessen,

etc)?

• Ja

• Nee

28. Heeft u ervaring met solo (alleen) zingen in het openbaar?

• Ja

• Nee

29. Heeft u ervaringen met solo(alleen) a capella (zonder instrumenten) zingen in het openbaar?

• Ja

• Nee

Bedankt voor het invullen. U kunt de vragenlijst nu aan de onderzoeker terug geven.

Appendix E
Normality Distribution

Table E1

Test for normal distribution of the mean SCR per measuring moment split into the three different groups of conscientiousness. A p value smaller than 0.05 indicates that the data is not normally distributed and indicated by a star (*).

Moment	Group	Shapiro-Wilk		
		Statistic	*df*	*p*
Anticipation	Average	.902	16	.087
	High	.949	22	.308
	Very High	.823	14	.010*
Singing	Average	.928	16	.228
	High	.918	22	.071
	Very High	.926	14	.267
Baseline	Average	.932	16	.265
	High	.938	22	.180
	Very High	.813	14	.007*