

Utilisation of a social robot as a means to reduce stress among students: an experiment

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Abstract

Performance pressure focuses on the effort towards enhanced performance. There have been many experimental studies who have shown the effectiveness of abbreviated progressive muscle relaxation therapy, otherwise known as PMRT for a number of medical conditions and psychiatric disorders and plays a major role in treatment of anxiety disorder, as well as panic disorders. Other studies have shown that introducing a social robot (for instance, the Paro) can reduce stress, improve the mood and encourage interaction between humans and robots, and between humans themselves. The SAMBuddy cuddle has a similar exterior as the Paro as well as the possibility to save sound recordings. Therefore, the SAMBuddy cuddle will be introduced to students and will use PMRT techniques as an intervention for performance stress. The data for this study was collected through the results of a questionnaire completed by participants during two separate experiments. Each participant completed two identical questionnaires before and after the experiment. The results of the MANOVA display that there is a non-significant difference in the results between the control group ($N = 20$) and experimental group ($N = 24$); $F(2.41) = 1.815$; $p = .176$.

The aim of this research was to research if the SAMBuddy cuddle had an effect on university of applied sciences students. According to the results, the p-value is not significant meaning no hard conclusions can be drawn. Ultimately leading to the fact that the SAMBuddy cuddle had neither a positive nor a negative effect on the stress students experience. However, the limiting factors of this study need to be kept in mind.

I. INTRODUCTION

Stress is an increasing social factor that can have a negative effect on the individual as well as society as a whole [1] [2] [3]. Long-term or chronic stress can eventually lead to various psychological complaints such as depression and anxiety disorders [1] [2] [4] [5]. Psychological problems can manifest in physical complaints such as tense muscles, cardiovascular diseases and a weakened immune system, which makes a person more susceptible to various (infectious) diseases [1] [2] [4] [6]. If no (preventive) measures are taken, these complaints can eventually transform into a burnout [1] [2] [7].

Stress begins in the brain and it affects the brain, as well as the rest of the body. Acute stress responses contribute to adaptation and survival through responses of neural systems [8]. Psychological stress is frequent in adolescents and usually stems from school [9]. Students in tertiary education face a wide span of stressors related to academic demands. Research has shown that academic related stress can reduce academic achievement, decrease motivation and increase the risk of dropping out. A long-term effect of academic related stress is the reduced probability of sustainable employment [10]. Available evidence suggests that students who are experiencing stress for a longer period of time, report an increased incidence of anxiety, insomnia,

depression, loss of appetite and impairments in academic functioning [2] [11] [12] [6] [3] [13] [14] [4]. When exposed to persistent stress, people tend to retract from social interactions and become irritable and hostile on a regular basis [15]. This eventually leads to a predisposition for antisocial behaviours, with social detachment and violence being included [15] [5]. The notion that the previously mentioned factors could have a negative contribution on the career of the person, as well as society as a whole is therefore a plausible hypothesis.

In 2013, The World Health Organization (WHO) stated that presumably mental diseases, including stress-related disorders like depression and anxiety, will be the second leading cause of disabilities by 2020 [16]. Occupational stress alone has been estimated to cost several hundred billions of USD per year in absenteeism [10] [16], reduced productivity and medical and insurance costs in the United States of America [16]. Despite the fact that the consequences of stress entail increased healthcare costs, evidence shows that stress among employees and students has a negative impact on individuals, institutions and society as well [17] [18] [5] [7] [19] [20] [21]. Besides the economical consequences, stress can impact the brain and have a lasting effect on the structure and function of the brain circuitry, leading to long lasting changes in the behaviour of the individual [22].

Stress causes employees to be less productive, which increases the chances of resignation [5] [7] [19].

Resignation can affect one's mental health negatively [23].

Employees who are less productive due to stress make mistakes more often, have difficulties completing or starting tasks properly and coping with the workload, which can lead to overstimulation and conflicts with colleagues [21] [5].

Stress is a social problem that manifests itself in all parts of the world [16] [10] [17] [18] [5] [7] [19] [20] [21]. There are sufficient indications to assume that stress among students affects Dutch students as well. In 2021, the Dutch government urged universities to devise a preventive approach to prevent or reduce stress and performance pressure among Dutch students [6] [24] [25]. According to [24] and [6], students feel most stressed about their busy schedules, finances, studies, and future. Roughly 40 percent of all Dutch students state that they are stressed regularly and 63 percent state they suffer from performance pressure. This stress often leads to irritability, anger, aggression, insomnia and a loss of appetite [24]. Performance pressure focuses on the effort towards enhanced performance [26]. Nearly all students experience stress pursuing educational goals [27].

Progressive muscle relaxation otherwise known as PMR, was first discovered by Jacobson in 1934. PMR was identified as the tensing and releasing of 16 muscle groups.

In 1973 Bernstein and Borkovec studied adjustments to the technique, to fit the behavioural stress management. A few of those adjustments were relaxation through recall, recall and counting and just counting [28].

Progressive muscle relaxation therapy otherwise known as PMRT [29], plays a major role in treatment of anxiety disorder, as well as PMRT has been found to be effective against panic disorders [30]. PMRT is easy to practise without supervision and can be practised in any location without additional side effects. PMRT reduces muscle tension, blood pressure, breath and heart rate, and has a positive effect on the quality of life and stress levels [29]. There have been many experimental studies who have shown the effectiveness of abbreviated PMRT for a number of medical conditions and psychiatric disorders. However, only a few of those studies have researched the muscle tension between patients and healthy participants before treatment, or have shown that PMRT influenced muscle tension. Some researchers have considered PMRT to be no more than a ‘psychological placebo’ [30].

Social robots may be an effective way to decrease stress in adolescents, and thereby improving mental health [9]. Studies have shown that introducing a social robot (for instance, the Paro) can reduce stress, improve the mood and encourage interaction between humans and robots, and between humans themselves [31]. However it is still unclear whether a social robot is just as capable to reduce stress as a conventional method [32]. The SAMBuddy cuddle is a stuffed animal robot filled with hardware components [32]. As the SAMBuddy cuddle has a similar exterior as the Paro, the SAMBuddy cuddle will be introduced to students and will use PMRT techniques, stress levels will be measured through the use of a questionnaire.

With the gained knowledge as described previously, the research question of this study is: ‘‘Does the SAMBuddy cuddle have an effect on stress reduction in students who experience performance pressure?’’

II. BACKGROUND

Social robots can be used for different purposes such as palliating mental health issues [33], a tutor for primary school children [34], peer learners [35], companions [36] and as service providers in the hospitality industry [37]. [38] describes a social robot as ‘‘an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioural norms expected by the people with whom the robot is intended to interact.’’ Despite the fact that there are many possibilities in the field of social robotics, not enough studies have been conducted to determine to which extent social robots actually make a positive contribution in different fields [35] [39] [40]. [41] states there is limited evidence that social robots can contribute to improved mental health as well as interventions by providing comfort or coaching and therefore, the use of social robots in different contexts should be handled with extra care. Another research states that the popularity of (social) robots can contribute to ‘overthrust’ in which people’s expectations and the capabilities of the robot do not match and can result in disappointment [42]. Due to the limited number of studies and data, it is of great interest to research social robots in

different settings and the effect of its presence on people. This research will use the social robot ‘The SAMBuddy cuddle’ to research whether the use of a social robot contributes to stress reduction among students. The SAMBuddy is a social robot in the form of a cuddly toy. The goal of the SAMBuddy is to support children in their social-emotional development through conversations. The SAMBuddy cuddle is around 40-50 centimetres and designed this way to make it easier to hold. The SAMBuddy cuddle features a question and record button and has the ability to play music. The recordings can be listened to by parents, guardians or teachers throughout the use of an app [43]. Earlier research with the SAMBuddy cuddle has shown that the cuddle is able to establish trustworthy relationships with children and has shown that children can comfortably interact with the SAMBuddy cuddle [32]. For this reason the SAMBuddy cuddle has potential to be involved in stress reduction circumstances.

Stress

The definition of ‘‘stress’’ was first coined in 1936 by Hans Selye, a Canadian-Austrian physician who defined it as: ‘‘The nonspecific response of the body to any demand [44].’’ The definition has changed several times over the years and it became clear that different disciplines used different definitions. The behavioural sciences (like psychology) used the definition: ‘‘perception of threat, with resulting anxiety discomfort, emotional tension, and difficulty in adjustment [44].’’ Finally, the mechanical engineering discipline used the word ‘stress’ for a completely different purpose: The measure of what materials feel from externally applied forces [45]. In 1991, Richard Graveling mentioned the importance of an unambiguous definition for stress for the first time. By using different definitions, it is more complicated to research stress, understand the definition, take it seriously and develop (preventive) interventions [46]. George Engel introduced the biopsychosocial model in 1977 that explains mental and physical disorders on the basis of biological, psychological and social factors [47]. The World Health Organisation, otherwise known as the WHO, a specialised agency of the United Nations that has a guiding as well as a coordinating role in the health and well-being of member countries, adopted this model and described the definition of stress based on the model. Today, the majority of the world uses the WHO definition of stress: ‘‘Work-related stress is the response people may have when presented with work demands and pressures that are not matched to their knowledge and abilities and which challenge their ability to cope’’ [48].

Burn-out

As mentioned previously, long-term or chronic stress can eventually lead to a burnout [2] [5] [3]. The term ‘burnout’ is a commonly used term while at the same time, there is no unambiguous definition available. It is not uncommon to see the word being used in different literature with no further explanation which can result in an interpretation which differs to a great extent among different people [2] [3]. The World Health Organization (WHO) defines ‘burn-out’ in the 11th Revision of the International Classification of Diseases (ICD-11) as follows [49]:

“Burn-out is a syndrome conceptualised as resulting from chronic workplace stress that has not been successfully managed. Burn-out refers specifically to phenomena in the occupational context and should not be applied to describe experiences in other areas of life [49].”

The WHO limits the definition to the occupational context [49] while several studies apply the word in an academic, familial or leisure context [50] [12] [51] [52].

Stress among students

Universities have admission requirements, often in the form of a mandatory previous education or knowledge level or a minimum average mark for an entrance exam [17] [44]. Although these admission requirements can offer many advantages such as students finding out more quickly whether a program or study really suits them, there are also many disadvantages that should be taken into account [17]. [17] states that students from 'under-presented groups' often obtain lower grades and therefore do not have the opportunity to start with a study. The same research also indicates that no major differences have been observed between students from these circles and students from 'overemphasised groups' in obtaining a degree [17]. Broadly speaking, both groups seem to obtain a diploma within the same period of time regardless of their previous education or average grades [17]. The study states that many students who do have the capabilities drop out of university or do not start with a study because the demands of universities are not working in their favour. [17] States that the students with the lowest entry grade were 2.17 times more likely to drop out. One of the most noteworthy risks for dropping out is the incapability of students to keep up with academic demands [17]. However, [44] states that equality of opportunities in access to higher education does not guarantee equality of success. The study reveals that even when different obstacles are reduced by universities (like lower fees or less admission requirements), students from 'under-presented groups' are more likely to drop out and are less likely to obtain a diploma [44]. The same study states that these groups experience a lot of stress because they often have to deal with expectations that they cannot meet immediately but do want to meet, causing them to overload themselves with academic pressure [44]. Performance pressure is the primary stress factor among students and the reason why it is important to look for ways to reduce this stress among students for their mental well-being [6] [44] [28] [24].

III. RESEARCH METHODS

The goal of this research is to study if the SAMBuddy cuddle has an effect on stress reduction in students who experience performance pressure. To achieve this goal the following have been chosen. The participants will be randomly divided into two groups: the experimental group and the control group. The experimental group will undergo a PMR-session for three minutes with The SAMBuddy Cuddle, while the control group will solely hug with the cuddle. Both groups will complete the same questionnaire before and after the experiment. The collected data will be analyzed in order to identify whether there is a difference between the results before and after the interaction with the

cuddle, as well as a possible difference between the results of the experimental and control group. The experiments will be conducted over a period of two weeks.

Questionnaire

The questionnaire consists of thirteen questions which are adopted from the Beck Youth Inventories 2nd Edition (BYI-2-NL) and are modified to fit the current research. The BYI-2-NL itself consists of five self-report questionnaires that can be combined with one another or used separately. The questionnaires originally measured to what extent children or teenagers experience symptoms of depression, anxiety, anger, disruptive behaviour and self-image problems. The questions are adapted from the scales of depression and anxiety because the symptoms from these scales can occur in students who experience stress as well. The questions are edited to make it suitable for adults in the age category 18 to 30 which is tested through a pilot test. Originally, the BYI-2-NL was administered using a four-point Likert scale. For this research, the researchers converted the scale to a five-point Likert scale on which people can answer with (1) strongly disagree, (2) disagree, (3) neutral, (4) agree and (5) strongly agree where the following applies: the higher the score, the more likely it is that students experience stress. The five-point Likert scale was specifically chosen because it is considered to be a simple scale and therefore, offers a reliable outcome [53] [54]. According to [53], respondents are less likely to fill in extremes when asked for an opinion or assessment. With a seven-point scale, there is a chance that the respondents do not understand the answer options and as a result give incorrect answers [53] [54] [55]. With a three or four-point Likert scale there is a high chance that the respondents will be forced to think in extremes which can result in unreliable data [53].

Reliability

Prior to the analysis of the results, a reliability analysis has been conducted in SPSS to research whether the questionnaire is reliable. The questions 11 and 12 have been recoded because of the fact that a high score on these questions would indicate that the respondents do not experience stress. The questionnaire consists of one scale and is reliable (N of items = 12; $\alpha = .768$). As an individual item, question 13 has a Cronbach's Alpha in the minus ($\alpha = -.028$). The question was not clear and interpreted differently by each respondent, this was captured while filling in the questionnaire. To guarantee the overall reliability, it has been decided to delete the question and therefore, it will not be included in the further analysis of the results.

IV. RESULTSⁱ

Participants

The participants are Dutch University of Applied Sciences students in the age category eighteen to thirty years old. The students will be randomly selected and no personal data will be collected other than sex.

Setting

The experiments were collected in a quiet classroom. The setting for each experiment was standardized to ensure the reliability of the experiment.

Data

The data for this study was collected through the results of a questionnaire completed by participants during two separate experiments. Each participant completed two identical questionnaires before and after the experiment.

The results are statistically significant if $p < 0.05$. When two sample variances are nearly equal, the F -value will be close to one which means the null hypothesis can be accepted. The results of the MANOVA display that there is a non-significant difference in the results between the control group ($N = 20$) and experimental group ($N = 24$); $F(2.41) = 1.815$; $p = .176$.

As shown in figure 1 and 2, the box plots display a summary of the data. Figure 1 displays the data before the interaction with The SAMBuddy cuddle and can be interpreted as follows:

25% of the scores fall below the (first) lower quartile value which means the minimum score is 2.42 for the control group (C) and 2.33 for the experimental group (E). The median marks the midpoint of the data and is displayed by a division line in the middle (Mdn. of C = 3.21; E = 3.29). Half the scores of the median are either $>$ or $=$ 50%. 75% of the scores fall below the third (upper) quartile (C = 3.58; E = 3.67). The maximum score represents the highest score (Max. of C = 4.50; E = 4.75). The lower and upper whiskers display the scores outside the median. The outliers are displayed as dots and can be defined as data points located outside the whiskers of the box plot and will not be used for the interpretation of the data due to the fact it deviates largely from the rest of the data. This choice will be explained further in the discussion section.

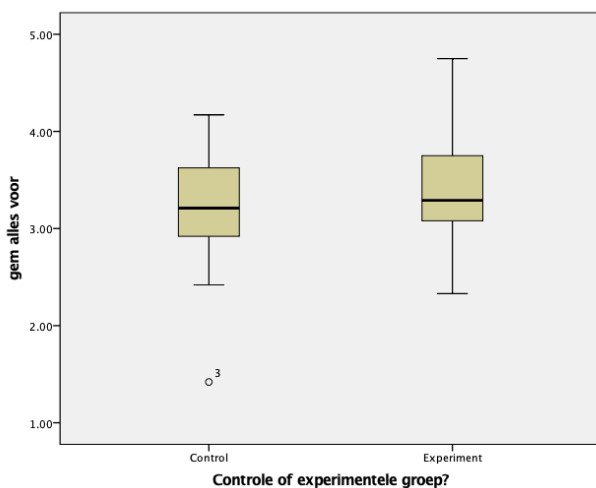


Figure 1: Boxplot data before interaction

Figure 2 displays the data after the interaction with The SAMBuddy cuddle. The minimum score of C = 1.67; E = 2.58. Mdn. of C = 2.92; E = 3.25. 75% of the scores fall below the third (upper) quartile (C = 3.25; E = 3.33). The maximum score for C = 3.92; E = 3.67. The outliers are displayed as dots.

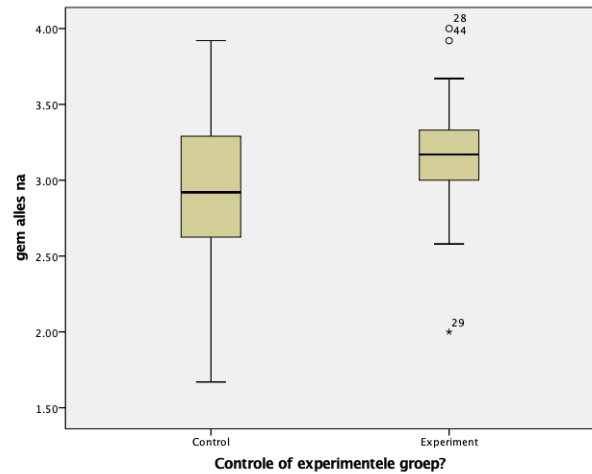


Figure 2: Boxplot data after interaction

V. DISCUSSION

Earlier research with the SAMBuddy cuddle has shown that the cuddle is able to establish trustworthy relationships with children [32]. For this reason, it was assumed the SAMBuddy cuddle could have a potential to be involved in stress reduction interventions among adults. To take the results of this study in consideration the following limitations should be kept in mind. The fact that no firm conclusions can be drawn can be observed by means of boxplots in figure 1 and 2, and display the outliers of the results as dots which means the data points are numerically distant from the remainder data. During the data preparation phase no issues were identified which leaves one possible explanation for these largely deviated data points. As stated in the research methods, the BYI-2-NL was originally administered using a four-point Likert scale. For this research, the researchers converted the scale to a five-point Likert scale to prevent people from thinking in extremes when answering the questions. The questions were originally designed to fit a four-point scale while the researchers did not adapt the questions to fit a five-point scale. There is a possibility that this had an influence on the results. For future research, it should be taken into consideration that the questions of questionnaires should fit the scale they are measured by and in case of an alteration of an existing questionnaire, the questions and the scale must be coordinated.

The prototype of the SAMBuddy cuddle that was used during this research produced a crackling noise during the PMRT sessions with the SAMBuddy cuddle. Participants commented about the noise and indicated that the noise made it hard for them to relax. For future research it will be encouraged to use a version of the SAMBuddy cuddle that does not make this noise, by means of a better sound system. Furthermore all of the participants of this research are Dutch students of a university of applied sciences ($N = 44$), therefore the diversity in background is limited and it is possible that the sample size could have influenced the generalizability.

VI. CONCLUSION

Stress is an increasing social factor that can have a negative effect on the individual as well as society as a whole [1] [2]

[3]. Psychological stress is frequent in adolescents and usually stems from school [9]. Research has shown that academic related stress can reduce academic achievement, decrease motivation and increase the risk of dropping out [10]. Therefore the research question of this research is: "Does the SAMBuddy cuddle have an effect on stress reduction in students who experience performance pressure?" According to the results, the p-value ($p = .176$) is not significant meaning no hard conclusions can be drawn. Ultimately leading to the fact that the SAMBuddy cuddle had neither a positive nor a negative effect on the stress students experience. However, the limiting factors of this study need to be kept in mind. Despite the fact the SAMBuddy cuddle did not have a remarkable effect, the participants were interested in the functionalities of the cuddle and social robots in general which may be beneficial for future research and the recruitment of participants.

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