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Improving sleep quality by the mean of a smart bed

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Abstract. Sufficient sleep and quality sleep considered as one of the most important human needs. Less sleep may make human nerves, anxiety and less concentrate. Therefor, this paper focuses on the sleep types, and a kind of sleep bed, in order to find out how such a bed improve quality of sleep, and how a specific game helps to make a child improve their quality sleep? Also, this paper focuses on some environment factors may have effect on the sleep quality such as temperature, mattress softness, luminosity, air pressure and humidity. For this purpose, this research relays on the two experiments, the first one would be preparing the room with such a bed and supplies the room with measurement tools such as pressure sensors, body thermometers in order to measure sleep quality and it takes 28 days. Also, conducting a Questionnaire. The second experiment would be comparing quality sleep between standard bed and Smart bed.

Keywords. Sleep quality, Smart bed, Trampoline

1. Introduction

Sleeping considered as the most important physiological needs. It has significant impact on human health and life. Therefore, Lack of on time sleep, causes tiredness and loss of focus throughout all the day. Hence, quality and type of sleep is one of the most important things to remain positive healthy life (Hao, Xing, & Zhou, 2013). Based on the researches sleep and sleeping types has linked with some important factors such as, having well sleeping schedule (Hao, Xing, & Zhou,2013; Veldi, Aluoja & Vasar,2005 et al.,2014), changing the bed and sleeping place (Jacobson, Boolani & Smith,2009; Chen et al.,2014; Kortelainen, Mendez, Bianchi, Matteucci & Cerutti,2010) also, warm environment (Okamoto-Mizuno & Mizuno, 2012). Another factor is that the types of movements (Hoque, Dickerson & Stankovic,2010; Verhaert et al.,2011) and some games for instance, Trampoline.

Dreaming on a cloud. The idea is a metaphor which can become real, because the manufacturing of some functions (levitation, sleep quality improvement) can already be done; whereas the others are not quite impossible (trampoline). It is a levitating cloud which would be a mix of features: a mix of a bed and a trampoline (Beltran-Carbajal, Valderrabano-Gonzalez, Rosas-Caro & Favela-Contreras, 2015; Elliott, Shea, Dijk, Wyatt, Riel, Neri & Prisk, 2001; McCloughan, Aspinall & Webb, 1999). This object would have several roles:

- To offer a new way to sleep, and improve it
- Being funny
- Being a beautiful piece of furniture.

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Trampoline is a game that pushes children to do excercises physically, makes it an interesting game, because nowadays children are quite adhered to video games and they neglect nearly all other kinds of sportive movements. This game improves heart and lung health, it helps to improve lung capacity and respiration Like walking, jogging and cycling, it is aerobic game in nature and works with your cardiovascular system. Also it has significant beneficial in restlessness conditions and alleviates the stress, fatigue or inabilities that could be caused by stress can be reduced by trampoling According to some studies about this game and its impact on human physical and psychological health, and also its relationship to sleep and sleep quality (Purcell et al., 2007; Kutty, Jabbar & Ving, 2017; Adams & Adamson, 1973; Giagazoglou et al., 2015; Oakley, 2019; Nunez, 2020; Bulotaitė & Visagurskienė, 2017; Meyerber, Fraisse, Dhalluin, Ryckewaert & Violas, 2019).

Some studies on the quality of sleep have found improvements on it in the absence of gravity, observed more specifically by a reduction in respiratory disorders during sleep (Elliot et al., 2001). Therefore, an object that levitates. This function is already achievable, by an electromagnetic levitation system (Beltran-Carbajal, Valderrabano-Gonzalez, Rosas-Caro & Favela-Contreras, 2015). This technology is already in the world of interior design with the floating lamp by designer Angela Jensen. As for the trampoline, this is one of the challenges that we must take up because researchers have to design a light material, similar to the cloud, but which would allow us to make good ones, thus fulfilling the function of a trampoline. The artificial cloud is already a reality, it is the C.A.R.E (Charged Aerosol Release Experiment) project of NASA. Nevertheless, it remains to find the artificial cloud whose material will make it possible to make bounces.

Some studies, concerning to the topic have conducted such as (Kortelainen, Mendez, Bianchi, Matteucci & Cerutti, 2010; Verhaert, Haex, De Wilde, Berckmans, Vandekerckhove, Verbraecken & Vander Sloten,2011) to illustrate the relationship of sleep and quality of sleep with the type of human movements and the type of bed or sleeping place, and for that purpose, they have achieved interesting results. (Kortelainen et al.,2010) in their study showed the sensibility of sleeping bed and the sleeping quality, with the application of the bed surface composition and the heart beat intervals through a signal processing procedure. It also discovered that researching about the sleep disorders would not be exercised only in specialised sleep centers, but it could be possible through different sort of methods, meanwhile the importance of researching on the sort of sleep is due to a number of activities related to the sleep quality is in developing. (Verhaert et al.,2011) in their study demonstrated the importance and effects of motor pattern related to sleep and it's quality during postural changements and movements, an algorithm has been developed to determine the mobility based on the consumed time related to the mattress indentations. It also helps the populations which kind of mattress can they choose. The results determine a high sensitivity in detecting movements and postural recognition, Hence the irregularities (indentations) could be a factor to indicate an accurate measurements and evaluation of motor patterns during sleeping.

The improvement of sleep quality if main function of this object and will be the core of our experimentation. Indeed, sleeping is one of the physiological necessities and every single person needs nearly 8 hours of sleep per night. The results of all researches that deals with the impacts of the sleeping bed on sleep quality show that the indentation and irregularities of sleep place affects sleep and causes sleep disorders and vice versa (Amrit,2007; Chen, Li, Liu,Gao,Chen,Hu & Guo,2014; Hao, Xing, & Zhou,2013; Hoque, Dickerson & Stankovic,2010; Kortelainen, Mendez, Bianchi, Matteucci, & Cerutti, 2010).

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It is also known that the mode of programming our bed time i.e. our sleeping schedule and its daily regulation makes a big difference in the quality of our sleep, the correct way to optimize our sleep in a reproducible way is to take care about several important points repetitively every day; what is really important to remember is that a good, deep and healthy sleep has to be discovered experimentally, because it is quite person dependant and might not to be working obligatorily similar for every single individual. There are several critical points to remember in order to have a good quality of sleep; going to bed respectively in general, trying to regulate the duration of sleep over night constantly, attempts to have a dark environment as a bed place to permit the secretion of hormones which affect the quality of sleep according to their quantity of secretion. Over all, these factors are part of those which have interference in the sleep quality (Smith, Robinson & Segal, 2021; Hsu & Lo, 2013; Veldi, Aluoja, Vasar, 2005; Amrit, 2007; Bergholdt, Fabricius & Bendix, 2008).

For this reason, this main function will be the subject of the study, as part of the design of our "trampoline cloud bed" technology. The problem has been approached from several angles in the literature, such as the thermal environment (Okamoto & Mizuno, 2012), the pressures exerted on the body during sleep (Hoque, Dickenson & stankovic, 2010; Hsiu-Chen Hsu, 2013 ; Chen & al, 2014), the collection of nocturnal activity by the partterns of movements (Verheart, Haex, De Wilde, Berckmans, Vandekerckhove, Verbraecken, Vander Sloten, 2011; Veldi, Aluoja, Vasar, 2005), the collection physiological data (Kortelainen, Mendez, Bianchi, Matteucci & Cerutti, 2010). The results of the study will allow us to clarify the impact of factors involved in the quality of sleep, and which will participate in the design of the technology that propose, concerning the function of improving sleep.

2. Research contents. Methods

The core of the research will consists in findings in what proportion each parameter (temperature, mattress softness, luminosity, air pressure and humidity) actually affects the sleep quality (Ajwad, Yaghouby, Huffman, O'Hara & Sunderam, 2016; Hauck, Herman, Donovan, Iyasu, Moore, Donoghue & Willinger,2003; Tamanna, Parker,Lyons & Ullah, 2014; Okamoto-Mizuno & Mizuno,2012) . To achieve that, several experiments will be needed, conducted on a large panel of subjects.

Secondly, after determined what parameters would be controlled to get a significant enhancement of sleep quality, we will work on the development of the bed itself. Meanwhile, a smartphone application will be developed (Verhaert, Haex, De Wilde, Berckmans, Vandekerckhove, Verbraecken & Vander Sloten, 2011; Hao, Xing & Zhou, 2013). The goal of this application will be:

- To collect and process the statistical data retrieved by a bench of sensors. The sensors used will be chosen depending on the outcome of the previous experiment (thermometer), but will at least have an accelerometer and a set of pressure sensor in order to measure the movement of the user. It will also use the built-in microphone oh the smartphone (Hao, Xing & Zhou, 2013), as it involves no additional cost.
- To control, thanks to a user-friendly interface, all the parameters previously found (Room temperature and mattress softness for instance).

After that and during the development itself, another series of experiment would be conducted to test the bed. The two series of experiment will need to be conducted in a similar fashion - as far as possible - in order to measure significantly the improvement brought by our bed. To achieve that the research needs:

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- A dark, acoustically isolated room to conduct our experiments.
- Sonometers, light meters, pressure sensors, thermometers and barometers to assure ourselves that the conditions will be similar to a benchmark experiment.

3- Experiment

3.1-First experiment:

Similar to (Jacobson, Boolani & Smith, 2009) previous work and others (Jacobson, Gemmel &Hayes, 2002; Monsein et al, 2000) using the same kind of methodology, the pretest period of our first study would be 28 days. During this period, all subjects have to sleep in a standardized bed (medium-firm bed) into rooms used for the experiment. During nights, a battery of measure tools would be used to assess physiological data's (such as pressure sensors, body thermometers) during the ongoing sleep of the subjects. These data's are helpful to analyse such physiological parameters that are known to play a role in perceived sleep quality, and to draw a baseline of the sleep quality of subjects in a standard bed.

3.2-Questionnaire:

At the start of this experiment, all subjects would be asked to complete questionnaires concerning sleep habits, and day activities (like jobs or whatever) during the experimental period. Subjects with extreme sleep habits, or intense day activities would be excluded. Every morning, each subject would have to complete a sleep quality questionnaire to assess his perceived sleep quality. At the final stage of this experiment, all subjects would complete a stress questionnaire containing items related to behaviors manifested by anxiety and stress to assess these indirect effects of quality of sleep.

3.3-Second experiment:

This second experiment would be done after a first prototype of the bed we want to build up, to test its own effect on subjects sleep quality related measures. In order to compare results between standard bed and the first prototype, this second experiment design would be exactly identical to the first one.

4. Conclusion

This research is, as we are aware of it, quite ambitious. But the state of the research in this domain (see references) helps us being confident on the outcomes. It needs a considerable sum of money, and we hope that our funders will follow us. Sleep quality is a serious health issue, especially for elderly people, and our work is only done to contribute to the improvement of global public health.

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