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Original Article

Do Carpets Alleviate Stress?

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Abstract

Background: Owing to increased complexity in the evolution of society, stress has become an important public health problem, and is responsible for more than 30 types of diseases. Most of the research on stress conducted to date has focused on physical and psychological aspects; however, there are very few reports about the association between psychological stress and elements within the residential environment, such as the home, room, and furniture. Therefore, in this study, we focused on the effects of indoor flooring in the residential environment on stress, as flooring is a feature that the human body is in contact with for long periods of time. We objectively measured the extent of psychological stress perceived while walking on carpeting and on wood flooring.

Methods: Forty-two healthy subjects were recruited for this study, and were asked to walk on carpeting and wood flooring for 10 min each. Their electroencephalogram (EEG) and skin impedance values were measured for each task.

Results: The α-wave content percentage in EEG data and skin impedance values were significantly higher just after walking on carpet than just after walking on wood flooring.

Conclusion: Walking on carpeting induces less stress than walking on wood flooring.

Keywords: Stress, Carpeting, Wood flooring, EEG, Skin impedance, Plantar aspect

Introduction

Given the complexity of current societal demands, stress levels have increased, causing 30 or more types of diseases, including ulcerative colitis, rheumatoid arthritis, Meniere's syndrome, depression, primary glaucoma, and menopausal symptoms (1-3). For the most part, stress has been frequently discussed in terms of its relationship with disease, external injury, and physical stress and its association with other sources of psychological stress imposed during work, school, and interpersonal relationships. However, very few reports have addressed the association between psychological stress and elements within the residential environment, such as the home, room, or furniture (4-6).

According to Penfield's homunculus, deep stimulation of the plantar aspect of the foot is perceived quite sensitively near the midline of the cerebral cortex parietal lobe, and has been suggested to be strongly associated with mental health (7-9).

Therefore, in this study, we focused on the effects of indoor flooring in the residential environment on stress, as the floor is an aspect of the residential environment that the human body is in contact with for long periods of time. Carpet and wood are currently the flooring materials that are most commonly used in Japan, Europe, and the USA; therefore, in the present study, we objectively measured and compared the extent of psychological stress perceived while walking on carpeting and on wood flooring. In general, people in developed countries spend approximately 90% of their lives inside their houses. Since the plantars are usually in contact with flooring materials, determining the best materials to alleviate stress would be a significant method for providing the basic amenities of living.

Materials and Methods

The subjects were 42 healthy non-smokers comprising 20 men and 22 women ranging in age from 20 to 68 yr (mean ± SD, 30.5 ± 15.1 yr). The present study was conducted with approval of our university Ethics Committee, and informed consent was obtained from all subjects.

In a test room, carpeting (Fig. 1) was laid onto half (3.9 m × 5.2 m) of the floor (7.8 m × 5.2 m) and blanketed onto an adjacent side wall. Wood flooring (Fig. 2) was laid onto the remaining half (3.9 m × 5.2 m) of the floor and onto the adjacent side wall as well. The carpeting used was a tile carpet obtained from TOLI Corporation (SMIFEEL ATTACK 260, product number AK2603, 100% nylon: pile length, 5 mm; thickness of the backing layer, 5 mm; total thickness, 10 mm; color, mocha).

The wood flooring used was ADVAN'S NEW HDF laminate flooring (ROY'S QUICK FLOORING, product number: ECRWCL 1405: color, oak natural; thickness, 8 mm; width, 142 mm; length, 1215 mm). The wood flooring was bound together, and, in order to achieve the same firmness as the carpet flooring (G value), 2-mm-thick under-sheets (ADVAN, product number: ECRWFE2) were arranged between the wood and the concrete floor. For this experiment, the room temperature and humidity were set to 20±1 °C and 40 ± 1%, respectively.

For the experiment, all subjects wore their everyday home clothing, including socks. The experiment was conducted in the following sequence: 1) the subject sat in a chair at a designated location in the test room ("rest time"), 2) walked on the wood flooring, 3) had a second rest time, 4) walked on the carpeting, and 5) had a final rest time (Fig. 3).

Electroencephalography (EEG) was conducted using the Brain Pro model FM929 (FUTEK Electronics Co., Ltd.): a sensor band was fixed to the subject's prefrontal area and EEG measurements were taken for 2 min immediately following the task of walking on the wood flooring for 10 min and for 2 min immediately following the task of walking on carpeting for 10 min.

Fig. 1: Tile carpet. The carpets used were tile carpets made by TOLI Corporation. Product name: SMIFEEL ATTACK 260; pile length: 5 mm; thickness of the backing layer: 5 mm; total thickness: 10 mm; color: mocha. Product number: AK2603. 100% Nylon

Fig. 2: Wood flooring. The wood flooring used was ADVAN's NEW HDF laminate flooring. Product name: ROY'S QUICK FLOORING. Color: oak natural. Product number: ECRWCL 1405. Thickness: 8 mm. Width: 142 mm. Length: 1215 mm

Four values were obtained using the EEG data: 1) the α-wave content percentage just after walking on carpeting (Cα); 2) the α-wave content percentage just after walking on wood flooring (Fα); 3) the β-wave content percentage just after walking on carpeting (Cβ); and 4) the β-wave content percentage just after walking on wood flooring (Fβ).

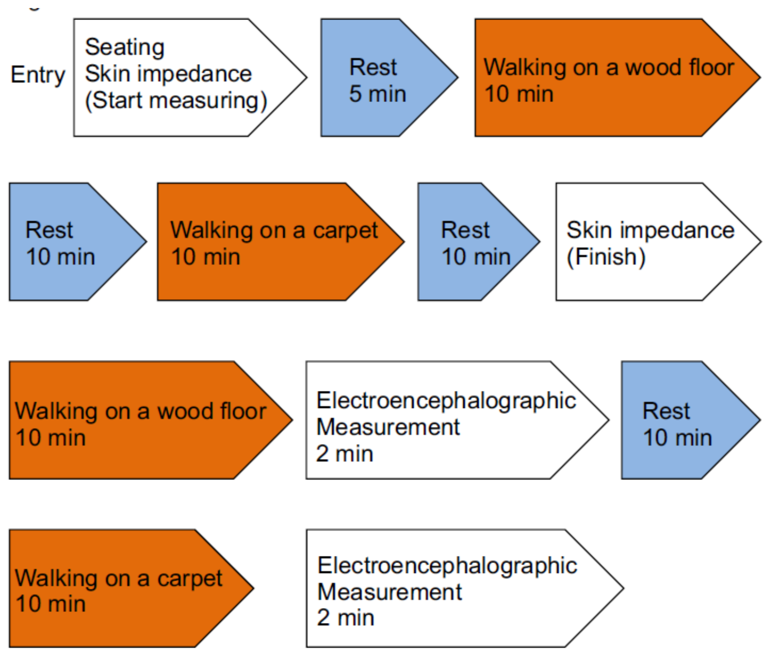

Fig. 3: Experimental protocol. The experiment was conducted in the following order: (1) rest time, where the subject sat in a chair at a designated location in the test room, (2) walking on the wood flooring for 10 min, (3) rest time, (4) walking on carpeting for 10 min, and (5) rest time

Skin impedance was measured using the Skin Impedance Meter Ver. 3.03 (Live Aid Co., Ltd; this instrument is currently being prepared for the mass market) (Fig. 4a, b) (10-12).

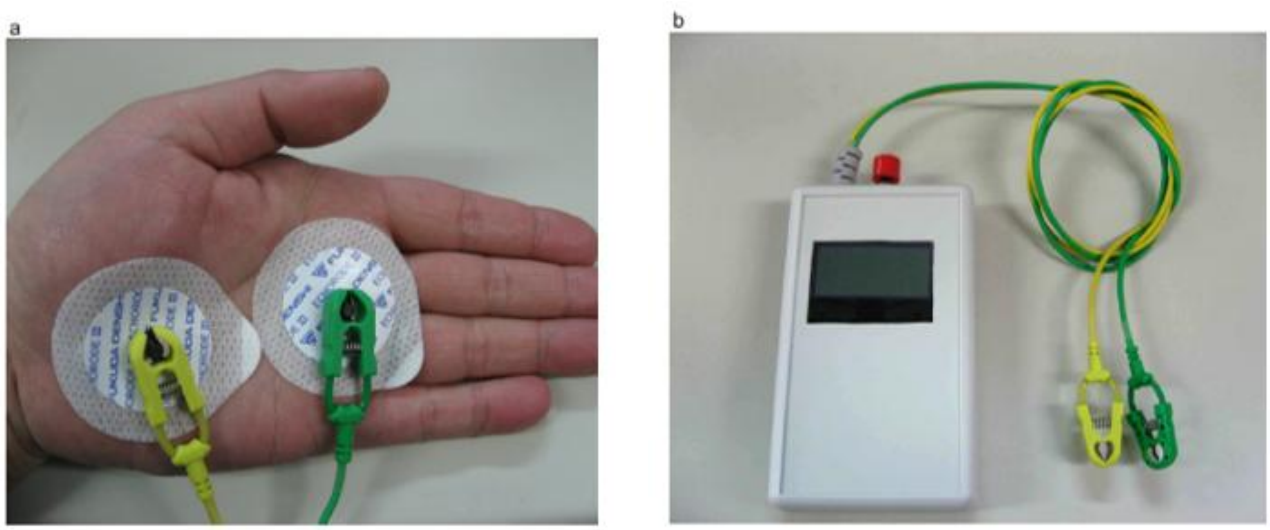

Fig. 4: Skin impedance measurements. (a) Skin impedance meter. The skin impedance values were measured using the Skin Impedance Meter Ver.3.03 made by Live Aid Co., Ltd. (b) Skin impedance electrodes. Two electrodes (Echorode III made by Fukuda Denshi Co., Ltd) were attached to the subject's left palm. An electrode clip was connected to each of the electrodes

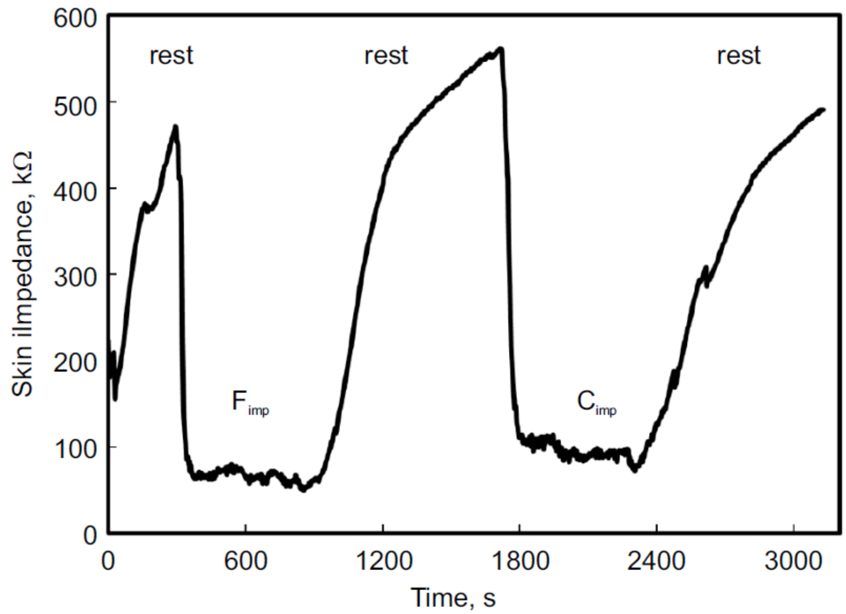

Fig. 5: A representative example of measured changes in a subject's impedance values during the experiment. Fimp represents the subject's skin impedance values measured while walking on the wood flooring. Cimp represents the subject's skin impedance values measured while walking on the carpeting. The impedance value (kΩ) was measured every 3 sec

Two electrodes (Echorode III from Fukuda Denshi Co., Ltd.) were attached to the subjects' left palms, and an electrode clip was connected to each of the electrodes. A 2- to 3-μAm weak current was allowed to flow to the body automatically, and the impedance value (kΩ) was measured every 3 sec. The measurement of skin impedance was sustained throughout each trial. For each trial, the mean impedance values while walking on carpeting (Cimp) and on wood flooring (Fimp) were used to represent the respective skin impedance value for each type of flooring. Fig. 5 shows a representative example of changes in a subject's impedance value (kΩ) observed during the trial.

The respective EEG readings were measured just after walking on carpeting for 10 min (Cα, Cβ) and just after walking on wood flooring for 10 min (Fα, Fβ). The respective skin impedance values were measured while walking on carpeting for 10 min (Cimp) and while walking on wood flooring for 10 min (Fimp). The α-wave and β-wave content percentages were compared statistically using the paired Student's *t*-test, and *P*-values<0.05 indicated a significant difference.

Results

The EEG data are summarized here. The content percentage of Cα was significantly higher than that of Fα (38.8% ± 3.8% and 36.9% ± 4.2%, respectively; $P = 0.0003$). In addition, the content percentage of Cβ was significantly lower than that of Fβ (20.7%± 6.0% and 24.4%±8.8%, respectively; $P = 0.003$).

With respect to the skin impedance data, Cimp was significantly higher than Fimp (156.2 ± 64.0 kΩ and 135.5 ± 52.4 kΩ, respectively; $P=0.0006$).

These results revealed that EEG and skin impedance measurements are excellent indicators of stress and relaxation, and that walking on carpeting is generally less stressful than walking on a wooden floor.

Discussion

Our experiments revealed that after the subjects walked on a carpet, their EEGs showed more α-waves and less β-waves than when they were walking on a wood floor. The impedance measurements were found to be consistent with the EEG results, indicating minimal amounts of sweat on the palm when walking on carpeting. Taken together, these findings strongly suggest that walking on carpeting seems to induce a lower stress state than walking on wood flooring.

Previous studies have used EEG measurements to evaluate stress, including reports related to the stress recovery effects in aerobics, yoga, and aromatherapy, as well as the circadian rhythm and sleep state (13-16). With respect to skin impedance, studies have shown that pain can be objectively measured using a skin impedance meter (17-19), and other reports (10-12) have suggested that the skin impedance evaluation we employed here can be used to accurately measure the degree of relaxation.

Recently, in Japan, considerable effort has been expended to avoid mites and dust, thereby increasing the prevalence of wood flooring at the expense of carpeting (20). In Europe and the USA, there have been numerous reports on the benefits of carpeting, such as prevention of dust to pass through in reverse (21), a soundproofing effect beneficial for mental health (22), and improvement in educational performance after laying of carpeting in schools (23). However, no studies have directly evaluated the relationship between stress and carpeting. Our results supplement these reports by demonstrating the potential effect of carpeting on reducing psychological stress. Overall, these results suggest the need to address the public perception of the benefits of indoor carpeting.

The limitations of the present study include the facts that: 1) only one type of carpet was evaluated; 2) the subjects were primarily young/healthy adults; 3) only one trial was conducted with no further validation; 4) the skin impedance meter used in this study has not yet been released on the market; and 5) the study was conducted in an artificial laboratory setting, and not in a natural environment such as a home, office, or hospital, and there is little empirical data against which to validate the results. In the future, we intend to validate our results by evaluating several types of carpeting over multiple trials, with varying environmental conditions and a greater number of subjects.

Conclusion

This study revealed, for the first time, that EEG measurements for α-waves along with measurements of skin impedance were significantly higher, and EEG measurements for β-waves were significantly lower just after walking on carpeting as compared to those measurements just after walking on wood flooring. These results strongly suggest that walking on carpeting induces lower levels of stress compared to walking on wood flooring.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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