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INFLUENCES OF THE SHOE SOLE HARDNESS ON THE PERCEPTION OF BELT SPEED CHANGE DURING TREADMILL RUNNING

Ming-You Xu[1], Hung-Ming Kung[2], Hung-Ta Chiu[1]

[1]Institute of Physical Education, Health and Leisure Studies, National Cheng Kung University, Tainan, Taiwan

[2] Physical Education Office, Chung-Jen Junior College of Nursing, Health Sciences and Management, Chia-Yi, Taiwan

Twenty-three subjects wore shoes with hardness of shore 45C and 70C to run on a motor-driven treadmill in this study. During the testing session, the console of the treadmill was covered by a black cloth and each subject must wear an earphone to isolate the external sound, in order to avoid the subject noticing the speed change of the treadmill. The runner was asked to say “Yes” of signal if he was aware of changing of the belt speed. The results showed that wearing the soft soled shoe, the mean correct and wrong responses are 2.3(**±1.4)** and 4.3(**±3.6)** times, respectively. With the hard soled shoe, the mean correct and wrong responses are 2.3(**±1.2)** and 4.8(**±3.5)** times, respectively. In conclusion, the shoe sole hardness did not affect the bad speed change perception of the subjects during treadmill running.

KEY WORDS: Treadmill running; sole hardness; proprioception; plantar sensitivity

INTRODUCTION: The material and construction of the midsole will affect the cushioning properties of the sport shoes. Previous studies have shown that the midsole hardness does not have significant influences on impact force peak of the ground reaction force while running because of the kinetic adjustment of the runner’s lower extremities before heel striking, and the adjustment is subject-specific (Wakeling & Nigg, 2001; Wakeling, Nigg, & Rozitis, 2002). The sport shoes with thicker or softer soles may have been over-emphasized on protective function, while the proprioception and reaction ability of human feet may decline as wearing this kind of sport shoes (Robbins & Hanna, 1987).
Proprioception could help people notice the change of the belt speed and the body position while treadmill running. The factors that affect the perception of the belt speed-change seemed to be complicated. They might include the belt shear force on the feet, the plantar sensitivity and the mental factor (Kong, Candelaria, & Tomaka, 2009). In the study from the Kong et al. (2012), the participants run for three minutes on the ground at their preferred speed, and then run on a treadmill at the same speed by their subjective perception under the blind of the treadmill speed. The results showed that the chosen speed of treadmill running was 2.73±0.62 m/s, which was significantly slower than that of running on the ground (3.99±0.78 m/s). Again running on the ground, the speed they chose was return to 3.80±0.74 m/s, still higher than that of treadmill running. The authors suggested that the unmatched perception of the preferred speed between overground and treadmill running could be the distortion on normal visual sensory inputs. Therefore, the subjective speed perception of treadmill running has seemed to be different from that of running on the ground.
The purpose of this study was to investigate the influence of shoe sole hardness on the belt speed-change conception of the runners, under no any information was offered to runners to be aware of the speed-change during running on a motor-driven treadmill.

METHODS: The present study included two experiments: experiment one recruited twenty-three males (age: 21.4 ± 1.6 yrs, height: 170.9 ± 6.5 cm, mass: 66.8 ± 7.1 kg), and experiment two recruited seventeen males(age: 22.1 ± 1.9 yrs, height: 172.4 ± 7.6 cm, mass: 68.2 ± 8.0 kg) as the subjects. All subjects did not have any sport injury within pass six months. Moreover, they were experienced in treadmill running. This investigation was approved by the Human Experiment and Ethics Committee of National Cheng Kung

University Hospital. All subjects in this study were informed of the experimental risks and signed an informed consent before their participation.
Two sizes (US 9 and 10) of shoes with different sole hardness (Shore C 45, 70) were used in this study. Except for the sole hardness is different, the appearance and the material of the shoes are all the same (see Figure 1). The subjects cannot distinguish the differences of shoes with soft or hard soles. A motor-driven treadmill (FUNA-7310, Tonic Fitness Technology) was used in this study. The treadmill motor would need a period of delay time to achieve the target speed after pressing the console speed keys. While a 60 kilogram man doing treadmill running, the belt speed was measured by a tachometer, and the results showed that the delay time was 11.5 s, 10.6 s, and 10.0 s as changing the belt speed from 10 to 11 km/hr, from11 to 12 km/hr, and from 12 to 13 km/hr, respectively. In this study, the delay time was defined as the belt speed changing period.

Figure 1: Testing shoes for this study

In order to avoid the subject noticing the speed change of the treadmill from any visual and auditory information, the console of the treadmill was covered by a black cloth in the both two experiments and the subject was asked to wear an earphone to isolate any external sound (see Figure 2). In experiment one, the subject wore his own jogging shoe to do three to five minutes of treadmill running at their preferred speed for warm-up. After that, the subject was asked to wear randomly the shoes with hardness of shore 70C (hard) and 45C (soft) to finish six minutes of treadmill running for each shoe sole condition. The subject would not be notified that the speed would change to slower or faster speed, and the changing times would not be mentioned before the experiment. The subject needed to say “Yes” of signal loudly if he was aware of the belt speed was changing. At the beginning, the subject would run at the speed of 10 km/hr, then after three, four and five minutes, the experimenter would change the speed to 11, 12 and 13km/hr, respectively. During the session, the exact time and times that the subjects said the signal while wearing the different two hardness soled shoes were recorded by the experimenter.

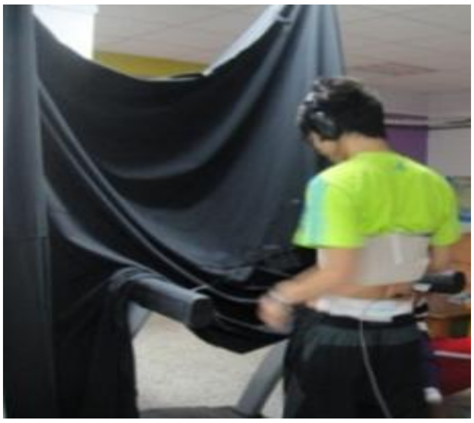

Figure 2: The set-up of the experiment. The console of the treadmill was covered by a black cloth. The subject had to wear the earphone with music playing in order to isolate any external sound.

In experiment one, the unknown of the speed change times perhaps caused the subjects to say the signal arbitrarily. Thus, another experiment was carried out to avoid this. In experiment two, the subject was notified that there would be only one time of speed change within five minutes of treadmill running, and the subject was asked to say “Yes” of signal at the moment that they felt the speed was changing. All the subjects would wear the shoes randomly with two different hardness soles and run at the speed of 10 km/hr at the beginning. The experimenter would change the speed to 11km/hr after 3 minutes. At last, the exact time that the subject said the signal was recorded.
In the both two experiments, if the subject said the signal within the speed changing period, it would be recorded as a “correct” response. In experiment one, the times that the subject said the signal is not limited; therefore, the responses even within the same speed changing period would all be recorded. If the subject said the signal not within the speed changing period, the response would be recorded as a “wrong” response. In experiment two, because of only one speed changing period, if the subject said the signal before it (at the moment, the speed did not change), the response was recorded as a “fault reaction”; while the subject said the signal after the speed-changing period (at the moment, the speed have changed, but it was not within the changing period), it was recorded as a “delayed reaction”. The dependent t-test was used to identify the influences of the shoe sole hardness on the speed change responses. The significant level α is set at 0.05. All the statistical analysis was done by SPSS 17.0.

RESULTS: In experiment one**,** while wearing the shoe with soft sole, the mean correct and wrong responses are 2.3(±1.4) and 4.3(±3.6) times, respectively. With the hard soled shoe, the mean correct and wrong responses are 2.3(±1.2) and 4.8(±3.5) times, respectively (see Table 1). There were no significant differences between the soft and hard soles. No matter wearing soft or hard soles, the mean wrong responses were almost twice of the correct responses.

Table 1: Correct and wrong responses under wearing different hardness of shoes in experiment one (n=23).

Variables	Shore 45C	Shore 70C
Correct responses	2.3 (±1.4)	2.3 (±1.2)
Wrong responses	4.3 (±3.6)	4.8 (±3.5)

In experiment two, eight subjects (47% of the total 17 subjects) responded correctly under wearing the shoes with Shore 45C (see Table 2). Of the nine subjects with wrong responses, eight subjects (89% of the nine subjects) made fault reactions and only one (11%) expressed delayed reaction. While wearing Shore hardness 70C, six subjects (35%) had correct responses. Of 11 subjects with wrong responses, eight (73%) made fault reaction and three (27%) expressed delayed reaction. Of the total 17 subjects, only five subjects (29%) performed the correct responses under both wearing the soft and hard sole conditions.

Table 2: The results of the experiment two (n=17).

Variables	Shore45C	Shore 70C
Correct responses	8	6
Wrong responses	9	11
Fault reaction	8	8
Delayed reaction	1	3

DISCUSSION: In experiment two, the subjects were told to have only one chance to judge if the belt speed was changing. The results implied that only 29% of the total subjects made correct responses no matter under wearing soft or hard sole conditions. Furthermore, most of the wrong responses belonged to the fault reactions. In experiment one, there are three speed changing periods during the six minutes of treadmill running. Therefore, the wrong responses could not identified as whether the fault reaction or delayed reaction. From the results of the experiment two, it has been assumed that most of the wrong responses in experiment one should be belong to the fault reaction rather than the delayed reaction.

Base on the results from the experiment one, there were no significant differences in correct and wrong responses between soft and hard soles conditions. The twice times of the wrong responses to correct responses indicated that the runner had bad perception of belt speed change as running on a motor-driven treadmill while no aware of speed change from visual and auditory information. Therefore, the present study suggested that the shoe sole hardness cannot affect the runner's bad speed change perception during treadmill running.

CONCLUSION: In conclusions, there was no significant difference in the subjective sensitivity of the belt speed change between wearing the shoes with soft sole or hard sole. No matter wearing the soft or hard soled shoes, the subjects performed more wrong responses of those most belonged to fault reaction. It has been suggested that sole hardness did not affect the bad speed change perception of the subjects during treadmill running.

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