The influence of different shoe conditions on plantar whole foot vibration perception in healthy adults

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Summary

Foot vibration perception is essential for balance and gait [1]. In contrast to natural calluses, shoes with thin, hard soles seem to increase plantar sensitivity [2,3]. This study investigated, whether different shoe conditions (barefoot, minimal shoe, running shoe) influence receptor specific whole foot vibration perception at 30 & 200Hz. While barefoot (BF) and minimal shoe (MS) conditions did not differ at either frequency, the running shoe (RS) impaired whole foot vibration perception at 30Hz, whereas it improved sensitivity at 200Hz. Thus, expected damping effects [5] stand in contrast to supporting mechanisms through thick running shoe soles.

Introduction

The perception of vibration stimuli at the plantar foot is essential for locomotion and balance [1]. Comparable to natural calluses, hard-soled minimal footwear can transmit mechanical stimuli with little dampening, in healthy young and elderly subjects [1,2]. Hard-soled shoes improve physiological sensitivity [3] and reduce the risk of falling in the elderly [4]. Thick soles are suggested to have cushioning effects leading to impaired perception [5]. However, it is unclear if different footwear conditions influence receptor specific whole foot vibration perception (WFVPT) at 30 & 200Hz.

Methods

38 subjects (sex (m/f): 13/25, age: 24.4±4.7 yrs) participated in this study. WFVPT at 30/200 Hz were evaluated using a vibration exciter platform, stimulating the **whole** foot sole. In order to examine the effects of different footwear on WFVPT, the measurement was carried out under three randomized measurement conditions. Subjects were BF, wore a MS or a RS while sitting comfortably on a chair with one foot placed on the top of the stimulating device. To analyze for group differences, Friedmann tests were used.

Results and Discussion

At both frequencies we found no difference of WFVPT between BF and MS condition. From a sensory perspective, minimal footwear enables physiological perception while at the same time protecting the foot [1,2]. At 30Hz we found significant differences between BF and RS ($p<0.01$, $r = 0.66$), as well as between MS and RS ($p=0.01$, $r=0.46$). In both cases subjects were less sensitive at 30Hz with RS. In contrast, sensitivity at 200Hz increased significantly ($p<0.01$, $r=0.68$), when subjects wore RS compared to BF condition (Figure 1). Obviously, the thick, cushioning sole act as high pass filter, indicating filtering effects at low frequency vibrations. Increasing sensitivity at 200Hz in thick cushioning shoes may be surprising.

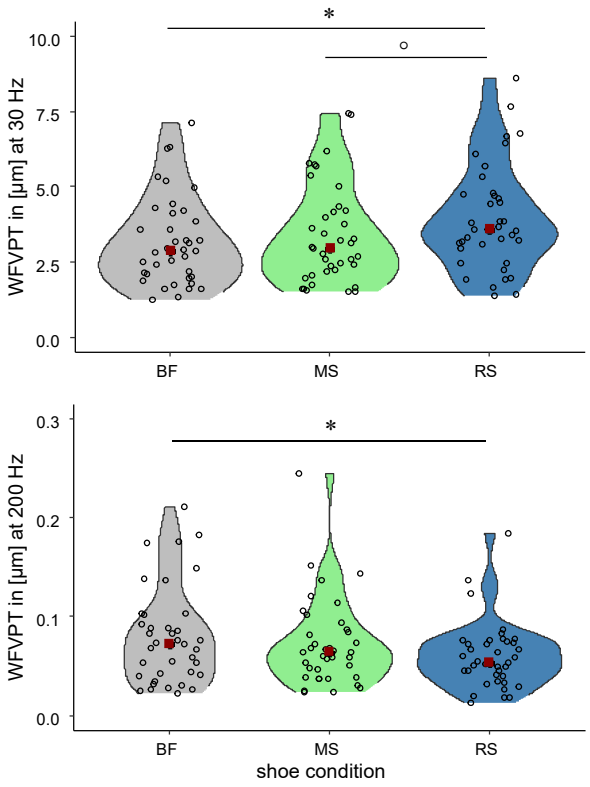

Figure 1: Whole foot vibration perception thresholds (WFVPT) in dependency of different footwear conditions at 30Hz (top) & 200Hz (below). Red dot: median. BF: barefoot, MS: minimal shoe, RS: running shoe. *$p<0.01$, °$p=0.01$.

Possibly, neurophysiological mechanisms as contrast enhancement and spatial summation, which is typical for Pacinian corpuscles, could have led to this result [6].

Conclusions

Our results give basic insights into human sensory physiology. Against recent research [5] and our expectations, we found different reactions of FA1 & FA2 mechanoreceptors towards RS intervention. Future studies may examine characteristics of vibration frequencies that are transmitted to the foot depending of the cushioning properties of shoes.

References

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