

USER-CENTRED EVALUATION OF LOWER-LIMB ORTHOSES: A NEW APPROACH

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Abstract: Objective of this study was to measure the user experience of lower-limb orthoses. 31 subjects experienced the use of a knee or a foot brace and evaluated them by AttrakDiff, PANAS and meCUE questionnaires. Significant differences could be detected in hedonic product perceptions and in experienced emotions. This could help explaining the low patients' compliance in this field of study.

Keywords: User-centred evaluation, lower-limb orthoses, user experience, usability, compliance

Introduction

ISO 9241 part 11 defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" [1].

Among the requirements for medical devices to be included in the German directory of medical aids (Hilfsmittelverzeichnis, further HMV) are functionality and usability to be found. They are to be examined under the standard from § 139 SGB V. [2]

Orthoses are included in the product group 23 of the HMV, therefore it is to assume that they are usable.

Dannehl [3] measured the compliance in two studies of 52 patients with functional knee brace and 53 patients with ankle-foot brace. The first group had a compliance of 30%, the second 50%. Nevertheless this orthoses were considered very suitable during the rehabilitation. Dannehl [3] concludes that a reason for the non-compliance is the lack of a user-oriented optimisation.

ISO 9241 part 210 defines user experience as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service"[4]. User experience includes hence not only the concept of usability but also non-instrumental qualities of a product and users' emotions before, during and after the interaction with the product. These three components, instrumental and non-instrumental qualities as well as user emotions, are central aspects within the CUE-Model (Components of User Experience) by Thüring and Mahlke [5].

The objective of this experiment is to evaluate the user experience of lower-limb orthoses, in order to test a new approach in the field of the user-centred design of medical aids.

Methods

Two functional knee braces (knee brace 1, knee brace 2) and one ankle-foot brace (foot brace) were tested. Thirty-one

individuals participated in the experiment and were sorted in three groups (see Tab. 1).

Table 1: Demographical description of the subjects.

group	group size	age	gender
knee brace 1	10	31 (10)	7 f, 3 m
knee brace 2	10	31 (14)	6 f, 4 m
foot brace	11	28 (10)	9 f, 2 m
total	31	30 (11)	22 f, 9 m

The subjects had first to put the orthosis on. The only provided help consisted of the instruction manual. Subjects' thoughts were recorded using the Thinking Aloud method.

After some corrections in the settings, the subjects could walk a few minutes in order to become accustomed to the brace. Subsequently they had to walk and to go upstairs and downstairs for about 15 minutes.

At the end of the experiment, participants reported their experience and evaluated the brace by the use of three questionnaires. The AttrakDiff by Hassenzahl, Burmester and Koller [6] is a well established questionnaire, differentiating between pragmatic and hedonic product qualities. The PANAS [7] offers two scales measuring the amount of positive and negative emotions independently. Finally, a newly developed questionnaire, the meCUE, was used. Based on the CUE-Model [5], meCUE consists of three modules providing a comprehensive evaluation of User Experience. The first module consists of a subset of scales measuring instrumental (effectiveness, efficiency) and non-instrumental (visual aesthetics, status, commitment) perceptions of interactive products. The second module addresses positive and negative emotions. Finally, the third module measures consequences of usage (product loyalty and intention to use).

Results

The results of the meCUE, AttrakDiff and PANAS are shown in Fig. 1 and Fig. 2, respectively. All orthoses became high scores for effectivity and efficiency by the meCUE. Other qualities are in the middle or low range.

A one-way ANOVA was performed in order to compare the results of the questionnaires for the three orthoses. Significant differences were detected by the meCUE's positive emotions ($F(2; 29)=5,828$; $p=0,008$; $\eta p.2=0,294$), meCUE's negative emotions ($F(2; 29)=6,514$; $p=0,005$; $\eta p.2=0,318$), AttrakDiff's identification ($F(2; 29)=3,525$;

$p=0,043$; $\eta p.2=0,201$) and AttrakDiff's attractiveness ($F(2; 29)=6,884$; $p=0,004$; $\eta p.2=0,330$). Post-Hoc-Tests (Scheffé) for multiple comparisons were performed. Significant differences were found by meCUE's negative emotions between knee brace 2 and 1

($p=0,012$), between knee brace 2 and foot brace ($p=0,018$). The same pattern was found also by the meCUE's positive emotions and AttrakDiff's attractiveness, where the knee brace 2 scored significantly worse than the knee brace 1 and the foot brace.

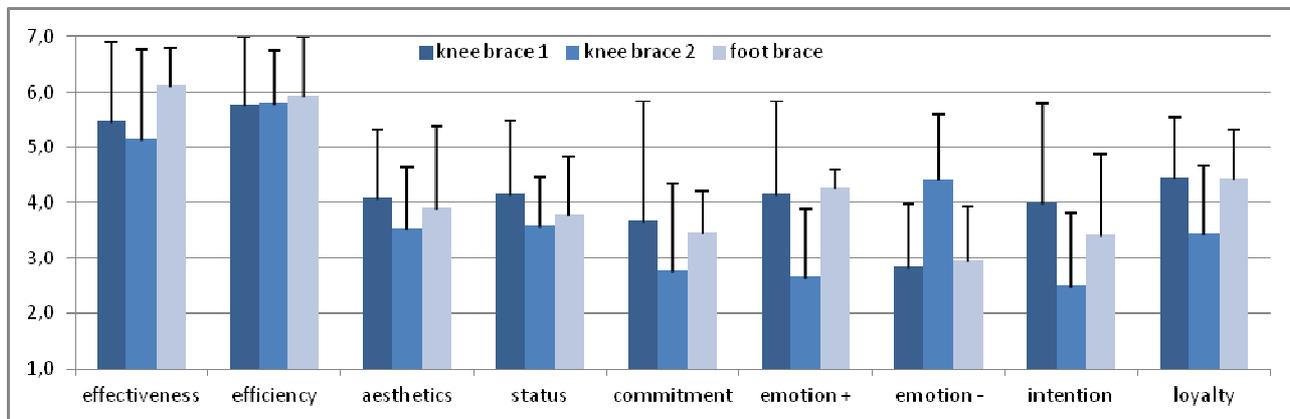


Figure 1: Results of the meCUE for knee brace 1, knee brace 2 and foot brace.

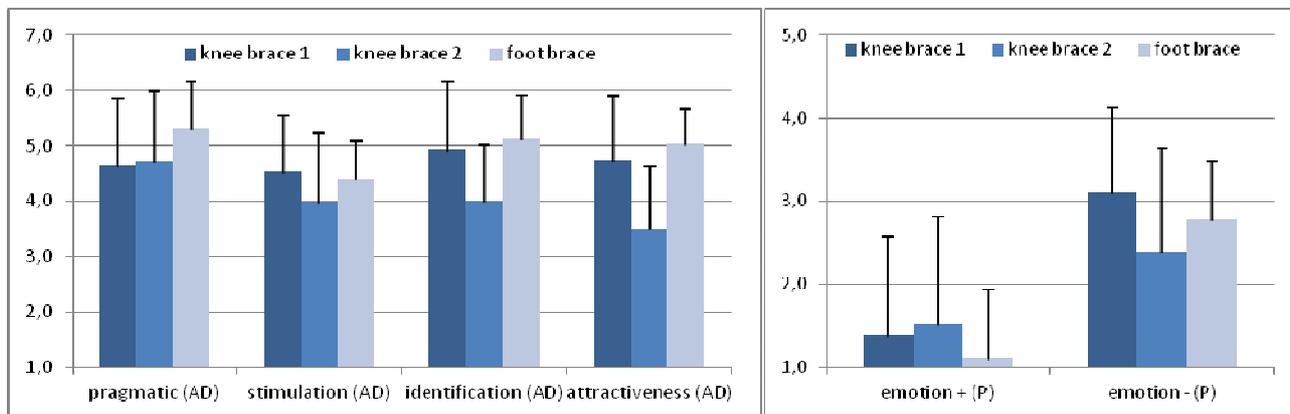


Figure 2: Results of AttrakDiff (AD) and PANAS (P) for knee brace 1, knee brace 2 and foot brace.

Discussion

The results clearly underline the importance of using user experience methods for a user-centred evaluation of lower-limb orthoses. As hypothesized, all three products were found to possess an acceptable level of usability. However, in hedonic product perceptions and in experienced emotions, significant differences could be measured. This finding could explain why patients find orthoses very suitable during rehabilitation but simultaneously show low compliance with regard to their usage behavior. The results of this experiment demonstrate that more research in this field of study is justified and needed.

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