

Assessing usability of a prototype soft exoskeleton by involving people with gait impairments

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Background

Soft exoskeletons provide support to the body without rigid structures and, therefore, require a certain level of functionality by the user. XoSoft (www.xosoft.eu) is a prototype soft exoskeleton designed for people with mild to moderate gait impairments.

During development, usability is a design aspect that needs to be assessed, ideally by involving future users of the system.

The purpose of this study was to assess user experiences of the usability of XoSoft prototypes.

Methods

Study participants

- 11 participants with gait impairments
- frailty (n=5), stroke (n=1), spinal cord injury (n=5)
- No cognitive impairment (MMSE score > 24)

Procedures

- Independent donning & doffing by participant
- Walking tasks with active support by XoSoft
- Completion of System Usability Scale (SUS) [1]

Soft Exoskeleton (Figure 1)

The prototypes were characterised by:

- Leggings-style garment, Velcro strap to anchor actuation
- Backpack containing pneumatic actuation, controlled by shoe insole sensor

- Actuation at ankle, knee, or hip
- Two versions of XoSoft were tested: Beta 2 and Gamma

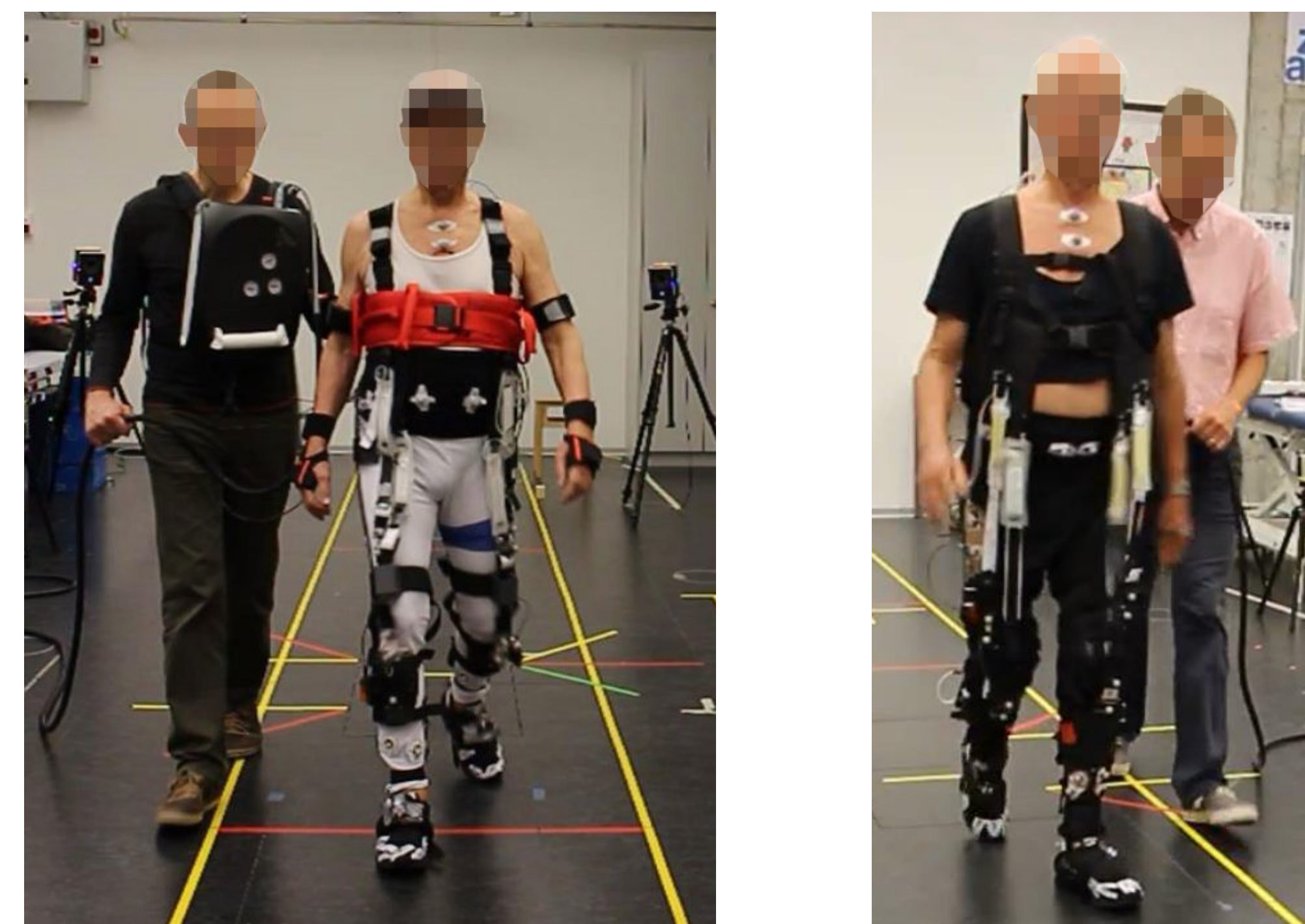


Figure 1: XoSoft (left: Beta 2, right: Gamma) worn by participant while walking (for Beta 2, accompanying person wearing backpack)

SUS

- 10 statements
- Rated on 5-point Likert scale
- Final score: 0 – 100, higher scores → better usability

Results

SUS-Scores	Median	Min	Max
Beta 2	52.5	0.0	95.0
Gamma	62.5	35.0	97.5

Table 1: Median, minimum, and maximum score on the SUS for Beta 2 and Gamma prototype

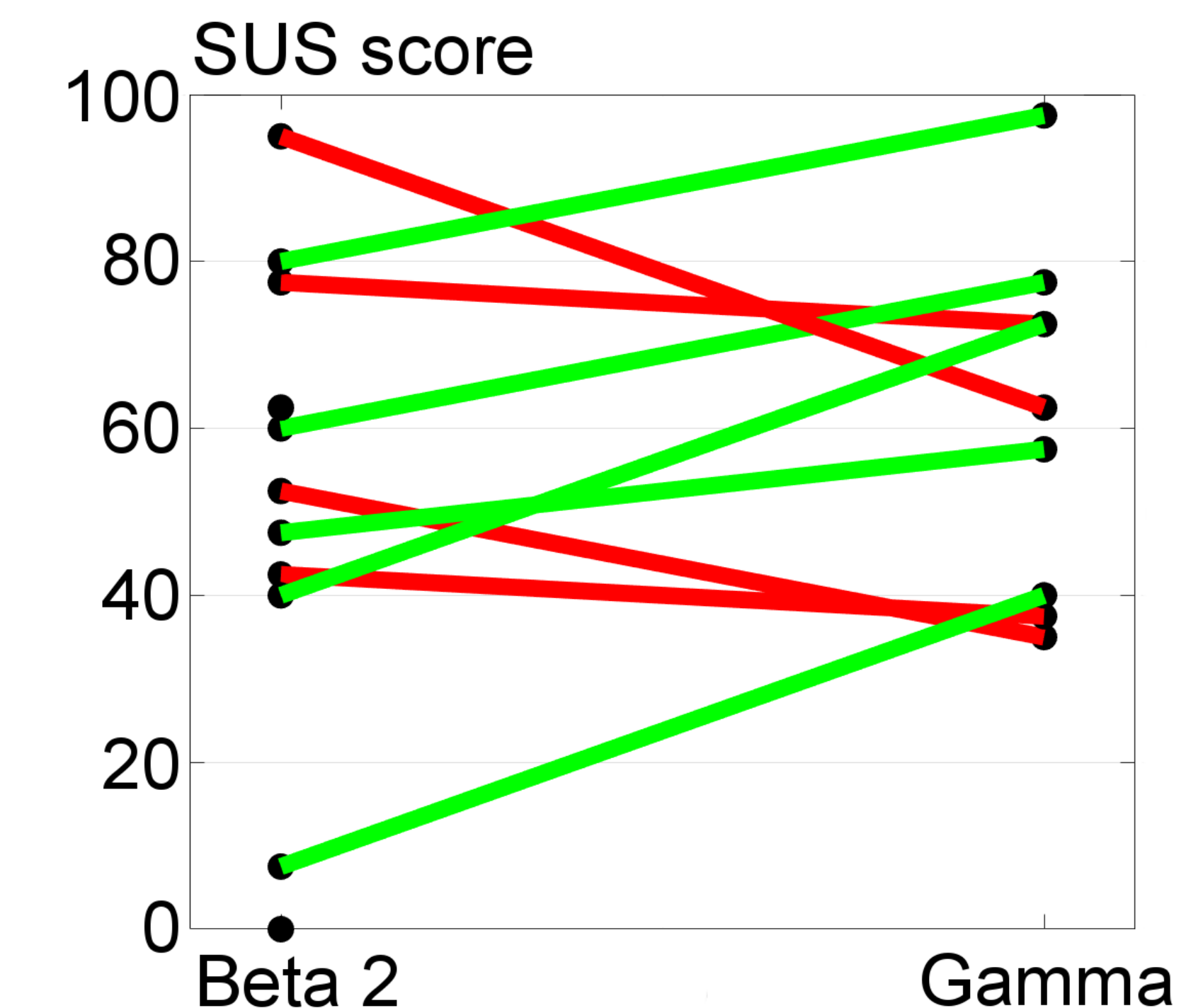


Figure 2: SUS score for each participant for Beta 2 and Gamma. Red: decrease, Green: increase in SUS score for Gamma

The median SUS scores improved by 10 points for Gamma, compared to Beta 2 (Table 1). Figure 2 indicates, that four participants rated the usability of Gamma worse than Beta 2. Only a total of 9 participant tested Gamma.

Discussion

The median scores of both versions were below criterion level to indicate acceptable usability (SUS>70 [2]). The improvement between Beta 2 and Gamma in the SUS scores for some participants indicate a positive trend towards a more usable system, but further improvements are clearly necessary.

SUS scores indicate large variability between participants. It is important to have a variety of people rating the same system as the individual requirements, experiences and preferences can differ substantially [3].

Literature

- [1] Brooke, J., in "Usability Evaluation in Industry", 1996
- [2] Bangor, A., et al., Int. J. Hum. Comput. Interaction 24(6), 2008
- [3] Sauer, J., et al., Appl. Ergon. 41, 2010

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