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Factors and values related to technology acceptance of Brain-Computer Interfaces as assistive technology

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Introduction: This study aims to identify which factors and values are related to the technology acceptance of end-users for Brain-Computer Interfaces as assistive technology (e.g. Alternative and Augmentative Communication or neuroprosthetics). We thereby aspire to facilitate the transfer of BCI technology to society and promote responsible innovation.

Material, Methods and Results: Participants were divided into three groups; neuro-muscular diseases (NM group; spinal muscular atrophy, amyotrophic lateral sclerosis, N = 7); spinal cord injuries (SCI group, N = 9); and Locked-In Syndrome (LIS group, N = 5). Participants in the NM and SCI group were educated about the state of art of BCI via a mini lecture, experienced a BCI demo, and participated in focus group interviews. Participants in the LIS group were visited at home and individually attended the mini lecture, BCI demo and interview. Interviews were recorded on audio and video and transcribed Ad Verbatim. Three coders (FN, AS, EL) coded the interviews three times, using the Noticing, Collecting, Thinking (NCT) method [1], Atlas.ti (version 7.5.6), and the Coding Analysis Toolkit (CAT; cat.texifter.com). Nine codes, based on previous studies [2,3,4,5], were used for the first round of coding. The list of codes was elaborated to 28 codes (see Table 1) in the second round (interrater reliability: Krippendorff's Alpha = 0.236; Fleiss' Kappa = 0.48). During the third round the three coders compared and discussed their codes (Krippendorff's alpha = 0.90; Fleiss' Kappa = 0.86).

Depending on group and type of sensors (invasive or non-invasive) participants were concerned or excited about a range of topics related to the (potential) use of Brain-computer interfacing. For example, invasive sensors were a point of concern for participants with LIS, but not for most participants in the NM and SCI group, who perceived the esthetics of current non-invasive BCI headset as a great barrier for technology acceptance and a direct threat to their value inclusion and dignity.

Category:	Codes:
Medical issues	Progressive disability (19); Situational disability (31)
Technical issues	Effectiveness (51); Efficiency (63); User experience (27); Esthethics (40)
Ethical issues	Agency (38); Responsibility (6); Info from peers (21); Info from professionals (12); Info from media (16); Risks of BCI intervention (32); Risks of BCI use (28); Real or expected benefits (56); Bodily integrity (19); Enhancement (27); Privacy (10)
Policy / Market	Legal issues (28); Economical issues (47); Standardisation (24)
Social issues	Relational issues (22); Societal issues (5); Potential users (70);
Values	Safety (20); Autonomy (21); Self-expression (9); Inclusion (13); Dignity (4)

Table 1. Categories with associated codes (number of quotations per code)

Discussion: While it is relatively easy to identify and count technical, legal, ethical, and societal issues, it is harder to understand the dynamics between issues and resolve conflicts between values and to come to responsible design choices. Compatible with [5] we recommend including end-users in the research and design of new AT and BCI technologies, for example through the use of Value-Sensitive Design.

Significance: These results clarify the main concerns from end-users which must be addressed by BCI developers to increase the wide-spread use of BCIs.

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