



BCI APPLICATIONS: Needs and Requirements of Disabled End-Users and Professional Users

C Zickler¹, V Kaiser², A Al-Khodairy³, SC Kleih⁴, A Kübler^{4,1}, D Mattia⁵, S Mongardi⁶, C Neuper², A Riccio⁵, M Rohm⁷, R Rupp⁷, P Staiger-Sälzer⁸, EJ Hoogerwerf⁶

¹ University of Tübingen, Germany; ² Graz University of Technology, Austria; ³ Clinique romande de réadaptation, SuvaCare, Switzerland; ⁴ University of Würzburg, Germany; ⁵ NEILab, FSL, Rome, Italy; ⁶ AIAS Bologna onlus/Ausilioteca, Italy; ⁷ Orthopaedic University Hospital Heidelberg, Germany; ⁸ Consultation Centre AAC, Bad Kreuznach, Germany

Background

The EU-project "Tools for Brain-Computer Interaction" (TOBI) aims at developing practical technology for non-invasive brain-computer interfaces (BCI) combined with other assistive technologies (AT) in the domains of communication, environmental control, entertainment and grasping (orthosis). An important concern of TOBI is the close integration of people with disabilities (end-users) and professional users (AT experts and caregivers) in the project. For assessment of the most urgent needs and requirements regarding new ATs, users from different European countries were investigated.

Material

TOBI Short Questionnaire:

Disabled end-users were asked

- to rate their satisfaction with current AT solutions in the domains of mobility, manipulation, communication, computer access, and environmental control on a four-point Likert scale (1="not at all satisfied", 4="very satisfied")
- to indicate whether they had or wanted independent access to devices for communication and entertainment.

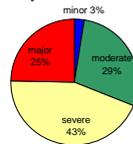
Professional users and disabled end-users were asked

- to rate the importance of various aspects of AT on a four-point Likert scale (1="not at all important", 4="very important"). The aspects were chosen on the basis of the "consumer based criteria for the evaluation of assistive devices" developed by Batavia and Hammer [1]. Professional users were additionally asked to rank the three most important aspects.

Participants: End-Users

End-users (N=77, 23 female; mean age 43.3 ± 13.6, range 19-71 years) were from Austria (12%), Italy (41%), and Germany (47%) and diagnosed with neurological/neuromuscular diseases (47%), spinal cord injury (37%), or cerebrovascular disorders (16%). Diagnoses dated back on average 15 years (SD±14.9, range 1-53). The end-users showed a high degree of impairment that is, they represented potential BCI-users.

Categories of Impairment



Minor	slightly impaired limbs
Moderate	severely impaired lower limbs or no verbal language
Severe	Severely impaired lower and upper limbs, able to use verbal language and able to handle special input device
Major	tetraplegic with nearly no control of muscles but able to use verbal language (device input channel) or tetraplegic, able to handle special input device (input channel), no verbal language

Objectives of the Study

To define

- end-user satisfaction with current AT-solutions
- end-user needs regarding access to devices for communication and entertainment
- the requirements (characteristics from the product or solution) of end-users with disabilities and professional users (AT-experts and carers) with regard to new assistive technology.

Participants: Professional Users

AT-experts (N=26) were from six European countries and had experience in working with all kinds of disabilities. Their areas of expertise were communication aids (N=16), ADL/orthosis (N=6), and environmental control (N=4).

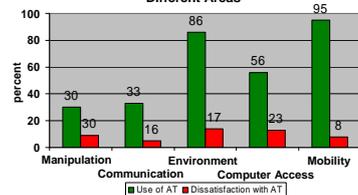
Carers (N=22, 36% personal assistants, 32% care givers, 32% other) from Germany (68%) and Italy (32%) spend on average more than 5 hours daily in assisting/care giving (M=5.36, SD±2.17).

Both groups of professional users showed a high degree of experience in their professions (years of experience: AT experts: M=9.92, SD±7.45; carers: M=12.50, SD±8.08).

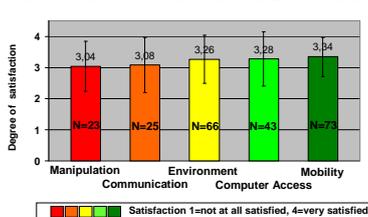
User Satisfaction

In the different domains of independence between 30% (manipulation) and 95% (mobility) of the participants used AT. Satisfaction in these domains was rather high. However, of those who were using AT in the particular domains, between 8% (mobility) to 30% (manipulation) were dissatisfied with their current solutions. Primary reasons for dissatisfaction were "functionality" (N=12) and "ease of use" (N=8).

Use of AT and Dissatisfaction with Current AT Solutions in Different Areas



Satisfaction with Current AT Solutions in Different Areas



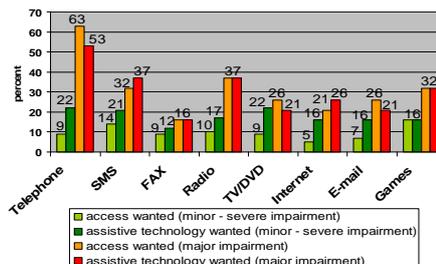
Devices for Communication and Entertainment

The majority of the participants had independent access to different devices for communication and entertainment. However, depending on the device 10%-22% would have liked to have access to different devices for communication and entertainment and even more (13%-30%) would have liked to use AT for this purpose.

Participants with Major Impairment

Participants with major impairment (N=19) were in a worse situation. Depending on the device 16%-63% of these participants had no independent access and wished to use AT to get access to the different devices for communication and entertainment. For the less impaired participants (N=58) only 5%-16% did not have and would have liked to have access.

Desire for Independent Access to Devices for Communication and Entertainment. Less Impaired and Major Impaired Participants



User Requirements

All three groups of participants chose the following four aspects as most important for new ATs: "functionality", "ease of use", "possibility of independent use" and "adaptability to the specific situation of the end-user". Both, end-users and AT-experts rated "functionality" as the most important aspect, while carers rated "ease of use" as most important. These findings were supported by the results of the ranking of the three most important aspects: 50% of the AT-experts rated "functionality" most important while 59% of the carers did so for "ease of use".

Importance of Different Aspects of AT

Aspect of AT	End-user	AT-experts	Carers
	M (SD)	M (SD)	M (SD)
Functionality	3.74 (0.44)	3.88 (0.33)	3.77 (0.43)
Possibility of independent use	3.67 (0.58)	3.81 (0.40)	3.65 (0.67)
Ease of use	3.60 (0.59)	3.85 (0.37)	3.91 (0.29)
Adaptability to specific situation	3.47 (0.64)	3.85 (0.37)	3.76 (0.44)

1= "not at all important", 4= "very important"

References

- [1] A. I. Batavia and G. S. Hammer (1990). Towards the development of consumer-based criteria for the evaluation of assistive devices. *Journal of Rehabilitation Research & Development*, 27, 425-436.

Discussion and Conclusion

The herein investigated group of AT end-users showed a high degree of impairment, that is participants represented potential BCI-users. The group of investigated professional users showed a high degree of experience in their professions. Between 30% to 95% of the participants used AT in the different areas, that means participants had a high degree of experience with AT. Sixteen percent to 30%

were not satisfied with their current AT solutions in the areas of manipulation, and computer access, i.e., there is a need for better or/and alternative AT solutions in the areas where BCI can contribute. Main reason for dissatisfaction was "functionality". With regard to the adoption of a new AT end-users and AT-experts rated "functionality" as most important while carers did so for "ease of use".

The main conclusions for TOBI were to develop BCI applications which will be effective (functional/robust) and simple (ease of use); to train not only end-users in using the BCI-applications but also carers in supporting end-users with BCI; to provide AT solutions with which users will be as independent as possible from the support of others and which will be adaptable to the specific situation of the end-user.