



## The sixth international brain-computer interface meeting: advances in basic and clinical research

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**To cite this article:** Jane E. Huggins, Gernot Müller-Putz & Jonathan R. Wolpaw (2017) The sixth international brain-computer interface meeting: advances in basic and clinical research, *Brain-Computer Interfaces*, 4:1-2, 1-2, DOI: [10.1080/2326263X.2017.1328211](https://doi.org/10.1080/2326263X.2017.1328211)

**To link to this article:** <http://dx.doi.org/10.1080/2326263X.2017.1328211>



Published online: 25 May 2017.



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EDITORIAL



## The sixth international brain-computer interface meeting: advances in basic and clinical research

The past four years have seen major advances in the field of brain-computer interfaces (BCIs) (also known as brain-machine interfaces or BMIs). The journal *Brain-Computer Interfaces* published its first issue in January 2014. The Brain-Computer Interface Society was founded in 2015. And the number of BCI articles in journals continued to increase; these studies explore a broad range of BCIs that replace, restore, enhance, supplement, or improve natural brain outputs or that are used in other scientific research. The new BCI Society organized the Sixth International Brain-Computer Interface Meeting, held 30 May–3 June 2016 at the Asilomar Conference Center in Pacific Grove, California, USA. Papers resulting from that Meeting appear in this special issue. A subscription to the BCI journal will now be a benefit for BCI Society members.

Like the first five meetings, the Sixth International BCI Meeting received funding from the National Institutes of Health, the National Science Foundation, and a variety of other governmental and private sponsors[1]. It continued the retreat format that distinguishes the International BCI Meetings from many other conferences. The 400 attendees came from 26 countries and represented 188 research groups or organizations. More than half were students (40%) or post-doctoral fellows (12%). Of more than 260 abstracts submitted for peer review, 14 were selected for plenary presentation and 220 were presented as posters [2]. All 234 accepted abstracts were published in the open-access conference proceedings [3]. For the first time, presentations at the BCI Meeting were recorded and are now available on the new BCI Society YouTube Channel [4]. These recordings include the Opening Session, the State of BCI Symposium, the Virtual BCI User's Forum, and some of the plenary abstract presentations.

The multidisciplinary nature of the BCI Meeting series continued in the 2016 BCI Meeting. The breadth of topics was amply represented in the 28 workshops that were organized by the BCI community and provided in-depth discussion of current and emerging BCI topics. These workshops are summarized in the first paper in this special issue [5]. It provides an overview of the varieties of BCI research and references to sources of additional information.

This meeting saw the second Virtual BCI User's Forum, featuring presentations to the BCI research community by people who need BCIs and have participated in various research projects. Two people with disabilities presented their

feedback in person, while others provided video comments. The Forum is available in its entirety on the BCI Society YouTube Channel. These research participants spoke about their personal experiences and the advantages and challenges of BCI applications. While BCIs are generally considered last-choice communication systems, their users still consider them to be an 'unbelievable gift' that can motivate both client and caregiver. They provide significant help at present and hope for the future. Key issues include system setup, training of caregiver system operators, and the availability of technical support. Furthermore, the exciting possibilities for BCIs that enhance rehabilitation and improve pain management are drawing increasing attention and research engagement. These BCI applications, which could benefit large clinical populations, may have tremendous impact in the future.

The articles in this special issue span the breadth, depth, future promise, and continued innovation of the BCI field; they also take a realistic look at the limitations of current BCIs that may slow widespread adoption. The first paper summarizes the 28 workshops; the next three papers provide detailed reports from three of them. One addresses the emerging therapeutic applications of BCIs [6]; the next is a detailed discussion of the advances made in BCIs for stroke rehabilitation [7]. Both review work in which a BCI aids recovery from disabling conditions, sometimes producing long-term effects that persist after BCI use is discontinued. The third workshop summary considers the barriers to commercial BCI translation and how they can be overcome [8].

The subsequent papers describe some of the innovative advances reported at the meeting, including incorporation of user responses to improve BCI accuracy [9], proof-of-concept of fMRI self-regulation [10], expansion of BCI testing in young people [11], and the feasibility of language models for communication in the home environment [12]. Studies continue to grow in rigor and to progress in evaluation of issues vital to real-world success, such as detection of the idle state [13]. Additional papers from this BCI Meeting will appear in an upcoming issue.

In summary, the Sixth International BCI Meeting's theme of 'BCI Past, Present, and Future' built on the foundation of BCI research to date, presented the current state of BCI research and development, addressed the issues of translating BCI research into clinical practice, and highlighted new applications for BCIs in the future.

The Seventh International BCI Meeting is planned for 2018. The BCI Society invites proposals for organization of subsequent meetings every two years after that.

### Acknowledgments

The authors would like to acknowledge support for the Sixth International Brain-Computer Interface Meeting through grant R13DC015188 from the National Institute on Deafness and Other Communication Disorders, the Eunice Kennedy Shriver National Institute of Child Health and Human Development, the National Institute of Neurological Disorders and Stroke, and the National Institute of Biomedical Imaging and Bioengineering within the National Institutes of Health. The opinions expressed are those of the authors and not the funding institutes.

### Funding

This work was supported by National Institute on Deafness and Other Communication Disorders [grant number R13DC015188].

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