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From Research to Reality: Advancing Pediatric BCI Innovations into Clinical Practice

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Introduction: Many children with moderate to severe quadriplegia are highly capable but may be unable to walk, use their hands, or speak. They face significant obstacles to their fundamental human right to interact with the world and to participate in life. Brain-computer interfaces (BCI) are a potential solution that removes the requirement of voluntary movement. Individuals can learn BCI by training their mental intent, similar to learning a new motor skill, and performance using a BCI system improves with training [1]. In July 2023, the Alberta Children's Hospital (ACH) implemented an Occupational Therapy (OT) led BCI clinical service in partnership with the BCI4Kids research program to provide novel interventions using BCI technology for these children.

Methods: The BCI@ACH clinical service was designed to provide non-invasive BCI options to allow children with moderate to severe motor impairments to achieve personalized goals (i.e., playing music/videos, baking, creative art, adapted gaming). The patient population included children ages 4 to 18 years old; the majority with quadriplegia (non-ambulatory with minimal hand function) and varying degrees of vision, hearing, and communication (Fig. 1). Patients either did not yet have an access method using commercial assistive technology (AT) or used BCI technology to augment their existing access method. A personalized approach aimed to teach children how to train their own BCI mental commands included the use of self-regulation tools, videos, photos, symbolic visuals and/or auditory prompts (Fig.2). Sessions included patient-motivating, goal-oriented activities to optimize repeated BCI practice. Room lighting, screen size and location, and visual software settings were adjusted based on patient needs. The use of both research and commercial BCI technologies allowed the OT to integrate with existing AT software. Customized social stories were created for the child/family to reinforce how they use BCI technology. Families also had the opportunity to receive training so their child could practice using BCI at home.

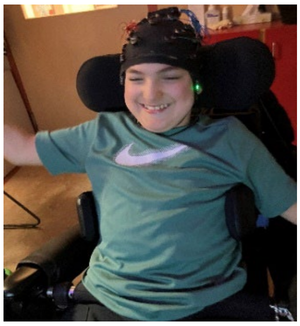
Figure 1: 14-year-old boy with spastic quadriplegia, cochlear implants, and CVI using BCI to turn pages in his favourite books.


Figure 2: 4-year-old boy training calm state with self-reg. stuffy puppy paired with photo.

Results: Over 18 months, 33 children and families received at least one BCI session. Two patients declined, and one waited for equipment. A total of 327 BCI sessions were provided at ACH. Fifteen patients learned one mental command, 14 learned two, and one is on the verge of three. Presently, seven patients are learning to use their mental command(s) in conjunction with scanning access, whereby items in a selection set are highlighted, and the mental command selects the item. Three are using BCI to supplement an existing access method in a hybrid manner, such as a chin-joystick with BCI. Common challenges include headset fit and design (i.e., wires losing connection to electrodes). Most families express satisfaction with the BCI clinical intervention. One parent's feedback, "He definitely has more success with BCI than switches, yes, he gets tired but not frustrated; he never got this far with switches."

Conclusion: A clinical service using simple BCI solutions can be implemented into a public health care system to allow children with complex physical needs to achieve personalized goals.

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References:

[1] McFarland DJ, Wolpaw JR (2018) Brain computer interface use is a skill that user and system acquire together. PLoS Biol 16(7): e2006719. https://doi.org/10.1371/journal. pbio.2006719.

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