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Non-verbal Communication using BCI, Haptic Feedback and Dance

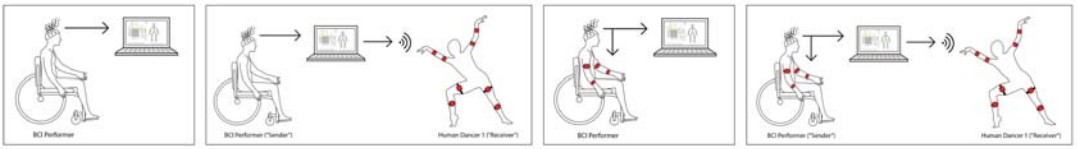
D. Landau[1,2*], J. Giron[1], D. Friedman[1]

[1]The Interdisciplinary Center, Herzliya, Israel; [2]HaMidrasha Faculty of the Arts, Beit Berl College, Israel;

*Mivtsa Kadesh St. 2, Tel Aviv, Israel. E-mail: daniel@daniel-landau.com

Introduction: Non-verbal communication is an extremely important aspect of our life, sometimes estimated to comprise of 65% to 93% of all communication, and the majority of our feelings and intentions are expressed with the help of non-verbal communication [1]. Nevertheless, this aspect of communication is often overlooked by the brain-computer interface community. Non-verbal communication involves sending and receiving signals with the help of body language, gestures, postures, proximity, haptic and facial expressions. Our over-arching goal is creating a new quality of non-verbal communication between disable and able subjects. Specifically, dance can be considered a form of non-verbal communication, as it plays an important role in sharing strong feelings of togetherness between humans. Previous research showed that observation of dance results in strong activation of motor brain areas, and, importantly, observation of live dance produces significantly stronger motor activity than observation of dance on video [2]. We report about our work in progress research, aimed at exploring the potential of multimodal feedback based on both haptics and live dancers in facilitating BCI performance.

Material and Methods & Results: We have developed a platform that combines several elements: motor imagery BCI (using the OpenVibe platform (Renard et al., 2010) and a gTec (Austria) gUSBamp amplifier), multiple programmable wearable units of haptic feedback, and visual feedback in the form of live dance. This architecture enables systematic exploration of motor imagery BCI enhanced with both haptic feedback and live visual dance feedback (specifically comparing four conditions; Fig. 1), in order to test whether multimodal haptic-dance feedback can enhance BCI learning curve and accuracy in paralyzed patient.



a *b* *c* *d*

Fig 1: Our technical and conceptual frame work allows systematic exploration of several conditions: a) BCI with no feedback, b) BCI with visual feedback only (while transmitting haptic feedback to dancer), c) BCI with tactile feedback only, and d) BCI with both tactile and visual feedback (with haptic feedback to dancer).

We have performed an exploratory pilot study in which one spinal cord injury (SCI) subject performed four practice sessions with binary (left hand vs right hand) motor imagery BCI and two sessions with the full apparatus[1]. The dancer responded to left/ right classes with movement of corresponding limbs to simulate synchronised dance. Each session included 40 triggers of left or right hand imagery, with an equal number from each class, in pseudo random order. Electroencephalography (EEG) was recorded from electrodes placed in 10-20 location C3, Cz, and C4, with reference on the earlobe. The subject has some residual capacity to move both arms, but he was asked to imagine grasping actions, which he cannot perform. The subject achieved beyond chance BCI accuracy: 67%, 63%, 76% and 78% classification in the training sessions, and 74%, 79% classification in the two pilot sessions. Both subjects, BCI performer and dancer, were interviewed using semi structures interview. The interview was transcribed and the results were analyzed in order to design the detailed experiment.

Discussion: The pilot study validated the operation of our technical platform, and established that a meaningful communication took place between the BCI performer and the dancer. The results are encouraging in terms of the reported motivation of the subject as well as the feasibility in carrying out the study under highly ecological conditions. This now allows us moving into the next step: studying whether multimodal feedback, including real human dancers and tactile feedback, can increase BCI learning curve and performance in disabled patients.
Significance: We present the feasibility of our technical and conceptual framework, which includes BCI, multimodal feedback, and dance, in a highly ecological setup.

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References:

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