

**Push/Pull: an excitable sculpture** was presented by the *Lo-fi* project at **LIVELab** in the Psychology Complex of McMaster University, Hamilton ON, on Thursday, May 3, 2018.

A call for volunteer EEG helmeted participants read:

*Push/Pull* is an interactive electronic sculpture that aims for a sense of “aliveness” through light and sound display. *Push/Pull* will be demoed by a live performer and with sonification of some viewers’ EEG input.

Since experiments in the early 20<sup>th</sup> century, the recording of rhythmic oscillations from the brain by means of scalp electrode electroencephalography (EEG) has shown correspondence between a high level of brainwaves and suppressed mental activity. In particular, the alpha rhythm segment of the brainwave spectrum has long been associated with a calm or relaxed state of mind, most readily attained by closing the eyes.

In this LIVELab event, we observed heightened alpha activity in EEG-helmeted subjects that corresponded to particular moments of attention provoked by watching/listening to a simulation of “aliveness.” We also heard the evidence of heightened alpha activity through its sonification. The simulated biological aliveness here has the form of a stationary alive sculpture, *Push/Pull*, that displays very low-fidelity agents activated by movement: LED patterns and layers of sound are induced as a dancer moves in front of the sculpture to activate it.

The central idea in performing this demo of *Push/Pull* in the LIVELab theatre was to sonify the measurement and recording of EEG output from several viewers watching the activated sculpture. We used the percentage of alpha wave in their EEG spectrum as a modulator of oscillator tones. Eight subjects were EEG helmeted with four electrodes running down the centre of the scalp, front to back. By successively increasing the pitch of the oscillator for each of the eight participants, we deliberately staged the event so that they, and anyone else in the theatre, could recognize their part in the constantly changing dynamic of the sonification. The sonification was layered over the sounds that emanate from the sculpture itself as the dancer moves in front of it. Together, the performer and the EEG participants co-produced a soundscape with constant feedback from both the sculpture and the eight stages of EEG sonification.

*Push/Pull* behaviour is based on a population of agents with low-fidelity embodiment, where heterogeneous agents are characterized by clusters of LEDs and abstract electroacoustic sound. This agent population is embedded in surfaces of the sculpture that have dimensionality and depth. Although the room is darkened, the sculpture and the performer are very visible. Behaviours of Artificial Agents (AA) are controlled internally to the system, and are manifested as movements of yellow clusters of light in the lo-fi display, and the behaviour of a Human Agent (HA) is controlled by the performer and is manifested in the movements of a red cluster of lights. The interaction begins with an initially small population of agents, each enacting visible and audible greets and responses to one another. The key activity of the performer, who is tracked by a camera, is to shift the position of the red light HA cluster so that it approaches

closely enough to an artificial agent to greet it. The AA population grows as greets increase, with a corresponding rise in intensity of light and sound expression, until a reset. We ran eight iterations of this cycle, assigning an iteration and a corresponding oscillator pitch to each of the eight EEG participants. We ran the demo in two rounds of these eight iterations. We had explained the basics of how *Push/Pull* works to the EEG subjects beforehand.

The well-known Alvin Lucier work *Music for Solo Performer* from 1965 is still a cultural touchstone. In it Lucier puts himself into a mentally relaxed state, mostly with eyes closed, to induce what is today called “alpha power.” His alpha waves generate sound beats that activate percussive instruments. With no further experience of the significance of alpha in the context of an art event beyond the Lucier performance of half a century ago, but thinking about the conventionally understood association of alpha with attentive relaxation, we opted to inverse its impact: the subjects’ EEG recorded responses to activation of *Push/Pull* generate dropout in sonification corresponding to high percentage of alpha. In our demo, lulls in the sonification from high alpha mean more attention to the sound and visual activity of *Push/Pull* itself, a feedback loop of quiescence during which viewers’ attention can more closely attune to whatever activity is inducing higher alpha in the first place.

Recent work on alpha power does suggest that more active mental states of ideation correlate with it, and we might add “relaxed creative ideation” to the description. Previously alpha has been associated with less cognitive activity, certainly less top-down frontal cortex cognition – a kind of cortical idling. For some of us this was a preset going in, in light of the Lucier performance and general cultural lore about alpha. More recent research puts forward that alpha power can be associated with high cortical function that inhibits the type of ideation that gets in the way of the focus and concentration required for creativity. [see *Role of Frontal Alpha Oscillations in Creativity*. Lustenberger, Boyle, Foulser, Mellin and Fröhlich. UNC Chapel Hill, 2016]

Some observations on the progression of the demo:

- when the display is quiet at the beginning of each iteration, during small AA population, the performer is moving very deliberately to “catch” and control the HA, and there tends to be a high amplitude in the sonification indicating low alpha;
- as the population increases and the performer is engaged with the HA, there is a strong suggestion of an autonomous world in the display. *Lo-fi* team members have described this as losing oneself – one easily gets absorbed in a simulation that seems autonomous and motivated;
- one of the subjects, who indicated verbally after the event that the sound was his main focus of attention, showed very high alpha throughout his section of both rounds. Since the visual events of agents greeting and responding is intermittent while the sound of the agent population, once it has increased, has a more steady and dense texture, this outcome makes sense.

Perception of and response to simulated aliveness is central to our ongoing *lo-fi* project. Still, watching the work being enacted is very different from engaging with it directly, and it remains a question as to whether both approaches will be deployed going forward.

Credits:

Nell Tenhaaf: event concept, sculpture design, programming

Melanie Baljko: agent architecture, programming

John Kamevaar: agent sound design

Nick Stedman: electronics design, programming

Julia Aplin: dance artist

Dan Bosnyak (LIVELab): EEG data sonification and technical design

Dave Thompson (LIVELab): EEG data recording

EEG volunteers: Paul Bradley, Shauna Jean Doherty, Paul Grunthal, Tanis MacArthur, Galen Macdonald, Jim Ruxton, Lorraine Shaw, Greg J. Smith

Please see <https://vimeo.com/325741559> for video documentation.

Note that I'm adding this text to put with the original, now very outdated, P/P doc:

*Push/Pull* has been in development since 2005. It has been exhibited in a gallery context only once, in *thelivingeffect* curated by Caroline Langill in 2010. After its run in this group exhibition, *Push/Pull* seemed more apt for presentation in demo format, i.e. with a performer running the piece and others watching. The gallery-going public found it difficult to know what to do with the work, thus the idea of an experienced interactant performing it for an audience. The work has been extensively reprogrammed since that first exhibition – it may now be more accessible to a range of people. Intentional moments of creative focus are set up: growth in the population of agents and in the intensity of sound layers signals a ramp up in autonomy and “aliveness.”