The use of ecological sounds in neurorehabilitation of apraxia.

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***Summary*- The CogWatch project aims to create an intelligent assistance system to improve activities of daily living (ADL) in stroke survivors, who suffer from impaired ability to use everyday tools (apraxia). This study explores the use of cues, based on ecological sound linked to the action goal, in rehabilitation of those patients. We hypothesize that patients with apraxia will benefit from supplementary sensory information relevant to the task, which will reinforce the selection of the appropriate motor plan.**

INTRODUCTION

Ecoacoustics define environmental sound as an audible product of physical event, caused by interaction of the materials (i.e. changes in the aerodynamics of surroundings) [1]. Recent research suggests that motor networks associated with mirror neurons respond to the action-related sounds [2], [3]. Use of environmental sounds was previous demonstrated to improve mobility in movement disorders e.g. Parkinson's disease [4]. Stroke survivors with apraxia suffer from the inability to use tools or perform hand gestures, caused by brain tissue loss in the left hemisphere [5]. Patients are prone to conceptual, spatial and temporal errors during ADL that can lead to potential health and safety issues (e.g., grasping the knife by the sharp edge) [6]. The aim of this study is to investigate the potential of event-based sounds in improving motor performance of stroke survivors manifesting apraxia.

METHODS

We are currently testing ten patients with left-brain damage (LBD) after cardio-vascular accident on the pantomime and actual tool use in three tasks: hammering, sawing, and toothbrushing. In addition, 20 age-matched controls will be tested, 10 on the dominant hand and 10 on the non-dominant hand. The experimental design comprises of four different cueing modes (prior to task execution): no cues, auditory instruction (step by step commands for each of the subactions f.e. 'Pick up the saw'), pictorial instruction (step by step 3rd person perspective display), and ecological sounds (10s recording of action goal). The movement data is collected with the use of 5 Qualisys Oqus cameras and analogue board interface. The sound stimuli were recorded with Rode N1 microphone and Yamaha Audiogram 3. Ethical approval was obtained by local ethics committee.

RESULTS

We have currently tested 6 patients with LBD, and 12 age-matched controls with right-hand (dominant hand). Preliminary results show improved motor performance in terms of movement organisation (see Fig. 1). Detailed analysis will focus on error occurrence [7] classification and kinematic variables noted in the literature as motor features of apraxia [8] such as movement time, peak velocity, deceleration phase, and movement path.

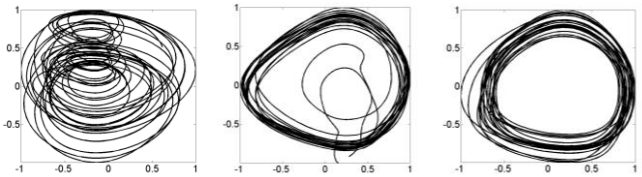

Figure 1 Normalised phase planes (velocity over time) for the apraxic patient performing a pantomime of hammering in comparison to control age-matched subject. Left panel shows the performance following pictorial instruction. Middle panel illustrates performance primed with display of ecological sound. Deviation from the circular form characterises poor motor control.

CONCLUSIONS

The results of this study will feed in the development of the CogWatch system. The aim is to find the most efficient cueing method that would improve the performance of ADL in stroke survivors.

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