P16- Musical preference for an optimal acquisition of rhythm and fluidity

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Abstract (9lines): The WII-mote was used to implement a positive reinforcement procedure to help naïve adults (N=30) to learn to produce two difficult spatial-timing aiming tasks. For the first, subjects were to produce a ballistic aiming task towards visual targets that were sequentially and briefly presented (100 ms). For the second task, subjects were to produce a slow and fluid movement to trace the contour of a visual infinite shape. Results demonstrated that subjects learning in the music condition (N=15) reached higher accuracy and stability in performance levels than those learning without music. The geometrical kinematic pattern was also better preserved in the music group when testing retention performances in a post-test session. These results confirm the power of music for the pleasure of learning and suggest that better encoding of space-time relationships may be provided in more pleasurable environments.
Key words : motor control, music, reinforcement learning, variability, and coordination

INTRODUCTION

Research in motor learning has a long and substantial history. Since the 1960's under the influence of cognitive psychology, theoretical emphasis has been clearly towards an information model of human behaviour in which feedback is the central experimental variable. Feedback is most often defined as the error detected in a comparison between a response and a standard, and feedback becomes input to modify the next response. The drawback from the use of feedback for motor control is that it requires a certain degree of explicit control, which in many cases can hinder the automatic organization of action. Furthermore, feedback is given on performance outcome, but the system must figure out ***how*** to implement change for performance increase. For these reasons, the Hullian drive-reduction reinforcement model (Skinner, 1969) may be more adequate for complex motor learning.

Operant conditioning is a method that is based on the principle of reinforcing only what is "good". It is thus the appearance of a target behaviour that is rewarded. Classically, subjects are not told what the target behaviour is; by varying response output the learner discovers the best strategy and response to emit. A real-time coupling between behaviour output and reinforcement emitting is thus the key to an optimized shaping procedure. In addition to encouraging non-verbal implicit learning, another central benefit of reinforcement learning is the question of motivation (Bilodeau & Bilodeau, 1969). Indeed, as learners are only reinforced on successful trials, the question of how to do it is not a matter of debate: subjects learn simply to repeat what was correctly produced. Through positive reinforcement, motivated pleasure emerges when frequency of appearance of the positive signal increases.

Following the hypothesis that motivation is "feedback in action" (Annett, 1969), we adapted the use of the Wiimote to shape individuals to use a specific kinematic pattern in a visuo-motor aiming task, by providing real-time reinforcement signals for successful trials. Various music extracts were proposed and subjects selected the extract that was to be used as the positive reinforcer for the shaping procedure. The main hypothesis of this study was that the presence of a preferred music would increase both motivations to learn, speed of learning and performance outcome (accuracy and stability).

METHOD

30 healthy adults participated in a 2-hour experimental session. They were assigned to either a group receiving musical reinforcement (MUSIC) or a group that performed with neutral reinforcement (BIP). All subjects performed the two experimental conditions. In the DISCRET condition, the task was to produce rapid and precise aiming movements to 7 targets that reconstructed an *infinity* shape (see fig.1-left). In the FLUENT condition, the task was to

produce a smooth and slow movement around the *infinity* shape without stopping at any one point (see fig.1-right). For each condition, subjects performed a pre-test (20 cycles without reinforcer), a test (120 cycles with MUSIC or BIP), and a post-test (20 cycles without reinforcer). Subjects selected the music, at the start of the session, by picking the preferred piece out of a play list of 10.

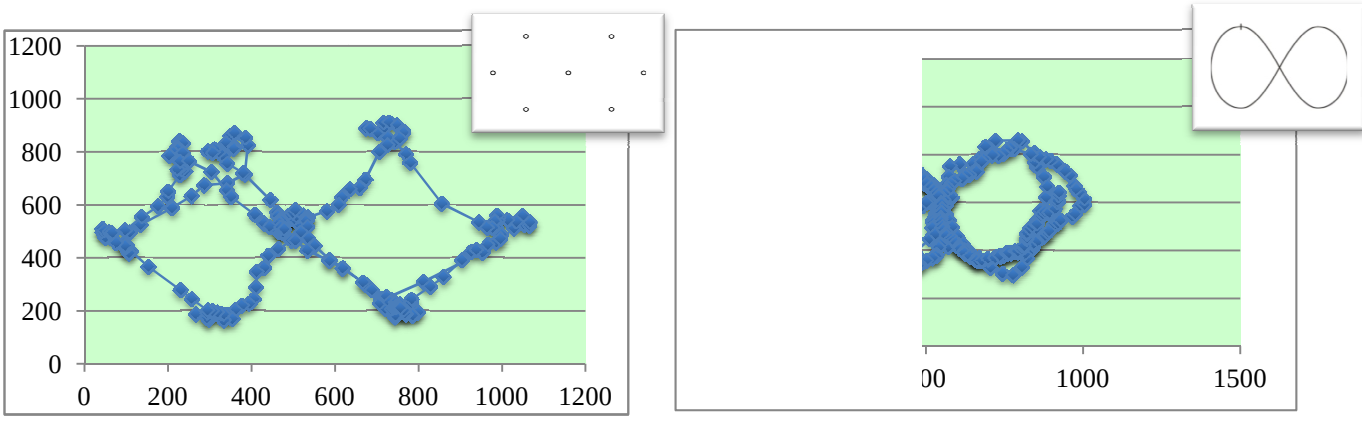

Fig.1 : Example from a subject with music, in the DISCRET (left) and in the FLUENT (right) conditions.

RESULTS

For each cycle, space and time errors were measured. Preliminary results suggest that all subjects improved space accuracy. For the BIP group, participants gained 1.9 pixels between pre and post-test; for the MUSIC group, 2.7 pixels were gained. Change in performance levels were also observed for time accuracy. Time error variability decreased for both groups in a similar matter. However, the BIP group maintained a reactive type of motor planning being systematically late to target appearance (- 20ms) whereas the MUSIC group adopted a predictive type of control being systematically in advance to target appearance (+120ms). The analysis of space coordination in X and Y axes further revealed that the subjects in the MUSIC group maintained better the general shape of the relative distances between the targets than those subjects in the BIP group. Finally, a majority of the participants in the MUSIC group referred to the session as being long but enjoyable; most of the participants in the BIP group reported being tired and discouraged because the task was too difficult. This subjective experience was objectively quantified with a significantly greater index of difficulty for the BIP group than the MUSIC group.

DISCUSSION

In the present study, we used the Wiimote to provide real-time positive reinforcement to subjects in order to favour the emergence of a novel motor behaviour. Our results suggest a beneficial effect of operant conditioning through music for a faster acquisition and stabilization of a complex task that requires precise kinematic control both in time and space. Most importantly it demonstrates the power of reinforcement learning for the emergence of pleasure, even for a very repetitive and constraining motor task.

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