The timing aspects of our movements can be implemented by two kinds of processes, referred as: event-based or emergent. The use of a particular timing process seems determined by task conditions, and especially the (dis)continuous nature of movements, which allows using different system resources (as perception of time processes or limb inertia), in order to determine time intervals. However, after testing different conditions in rhythmic tasks, it seems evident that these conditions implies differentiated goals, with on one side the maintaining of a frequency of movement (emergent timer) and on the other side an anticipation/coincidence process between a feed-back and time perception process.

Key words: Variability, Event-based Timer, Emergent Timer

INTRODUCTION:

Zelaznik et al. (2002) showed that time could be controlled in two different ways: (i) explicitly: timing control exploit cognitive representations of rhythms (ii) implicitly: timing control is based on the dynamical properties of limb movements. They spoke of event-based timers in the former case, and of emergent timer in the latter. They made the assumption that the discontinuous/continuous nature of the task determines the preferential use of one timer or the other. Delignières et al. (2004) reinforced this assumption by analysing the power spectra of time intervals produced either in a tapping task (discontinuous task involving the exploitation of an even-based timer) or a forearm oscillation task (continuous task involving the preferential use of an emergent timer). Figure 1 presents the mean spectra obtained. An obvious difference can be observed in the high frequencies, with a positive slope in the case of event-based timers and a negative slope for emergent timers.

![Figure 1: Mean log-log power spectra obtained in a tapping task (left panel) and in a forearm oscillation task (right panel).](image)

However, Lemoine et al. (2007b) showed that even if the (dis)continuous nature of movements constitutes the main determinant for the use of a particular timing process, other factors could play an important role.

The aim of this study was to test a number of tasks factors, in order to determine their relative contribution in the preferential use of event-based or emergent timing control.

METHOD

11 participants took place in 3 sessions. They were tested in 9 conditions, twice per condition. The basic task was a rhythmic oscillation of the forearm, performed in the vertical plane following a period of 800ms (given in the first 25 cycles by a metronome). Participants had to synchronize the maximal extension of the elbow with the metronome. In the different studied conditions, participants had to perform oscillations with a tapping event at maximal
extension (Tap), without the tap (Osc), and without the tap but with an auditory feed-back at the maximal extension (FB) (session 1). In session 2, we tested the effect of limb inertia placing a weight in the hand of subjects (with tap: TapW, and without tap: OscW) and finally we tested subjects in the classical Tapping and Air Tapping tasks. Finally in session 3 we tested the effect of movement discontinuity by testing participants in the Osc task with two distinct instructions: to perform the movement as smoothly as possible (OscS) and to perform oscillations with the shortest time of movement (OscD).

In order to detect the timing process used in each condition we applied the DWA method proposed by Lemoine et al. (2007a), which was proven to give more reliable results than spectral analysis.

RESULTS

We obtained a mean $\gamma_1$ index (from DWA) negative in the Tap, FB, Tapping, Air Tapping, TapW and OscD conditions, revealing the dominant use of an event-based timing; and positive for the Osc, OscW, and OscS conditions revealing the use of an emergent timing process. The ANOVAs carried out on $\gamma_1$ index revealed significant differences between the Osc and Tap conditions; between the Tapping and both Tap and TapW conditions; between the Air Tapping and both Osc and OscW conditions; between OscS and both FB and OscD conditions, and between Osc and FB.

DISCUSSION

Limb inertia plays a role in timer’s exploitation as can be seen in the Tapping, Tap and TapW conditions with an increase of $\gamma_1$ indices with the increase of inertia. As observed in previous works the presence of a tapping event results in the exploitation of an event-based timer. However, inertia or movement discontinuity cannot be considered as the main determinants of the exploitation of a particular timing control process. Indeed, in the FB condition participants used an event-based timer whereas in this condition the movement trajectory is the smoothest (measured via Normalised Mean Squared Jerk). Discontinuity and the use of inertia are probable origins but not the explaining factors of timers’ exploitation. On one side, the use of an event-based timer seems to be initiated from task constraints: task conditions seem to involve an anticipation/coincidence process between a feed-back (sensitive, auditory, kinesthetic ...) and a time perception process. On the other side, the use of an emergent timer seems to be dependent on limb’s inertia. Nevertheless, inertia seems to be an inciting but not sufficient condition. Indeed, emergent timers were exploited in tasks requiring frequency maintenance.

REFERENCES


