Proceedings XTerM 2019
Normandie Univ - Le Havre, France – June 26-28, 2019

DESIGNING FIELD OF PROMOTED ACTIONS FOR MOTOR LEARNING: THE USE OF VISUAL FEEDBACK IN POSTURAL REGULATION ON A MECHANICAL HORSE

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Abstract. The aim of this study was to investigate how the use of a real-time visual feedback (Fb) impacts on the learning of postural coordination patterns on a mechanical horse (MH). Twelve participants followed a protocol composed of a pre-test, three learning sessions, a post-test and a retention test. During the pre-, post- and retention tests, the participants had to perform four postural coordination patterns: a spontaneous pattern, an *anti-phase* pattern, an *in-phase* pattern and an *out-of-phase* pattern. During the three learning sessions, they performed one the four above-mentioned patterns. The participants and the MH were equipped with goniometers to compute the relative phase (RP). The real time computation of the RP was used a visual Fb for the participants. After each session, interviews with the participants were performed to collect their lived experience (*i.e.,* phenomenological data). Results showed that all participants' postural coordination significantly differed between the pre- and post-test and the phenomenological data revealed that participants extensively relied on the visual Fb to develop strategies to regulate their coordination with the MH. These results suggest that the design of tasks using a visual Fb would invite participants to efficiently explore new postural strategies and stabilize prescribed coordination patterns.

Keywords. Mechanical Horse, Feedback, Postural coordination, Phenomenology, Learning

1 Introduction

This communication presents a study, which sought to investigate the effects of a real-time visual feedback (Fb) on the learning process of postural coordination patterns on a Mechanical Horse (MH). This study belongs to a broader project aiming to understand the effects of the MH in rehabilitation for brain-damaged patients. [1] have already shown that expert horseback riders have (1) a better ability to maintain the rider/horse synchronization and (2) the postural coordination differed between the riders and non-riders (i.e., the riders displayed trunk oscillations in anti-phase with the MH, meaning that when the horse moves forward, the rider's trunk moves backward, while the non-riders showed out-of-phase trunk oscillations). Therefore, knowing that the efficiency of postural regulation on a MH is linked to expertise, we sought to characterize in depth the underlying processes involved in the learning of specific postural coordination patterns with the MH using a visual Fb method. In this context and as suggested by [2] we hypothesize that the use of a visual Fb would help to stabilize the prescribed coordination pattern.

2 Method

Twelve healthy participants volunteered to participate in the study. They all had no prior experience in horseback riding. The protocol was designed as follows: participants performed a pre-test in which they had to perform four coordination patterns in function of the MH oscillation frequencies: (1) *Spontaneous* coordination (SC) without visual Fb, (2) *in-phase* coordination (0°) with Fb, (3) *out-of-phase* coordination (90°) with Fb, and (4) *anti-phase* coordination (180°) with Fb. The visual Fb was given in real time and corresponded to a blue dot projected on the wall, which became green when the participants adopted the right coordination pattern. For each coordination pattern, the oscillation frequency of the MH was set at 50% and was incremented to 70% and 80% every three minutes. After the pre-test, participants were then equally and randomly spread in four groups: (1) the control group, (2) the 0° group, (3) the 90° group and (4) the 180° group to perform three learning sessions over three weeks. A post-test similar to the pre-test was then performed. Finally, a retention test was performed four weeks later. Participants and MH were instrumented of goniometers (one placed on the riders' right hip and one on the bottom of the MH) to conduct the postural coordination measurements; then, the angular positions of each oscillator were compared to those of horse's oscillator and allowed to compute the discrete relative phase (RP) (*i.e.,* the difference of time between two similar occurrences from two oscillators). After each session, participants did a self-confrontation interview using the video recordings of the session. These interviews aimed at qualitatively documenting the participants' experience with the visual Fb and notably how they were interacting with the visual Fb to reach and stabilize the expected coordination patterns. To compare the learning of the coordination patterns between the groups two statistical analysis were conducted with a four-way 4 ($Groups_{(control/0°/90°/180°)}$) x 2 ($Learning_{(Pre\text{-}test/Post\text{-}test)}$) x 4 ($Patterns_{(spon/0°/90°/180°)}$) x 3 ($Frequencies_{(50\%/70\%/80\%)}$) ANOVA and two-way 3 ($Sessions_{(S1/S2/S3)}$) x 3 ($Frequencies_{(50\%/70\%/80\%)}$) ANOVA and performed with SPSS software (SPSS Statistics 21, SPSS Inc., IBM, Chicago, IL, USA).

3 Results

The analyses of postural coordination patterns showed (1) a significant modification of the trunk/horse coordination after three learning sessions. Indeed, the coordination of the twelve participants significantly changed between the pre-test and the post-test, $F(1,8)=6.5$ ($p<.05$); (2) significant differences in the coordination of all participants in function of the prescribed pattern, $F(1.3,10.3)=21.8$ ($p<.05$); (3) and an interaction effect between Learning*Patterns. Indeed, the coordination performed in post-test during the 0° and 90° patterns was different from that in pre-test, $F(1.5,11.9)=11.8$ ($p<.05$); (4) finally, during learning sessions, a significant effect of learning group was shown ($p<.05$), in particular the 0° group.

The analyses of the interviews showed that participants adopted specific exploratory strategies in order to fulfill the tasks and adapt with the MH oscillations. More precisely, participants relied on (1) multimodal embodied elements such as, muscular activity involved in the interplay between anteversion and retroversion of the plexus, the MH noise, kinesthetic information related to the sensation of the saddle; (2) the search of the adapted coordination, such as changing the position of the trunk, or standing up on the stirrups, jumping on the saddle and (3) a specific and changing use of the Fb for monitoring their activity, by impacting on the dot trajectory and color (i.e., from blue to green). These exploratory strategies were associated to more important variability of the RP and in a more salient way in the 0° and 90° coordination patterns (Figure 1).

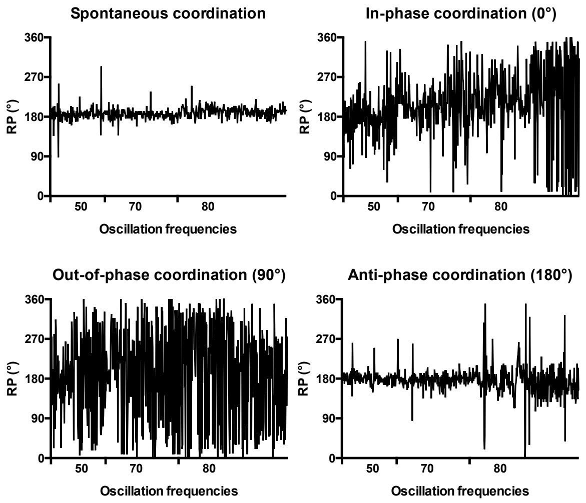

Figure 1. Depiction of four coordination patterns performed by a participant according to requested pattern (*i.e.,* spontaneous coordination, 0°, 90° and 180°), for each oscillation frequency.

4 Discussion

This study provided insights into how learning a coordination pattern with a visual Fb is shaped by the task constraint. According to [3], the design of field of promoted actions could be achieved in rehabilitation by using MH. Notably, the prescription of various coordination patterns on the MH during learning led to exploration after only three learning sessions [4]. The combination of the data about the participants' experience and behavioral data (the RP) enabled to understand how those coordination patterns were explored, learned and stabilized. Indeed, our results suggest that when participants were prompted to learn a pattern that differed from their spontaneous coordination, they were invited to explore more ranges of other coordination patterns. In doing so they developed exploratory strategies in which they involved their bodily engagement and cognitive activity in relation either to the MH speed, the Fb or both at the same time. Interestingly, when they stabilized a learnt pattern, the dot was no longer used as a support for inquiry but as a help for monitoring their activity (*i.e.,* the dot was used to control that ones' position was always right). This perspective highlighted the interest of articulating behavioral and phenomenological data, whose mutual enrichment [5] provided a more holistic depiction of activity. The upcoming and practical perspective is to apply and adapt the strategies used by healthy participants to develop rehabilitation protocols for brain-damaged patients [6] by taking experience into account during sessions of adapted physical activity in a clinical context.

Acknowledgement

This project received the support of the CPER/GRR1880 Logistic, 1343 Mobility, and Numeric and FEDER XTerM.

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