**ANR DynACEV**

The ecological dynamics framework conceives learning as the reorganization of the learners' behavioral repertoire (Davids, Araújo, Hristovski, Passos, and Chow 2012). It consists in the destabilization of the learners' initial repertoire and the stabilization of a new repertoire (Schöner, Zanone, and Kelso 1992).

High inter-individual differences can appear in the learning dynamics. For instance, learners may demonstrate no improvement in their performances during practice due to low exploration of the possibilities of actions than can be performed, while others may find an appropriate motor solution early in practice (Orth, Davids, Chow, Brymer, and Seifert 2018). These differences can be explained by the gap between the task demands and the learners motor repertoire and/or by task constraints that are not set to encourage the learners to search for new motor solutions.

**Aim and hypotheses**

This project aims at assessing the effects of variable practice and autonomy on the learning dynamics and on the motor repertoire of the participants. A climbing task was chosen.

Our first hypothesis is that participants would benefits from variable practice because the repeated confrontation to new climbing routes would encourage the participants to explore new behaviors. Inversely, as the participants in the control group are always practicing on the same climbing route (Figure 1), they may demonstrate early stabilization of behavior and performance due to the lack of constraints encouraging them to search beyond their initial motor repertoire, which should not be observed for the variable practice group.

Our second hypothesis is that participants would benefits of having some autonomy in the variable practice. Indeed, by giving to the participants the opportunity to choose between climbing a new route or practicing more on a previous route, the practice schedule would be more respectful of the participants learning dynamics, as they would better master their rate of exploration of the new route. Thus, they will be given the opportunity to stabilize and exploit emerging behavior during practice.

The key periods of exploration and exploitation during practice are assessed through the joint analysis of the performance and the behavioral dynamics of the participants.

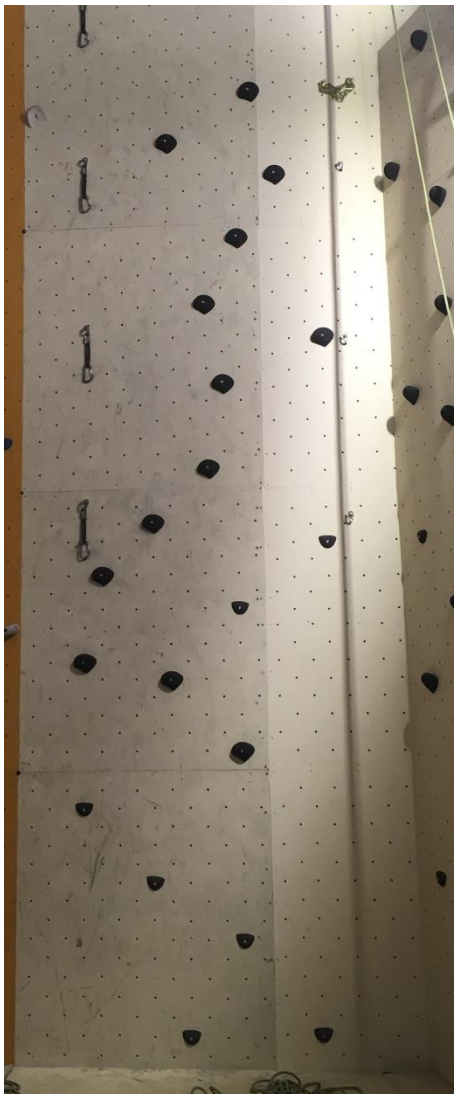

*Figure 1: Picture of the control route. This route was designed with two types of holds: one model for handholds and one for the footholds.*

**Performance dynamics**

As participants are prompted to climb as fluently as they could, their fluency is measured on each trial. It enables to observe their performance dynamics during learning. For illustration, we can observe the dynamics of the jerk of hip rotation for one of the participants on the Figure 2. The jerk of hip rotation is a

spatiotemporal indicator of the climbing fluency. The means and 95% confidence intervals suggest that this participant improve his fluency on the 1st to the 5th session, then stabilized between sessions 5th to 8th and, finally, kept on improving on the last sessions.

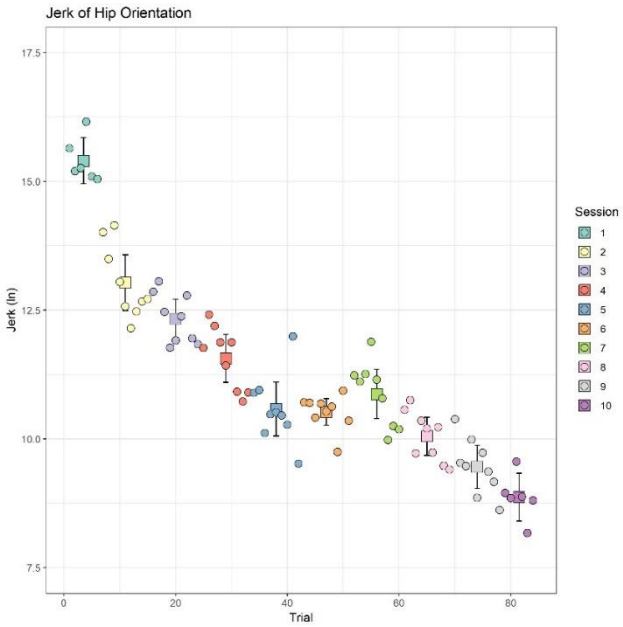


*Figure 2: performance dynamics of one participant in the control group. The squares represent the mean fluency score during the session, and the error bars the 95% confidence intervals.*

**Behavioral dynamics**

To describe the behavior of the participants, the total time of contact on each hold (in seconds) for each trial is measured using the Luxov® Touch system (http://www.luxov-connect.com/en/products/#touch, Arnas, France) (Figure 3).

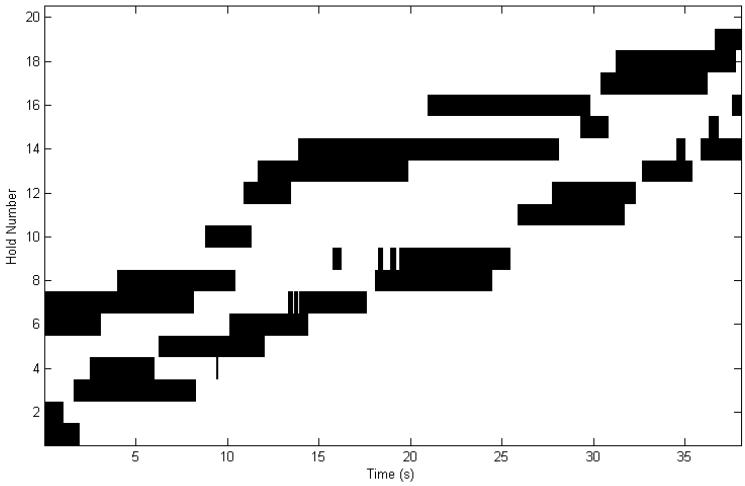


*Figure 3: Time of contact on each hold of the control route during one trial. Each black rectangle represent a contact with one of the hold. The label of the holds is on the y-axis, and the timeline of the climb is on the x-axis.*

The Figure 4 highlights whether the distribution of the time of contact on hold relative to the climbing time on the route is different between trials. A hierarchical cluster analysis (HCA) was applied on the relative time of contact on each hold to classify trials and to observe the behavioral dynamics of the climber.

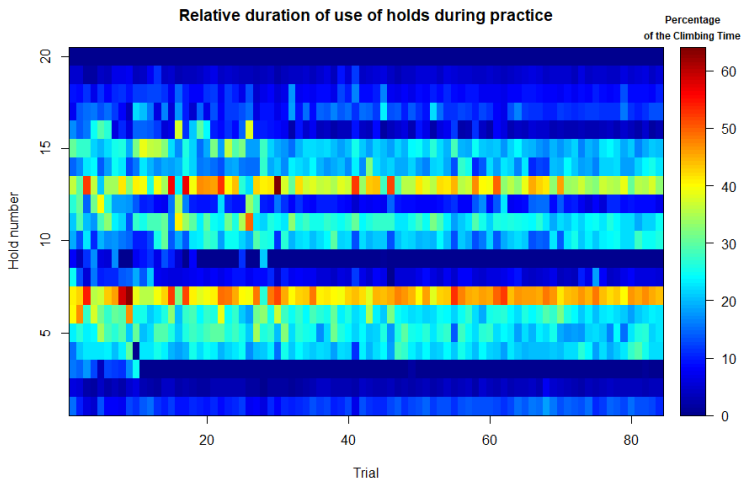


*Figure 4: Heatmap representing the relative duration of use of holds (in percentage of the climbing time) for each trial of one participant of the control group. Each line corresponds to one of the holds of the control route and each column corresponds to one ascent of the route.*

The application of machine learning analysis to the relative time of contact on each hold enables to classify the trials according to their similarity, thus, to reveal the different behaviors performed by the climbers during practice. As highlighted by the Figure 5, five behaviors have been revealed using a hierarchical cluster analysis. The Figure 5 also illustrate the behavioral dynamics of the climber, showing an intermittent regime early in practice, followed by the stabilization of the cluster 5.

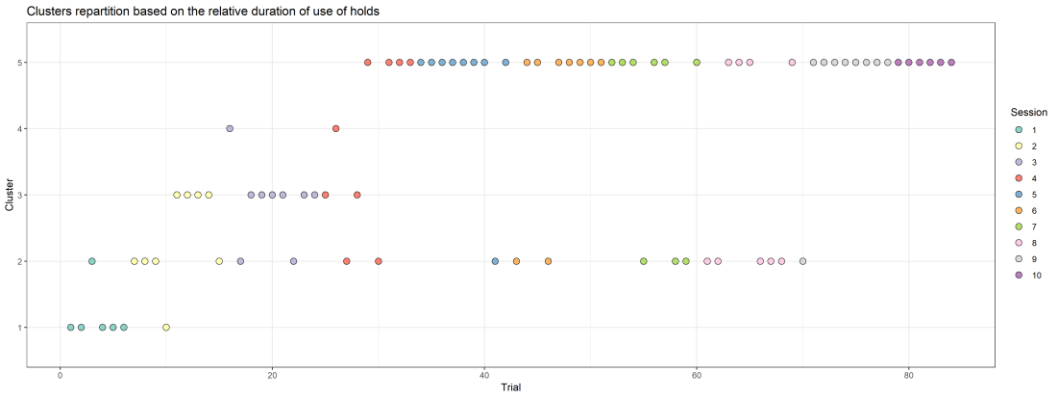


*Figure 5: Behavioral dynamics of one participants of the control group. Each point represents a trial on the control route. The cluster on the y-axis represents the five behaviors that the participant exhibited on this route during practice. the colors refer to the climbing sessions.*

## References

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