CLIMBERS' LEARNING DYNAMICS: AN EXPLORATORY STUDY

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Abstract

Climbers repeat ascents of routes to reach the top without stopping. Indeed, stops during the ascent induce fatigue that can be detrimental to performance, or even climber's safety. To decrease the impact of fatigue, climbers should learn to perceive the chain of movements needed to reach the top of the route in a fluent way. Methods: A novice climber followed a learning protocol composed of 13 climbing sessions, including 10 practice sessions and 3 test sessions (pre-, post- and retention test). Performance was assessed during each ascent using 4 metrics: (1) spatial fluency with the index of geometric entropy, (2) immobility score, (3) spatiotemporal fluency with jerk of hip acceleration and jerk of hip rotation and (4) climbing time. These scores were related to climber's behavior on the route using the Luxov® system giving time of contact with holds. Results: Climber improved all performance scores with practice while behavior changed nonlinearly during practice. Discussion: He appeared to perceive the route in functional terms as they perform the route more fluently and stabilize a chain of movements on the lasts trials. Instrumented holds appear to be interesting in training to detect crux in the route and assess climbers' fluency during ascents.

Keywords: Climbing, Motor Learning, Instrumented holds, Fluency.

Résumé :

Les grimpeurs répètent plusieurs fois la même voie pour atteindre le sommet de la voie sans faire d'arrêt. En effet, les arrêts pendant la grimpe amènent de la fatigue qui peut nuire à la performance, voir à la sécurité du grimpeur. Dans le but de diminuer l'impact de la fatigue au cours de la voie, les grimpeurs doivent apprendre à percevoir l'enchainement nécessaire pour atteindre le sommet de la voie de manière fluide. Méthode : Un grimpeur novice a suivi un protocole d'apprentissage composé de 13 séances d'escalade, dont 10 de pratique et 3 tests (pré-, post- et test de rétention). Sur chaque voie, sa performance était mesurée avec 4 métriques : (1) la fluidité spatiale, (2) le score d'immobilité, (3) la fluidité spatiotemporelle et (4) le temps de grimpe. Ces scores ont été mis en relation avec son comportement sur la voie en utilisant le système Luxov®. Ce système donne les temps de contact du grimpeur avec les prises de la voie. Résultats : La performance du grimpeur était meilleure avec la pratique et son comportement évoluait de manière non linéaire au cours des séances de pratique. Discussion : Le grimpeur étant plus fluide et stabilisant un enchainement de mouvement sur les derniers essais, il semble percevoir la voie de manière fonctionnelle. L'usage de prises instrumentées à l'entraînement semble intéressant pour localiser les crux de la voie et mesurer la fluidité des grimpes.

Mots clés : Escalade, Apprentissage Moteur, Prises instrumentées, Fluidité.

Introduction

In climbing, it is frequent that climbers repeat ascents of routes several times, and sometimes just part of routes, to reach the top without stopping. Indeed, stops during the ascent induce fatigue that can be detrimental to performance, or even climber's safety. Therefore, climbers should learn to perceive and act on an appropriate chain of movements to reach the top of the route.

Ecological psychology suggested that individuals perceive their environment in terms of affordances (J. J. Gibson, 1986), which were defined as opportunities of action emerging from the individual-environment interactions (e.g., the grasp-ability or reach-ability of handholds in climbing). Through direct experience in specific context, individuals are progressively more attuned to key components of the environment (Jacobs & Michaels, 2007) and discover optimal means of adjustment of their relation to the environment (E. Gibson, 1988), this process is called exploration. In this perspective, the concept of exploration that stems from the ecological psychology suggests that when practicing, individuals become more sensitive to properties of their environment to perceive and act on affordances.

This study aims at describing climber's behavior and performances during the practice of a route to investigate exploratory processes during a learning protocol. We hypothesized that climber would first demonstrate variability in his behavior related to exploration of the route and would, on a second stage, stabilize behavior and performance, which would be related to the perception of an appropriate chain of movements in this specific context (i.e., the repetition of trials on a climbing route).

Methods

The leaning protocol was composed of 13 climbing sessions, including 10 practice sessions and 3 test sessions (pre-, post- and retention test). During each practice session, participants climbed 3 routes: a control route (figure 1) and 2 other routes. This study only focuses on the control route. One of the 2 other routes changed on each session, each route being practiced during 2 sessions. All handholds were the exact same model and did not change during the whole learning protocol, only their disposition on the wall differed between routes. Climber had 3 trials on each route per session so that he realized 9 ascents per session with the following task-goal: "find the way to climb the route as fluently as possible, avoiding stops and saccades". He was also prompted to use all handholds of the route in a bottom-up order and he was forbidden to use handholds with both hands at the same time.

Climber wore a light and an inertial sensor unit (HIKOB®) on the back of his harness. Ascents were filmed with a GoPro® camera covering the entire wall. The harness light was video-tracked on Kinovea software to obtain climber's hip trajectory. Holds were instrumented with the Luxov® system to record the time to contact on each hold.

In the aim of assessing climbing fluency, we computed the immobility score on each trial of the control route (Seifert, Boulanger, Orth, & Davids, 2015), the jerk of hip acceleration and the jerk of hip rotation (Seifert et al., 2014), the geometric index of entropy (Cordier, France, Pailhous, & Bolon, 1994) and the climbing time. To describe climber's behavior during practice, (1) the time spent on each hold, (2) the percentage of the climbing time spent on each hold, (3) the number of touched holds and (4) the percentage of the climbing time spent on 4, 3 or 2 anchors were computed for each ascent. All treatments were performed with Matlab R2014a software.
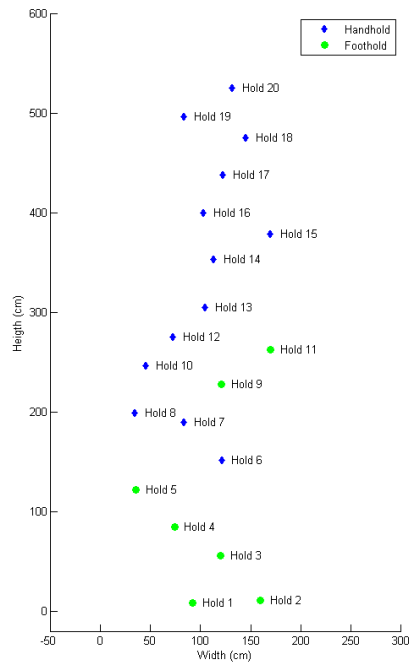
Figure 1. Representation of the control route with handholds in blue and footholds in green. Each hold was labeled with a number written next to its location.
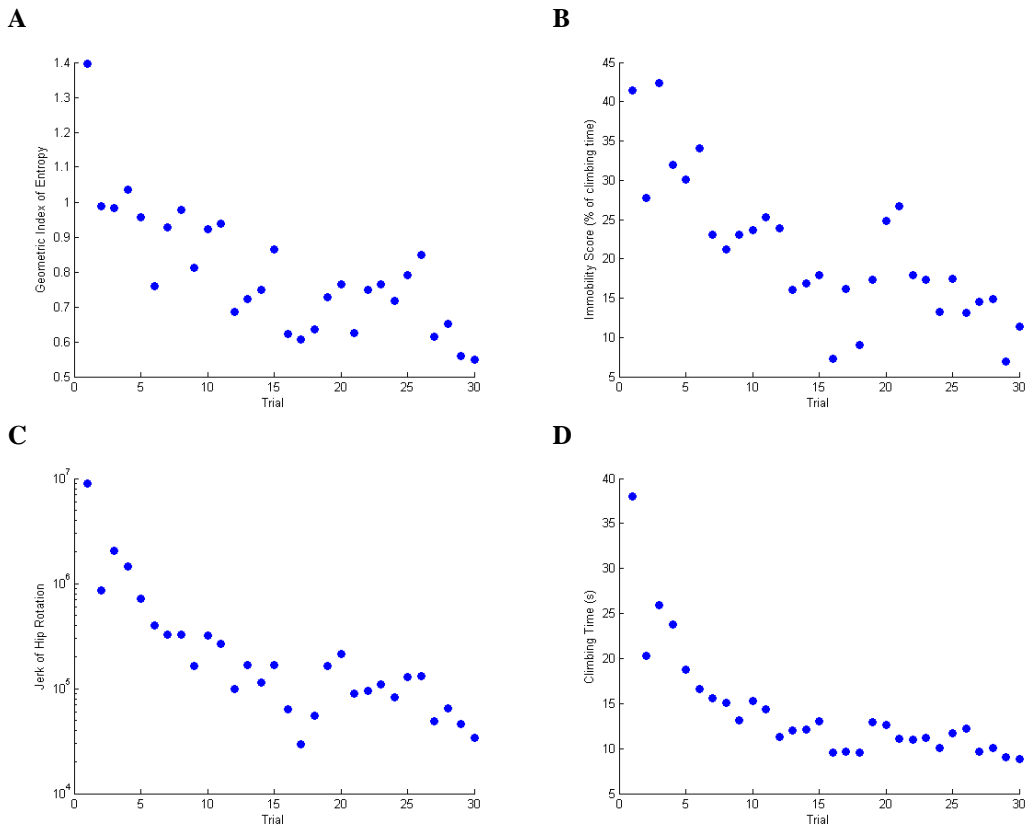
Results

Figure 2. Dynamics of the performance metrics: (a) geometric index of entropy, (b) immobility score, (c) jerk of hip rotation and (d) climbing time across trials on the control route.
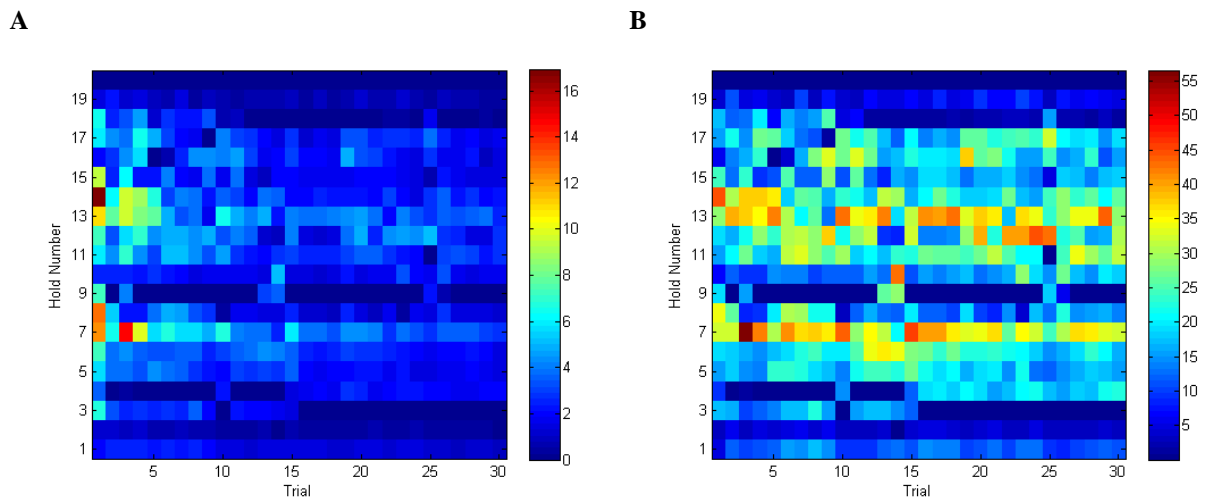
A   B

Figure 3. Heatmaps of the use of holds for each trial on the control route. Pannel (a) displays the time spent on each hold in seconds, while pannel (b) shows the percentage of the climbing time spent on each hold.

Discussion

Participant climbed the route more fluently over the learning sessions according to all the observed performance metrics (figure 2). Performance improvement can be dissociated in 2 steps: first, climber seem to improve the fluency scores sharply until the 18th trial and second, climber's progression seems to reach a plateau.

The heatmaps suggest that climber explored different ways to reach the top of the route until the 15th trial (figure 3). Hence, exploration appeared to be more local, with few changes in the organization of the use of the holds. The learning dynamics seem to follow a nonlinear trend if we refer to climber's behavior during practice.

According to these results, climber would perceive the route in functional terms as they explore different ways to perform it until they find and exploit an efficient chain of movements.

Thus, the use of instrumented holds is interesting in training (1) to detect crux in the route by measuring the time spent on each hold and (2) to assess climbers' fluency during ascents by measuring the time spent on 4 or on 3 or 2 anchors, the time spent on 4 anchors referring to immobility.

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