LEARNING STRATEGIES AND ENERGY CORRELATES IN A COMPLEX CYCLICAL SELF-PACED SKILL ACQUISITION

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INTRODUCTION

It is well known that as motor skills are being acquired, their execution becomes increasingly efficient, i.e., the amount of energy expended decreases and/or the mechanical output increases (Durand et al, 1994; Sparrow et Irrizary-Lopez, 1987).

Furthermore, skill acquisition is considered as a complex process in which the transformations produced are generally presented as a systematic search of the optimal solution in the perceptual motor work space. (Newell et al, 1989). Seller (1994), in learning discovery condition, observed that the learner was able to assess the efficacy of this strategy without feedback or instructions.

According to these authors, the search strategy orientation provides a basis for understanding the macro level behavioral changes in the movement form or coordination.

The aim of this study was to examine the behavioral and energetical aspects of the individual search strategies in learning a complex cyclical task.

METHOD

Subjects

Five physical education students from the University of Montpellier, France, volunteered to take part in the experiment. They were not experienced skiers, but all actively participated in some sport. Their mean age was 24.6 years (SD=1.14), their mean weight, 74.00 kg (SD=4.30), and their mean height 1.80 m (SD=0.03).

Subjects were trained for five sessions and then took a post-test. The training sessions were conducted on five consecutive days, and the post-test was given one week after the final training session. The sessions and post-test always took place at the same time of the day. The training sessions consisted of a 100min warm-up followed by four 4-min learning periods with a 4-min break between them. The post-test was identical to the training sessions. The instructions given during the sessions were recorded on tape.
Tasks and apparatus

The subjects were instructed to learn to make slalom ski-like movements, which were “as wide and frequent as possible”. The movements, which were lateral and cyclical, were executed on a ski simulator (see Vereijken, 1991, for a detailed description). This apparatus (Skier's Edge) consists of a platform on wheels which moves back and forth on two bowed, parallel metal rails. The subject's feet are strapped to the platform, which in turn is fastened to the rails by means of two adjustable rubber belts.

Variables measured and calculated

Oxygen intake (VO2) was measured continuously using an open-chain, cycle-to-cycle system (CPX, Medical Graphics). The subjects were filmed throughout the training sessions and the post-test (Panasonic HiSi video camera, 500 obturations/s, sampling rate 50 Hz, mid-frontal view). The videotape was analyzed frame by frame and movement amplitude was measured. After placement of a video timer (type VGT 33, FOR A), the frequency in Hertz was calculated from the time codes recorded at the rightmost and leftmost points of the movements (+/- 20 ms).

The subject's movements were analyzed for the last 15 seconds of each of the 4-minute learning periods and the 4 post-test periods, for a total duration of 24 minutes. For each of these 15-second segments, the recorded oxygen intake patterns were synchronized with the kinematic parameters of the corresponding periods (averaging over 15 s).

The following variables were calculated: mean movement amplitude in cm (A), mean cycle frequency in Hz (F), mean oxygen intake per unit of body weight in ml.kg.min\(^{-1}\) (VO2), and movement cost. (VO2 \(\div\) A \(\times\) F, expressed in ml.kg. cm.s\(^{-1}\)). Changes in each of these variables across training sessions were studied. An analysis of variance was conducted using the following design: 5 x 4 x 6 (subjects x periods x sessions).

RESULTS AND DISCUSSION

The mean amplitude and frequency increased significantly across sessions. The mean oxygen intake increases in a constant fashion whereas the movement cost decrease significantly in the same time with a fluctuation on the fourth session. The evolution of the individuals frequencies did not follow the average pattern, frequency was stable for subjects 2 and 5, decreased for subject 1, and increase for subject 3 and 4. On session 1, the movement frequency adopted by the various subjects differed, the correlation (r) between the subject's weight and the frequency was .51. On the post-test, this correlation dropped to .09 (figure lb.).

Learning strategies were approached by analysing the topologic characteristics of the individual patterns of the amplitude/frequency ratio: The gradient of the increment (regular or not), the directional or undirectional aspect and the number of explored dimensions (figures 2)

Subjects 4 and 5 displayed a progressive local strategy: the gradient of increment was small and regular. Subject 4 explored two dimensions (amplitude and frequency) whereas the subject 5 kept one dimension constant (the frequency). Subject land 3 displayed an irregular strategy: the gradient of increment can be weak or very large depending on the moment in the learning process. Both subjects explored the two dimensions but not in the same direction.
Fig. 1. Evolution of the Individual Patterns in Amplitude (a), Frequency (b), Oxygen Intake (c) and Movement Cost (d) across Learning Sessions.

Fig. 2 Individual Learning Strategies and Movement Cost.
In each cyclical task, there is an optimal pattern of response (Durand, 1992a, 1992b; Sparrow, 1983). There are many possible strategies to reach this optimal point that emphasize or not efficiency. It seems that regular strategies with weak gradients provide a simultaneous gain in economy (figure 2g and 2h). The motor workspace is explored in a proximal way, which is consistent with the "local search strategy" described by Newell, (1989). In the irregular strategies (figure 2a and 2e) when a qualitative advance occurs in the perceptual motor workspace, it is characterised by some breaks in the gradient of increment. These breaks enhance in the first time a supplement of energy expended (see the peak on figure 2b and 2f) and in the second, a gain of economy. The subjects then explore this region where the coordination adopted is less energy demanding for a quite similar quantity of work done. This appears on figures 2a and 2e by a largest density of points.
What is not yet clear is how subjects assess their strategies and what factor could be determinant for deciding the maintenance or the shift in the strategy used. Another point to be explored is how to quantify the efficacy of the search strategies in terms of amount of distance performed in the perceptual motor work space, related to the quantity of work done and the level of performance reached. The aim of a search investigation could be to define some strategies's profiles of “good or bad learners”.

REFERENCES


