QUANTIFICATION OF INTERSEGMENTAL ASSOCIATIONS IN ROCK CLIMBING AND COMPARISON BETWEEN EXPERT AND NON EXPERT CLIMBERS.

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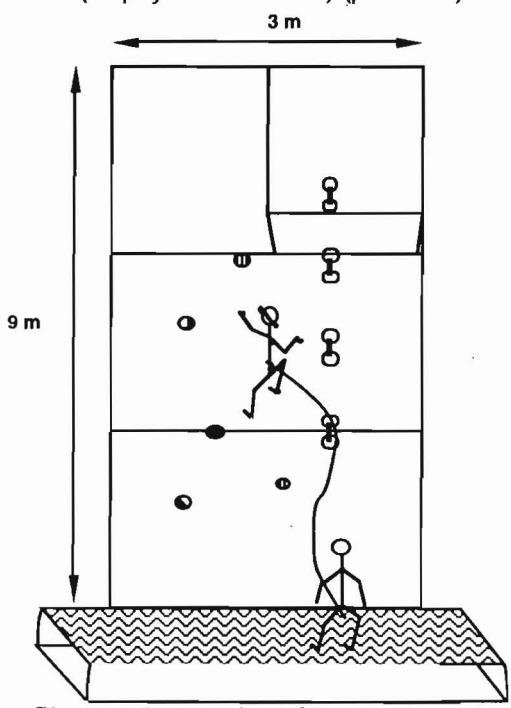
INTRODUCTION

The approaches usually used to increase knowledge about rock-climbing are numerous and different : psychological (Lefebvre 1980), physiological (Hardy and coll 1982), biomechanical (Rougier and coll 1991), psychosensorimotor aspects. Though the goal of these different approaches is to compare expert climbers and non expert climbers, none of these tries to compare behaviours of climbers through automatic control - to show the different strategies for instance -.
It is therefore necessary to record the movements of members (hands and feet), and secondly to describe climbers' movement by adequate statistical objects and then to propose statistical methods that allow to compare climbers.

METHODS

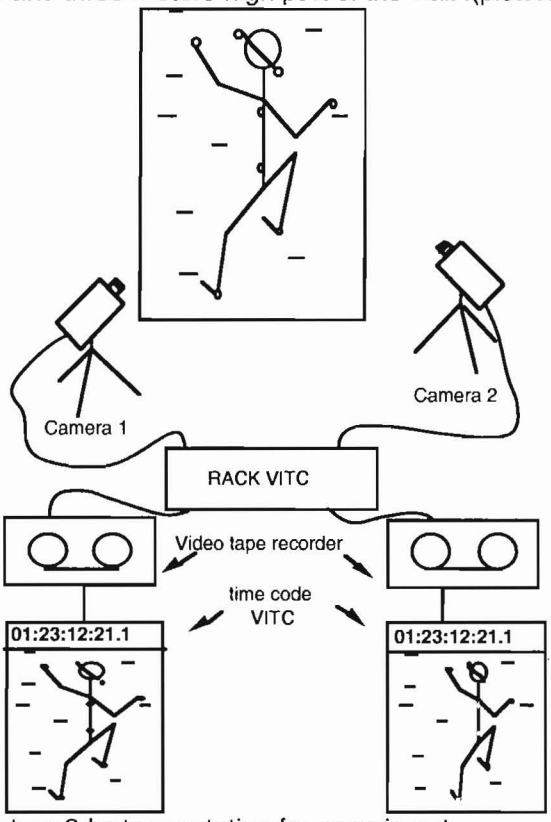
Behavioural data acquisition

The experiment consists in climbing an artificial rock-climbing wall at a maximum speed. The studied conditions takes place after a first climbing without any knowledge about the wall and after a second climbing (following a training practice). The dimensions of the wall are nine meters high and the width is defined by vertical lines. (Dupuy and col 1992) (picture 1).



Picture 1 An overview of the experiment

The studied population consists of eight expert climbers and seven non expert climbers. An expert climber is called so if his level reaches more than " 7a / 7a+" and a non expert, if his level doesn't overrun " 7a".
The system used to record climbers' movements has been developed in the Laboratory of Industrial and Human Automatics of the university of Valenciennes. (SAGA3, Cloup 1989).
The heart of this system lies on the use of reflexive markers, lighted by infrared spots. The enlightened markers are placed on the climber' s hands and feet. The ascent of the wall is recorded by two synchronized cameras, both of them connected to a videotape recorder (50 Hz).The scene of the cameras is defined by a three-meters-wide and three-meters-high part of the wall .(picture 2)

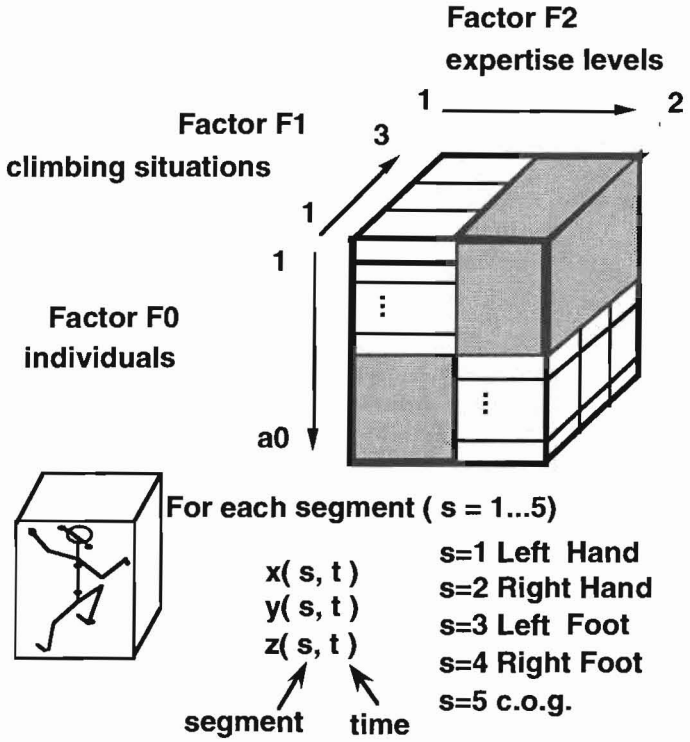


Picture 2 Instrumentation for experiment

Data analysis problematic

During the experiment, a set of data is collected in a hyperparallelepiped (picture 3) (Loslever 95) in real time, aiming at recording the climbers' movements. With this set of data, it is necessary to build, for each subject, a chronology of situations where the extremity of the four members is in contact with the wall.
These situations are called "quadricontacts". A quadricontact is defined by a precised position of the four members, each of them occupying a hold. The real problem occuring, is to find the differences between expert and non expert climbers' strategies of rock-climbing. So, it's necessary to find a technic to characterize the behaviour at first and subsequently to compare the data issued of individual evaluations.

The small sample of climbers , on the one hand, and the difficulty to consider, a priori, some probabilist behavioural models on the other hand, require to use statistical describing technics to solve this double problem.
In these conditions, all of the studied statistic units, i.e. 13*3=39 climber-condition have to be taken into account.
The first thing to do is to count and find the individual quadricontacts. The object of the following step is the study of the moves of grips between two following quadricontacts.



Picture 3 : the data structure : a hyperparallelepiped

Identification of climbers' quadricontacts

For each climber, the pictures sequences including the quadricontacts must be found. As the quadricontact notion is complex, this research can't be computed. Each sequence is spotted by the operator who extracts the data. He has to display it many times in order to determine spatio-temporal characteristics of the quadricontacts. This step of identification of quadricontacts is very long and difficult.

Intersegmental associations quantification

Between two following quadricontacts, generally only one member (RH : right hand, LH : left hand, RF : right foot, LF : left foot) has moved. In order to underline the different strategies in the movements, we count the frequency at which a member m' (m'=1..4) moves, between the quadricontact i and i+1. Therefore, an intersegmental association table is built for each climber. The value T(m,m') gives the number of times that a member m moves after a member m'.

Interclimbers comparison

Each climber is represented by a transition matrix. The data set in relation to the fifteen climbers are considered under two entry tables. The fifteen lines

correspond to the subjects and the sixteen columns to the possible intermember associations.
In order to point out classes of climbers, on the one hand, and the types of associations that distinguish them most, on the other hand, this table is also studied by the means of C.F.A.

RESULTS

The number of variations of quadricontacts is about nine to fifty (average=19, ect=8). Globally, we notice that the more frequent associations are first between the two feet t(RF,LF)=15% and t(LF;RF)=14% , second along the two " diagonals hand -foot " t(LH,RF)=12%, t(RH,LF)=9%. There is practically no " hand- hand" association. The average number of associations between expert and non expert group is nearly the same (13, 14 respectively), that seems to show that differences don't proceed from the number of quadricontacts
The C.F.A. shows that among the sixteen possible types of associations, the most discriminant ones are respectively LHLF, RHLH, LFLF et RHLF. It seems that the associations LHLF, LFLF, RHLH are more frequent for the non expert (77% against 23% on the set of this association type). The association RHLF is more frequent for the experts (61% against 39%).

CONCLUSION

It seems that the differences between expert and non expert athletes could be due to the way they alternate the successive positions of hands and feet ; experts prefer the association " hand to foot" though non experts would rather the association "hand-hand" or "foot-foot". The expert is thought to try to perform the most efficient and the most economic movement, the expressed hypothesis is that his mental card of the environnement is very near to the reality so the expert has a better control of the informational incertainty.

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