An Unfeasible Experiment: ZER0GYM. Current State and Prospects

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Introduction: the ZER0gYMN project

Gravity is the main environmental factor that molds and shapes the living species: plants, animals within these, primates and man, it is also the more stable evolutionary and adaptation factor to our planet. The first question that arises is "what happens when gravity acceleration is shifted to zero? The final aspect of our proposal is to contribute to improving the well-being in studies of habitability during long-duration space missions in whom physical activity becomes a major factor in the success and efficiency of the astronauts. The project, although not possible to be actually performed in 0g, was developed during an ESA (European Space Agency) parabolic flight (experiment CROMOS awarded by the ELGRA European Low Gravity Association) during which Irene Schlacht and Henrik Birke performed some propaedeutic exercises during the empty parabolas as a test of feasibility of the proposed experiment (Masali *et al.*, 2007). In view of new experiments (Masali *et al.*, 2010) a specific protocol of Rhythmic Gymnastics exercises modulated on the conditions of microgravity has been proposed (Tab. 1, by coach A.Tinto) and here discussed. The project coded for ESA apply as "ZER0gYMN experiencing the Rhythmic Gymnastics in Microgravity Conditions", in an ESA student educational program such as "Fly your Thesis" or similar, is addressed to students or graduate students of the Turin University School of Motor Sciences (SUISM). First objective of this experiment is to evaluate the differences from the earthly gravitation condition and microgravity in the perception of sound/rhythm by the gymnast. The study is aimed to elucidate the particular aspects of human movement and sensitivity expressed by

1	Upright, legs slightly apart, with pelvis retroversion and bents legs, spine rounding and return to upright position;.
2	Lying on back, a rolling of the body to the right, gathering the legs to the chest by lifting torso off the floor (sitting position), return to the supine position and repeat on the left;
3	Erect, step left forward impel of the right leg forward, right leg resting on the floor and immediate chest bend with forward impel the left leg up behind, return to standing position and repeat on the other side;
4	Upright, forward overturn, resting on the feet, knees bent, following lateral overturn on the with rolling back side and finishing in an upright position;
5	In pairs, one performs the vertical to the ground and the partner tries to place his/her feet touching the ground and pushing her legs in different directions;
6	In dorsal support on the shoulders, run the legs wide apart in the sagittal plane in an alternating and with a greater push of a limb (forward or backward) to hit the ground on back or flipping back the body;
7	Body rotation around the sagittal axis, arrival and semi-flexion of the torso forward in support of a limb (the other is flexed forward) return;
8	Tours of the body resting on forefoot, free leg in different positions (passé, arabesque, attitude ...);
9	In pairs, one on his back with bent legs and stretched out arms acts as a support for the companion, the companion takes different positions (vertical support with hands on the shoulders of his companion, prone horizontal resting on knees and hands on the companion partner's hands, resting on the hips prone held by the partner), according to the training of gymnasts can perform different level positions;
10	With the help of several companions, pick up a gymnast (arms and body standing up), the gymnast performs a bow back and forth, aided by his companions, puts hands on the ground and overturns.

Tab.1. *Exercises for 0g Gymnastics. Coach Amalia Tinto.*

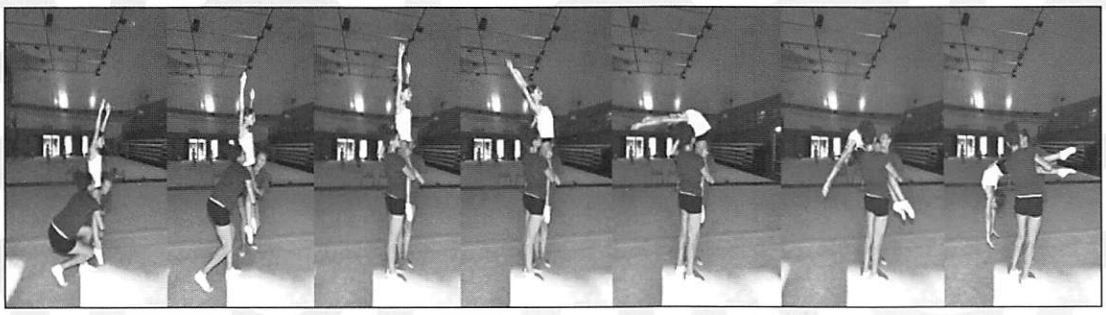

Fig. 1. *Images of the specific Rhythmic Gymnastics exercise proposed.*

this Olympic specialty in 1g and 0g conditions, as well as promoting the themes of physical activity and education to movement in Space. The Microgravity changes the circulation and sense of orientation in a complex of issues. It investigates the relationship between ZER0gYMN Gymnastics (Rhythmic in particular) movement and visual orientation in a neutral 0g posture. The project foresees the use of specific representation prepared in the specific motor context being tested under microgravity conditions during a parabolic flight. The chance to experience Rhythmic Gymnastics exercises specifically structured to express the complexity of this type of extreme physical activity, could make an important contribution to studies on human movement when stripped of its major parameter, the weight. A further aim of the proposal is to contribute to increase the component of well-being in studies of habitability during long-duration space missions, in which physical activity becomes an important factor in the success and efficiency of the astronauts.

The earlier experience

The research group mainly related to the Extreme–Design (Extreme–Design.eu) group started some propaedeutic studies considering "Gymnastics as a countermeasure to 0g" within the ESA student Project Phobos). As previously mentioned first evaluation of the feasibility of testing specific motor activities in microgravity has already been made during a trial in parabolic flights with ESA considering anthropometric extremes such as Irene Schlacht (5th ♀percentile) and Henrick Birke (95th ♂ percentile). As demonstrated by the experiments of Kitsou Dubois (Dubois, 2001), gymnastics and dance can be performed in 0g/μg offering a new opportunity to develop the study of Human Movement. The compensation of gravity parabolic flight can allow studying the perception of rhythm in 0g/μg/MACROg (from 0 to 2,5g) and the actions that can performed in the gym. The clearing of underwater gravity compensation (neutral buoyancy) may be used to develop the technique (according to K.Dubois personal communication and swimming pool demonstration in Chambery).

The exercises

We present some physical training exercises aimed to orientation education in space as a function of microgravity. Three areas/sectors have been identified: on the ground, with tools and water. 10 exercises on the ground are presented in ten study sessions prepared with the collaboration of SUISM students (Tab. 1).

Concluding remarks and perspectives

Technical difficulties and environmental change in the regulations have been delaying the possibility of continuing the Birke-Schlacht experiment in microgravity. The preparation of specific exercises developed in an environment of Neutral Buoyancy increasingly using collaborative structures, aerospace industrial environment existing in Turin, the exchange of actual experiences with the Technical University of Berlin and ESA-ESTEC allow developing this new field of investigation.

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