LEARNING TO INTERCEPT TARGETS DRIVEN BY FORCE FIELDS: EFFECTS OF MODULUS AND ORIENTATION VARIABILITY

Alessandra Sciutti[A,B], Francesco Nori[A], Giorgio Metta[A,B], Thierry Pozzo[A,C,D] and Giulio Sandini[A]

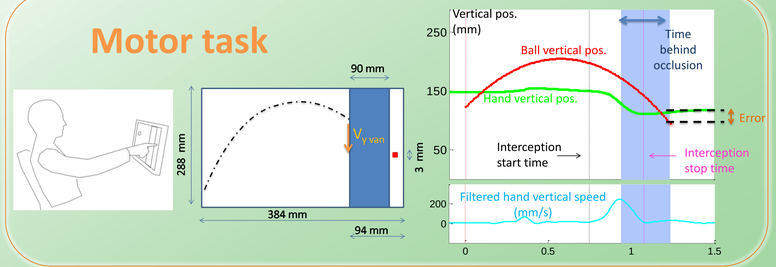
[a] RBCS Lab, Italian Institute of Technology, Genoa, Italy , [b] DIST, University of Genoa, Genoa, Italy, [c] INSERM, U887, Motricité-Plasticité, Dijon, France,[d] Université de Bourgogne, Dijon, France.

Introduction

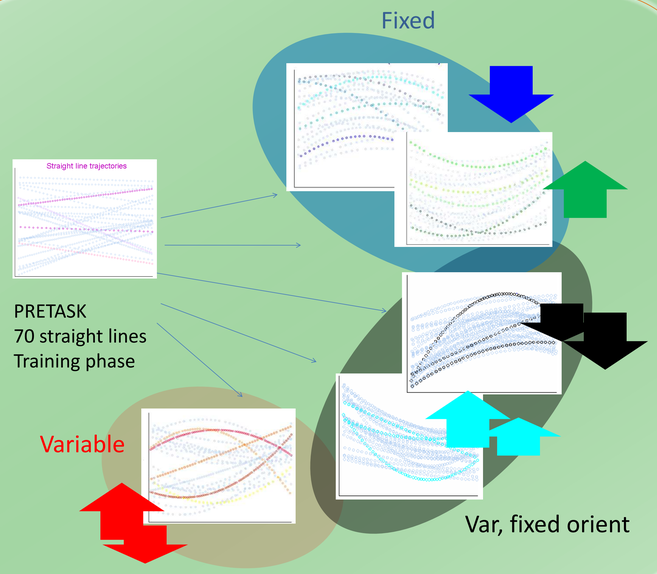
In previous studies we observed that intercepting a target may require modeling the force field which drives its motion. The question we address in this study is what force field parameters are to be modeled. Therefore, we performed an experiment to understand whether **force field direction** and **modulus** are both involved in the modeling process. We investigated how the stability of these force field features affects the prediction and in particular the **motion strategy** adopted in the interception. Moreover we compared interception results with the ones of a similar purely **visual task** to evaluate whether different mechanisms are involved in prediction in dependence of the goal of the predictive effort.

Setup

Motor task

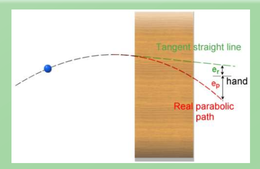


Experimental design

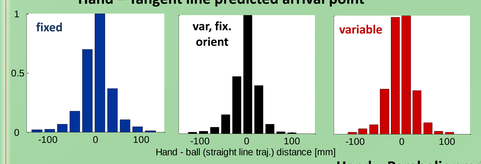


Motor Task Results

Models



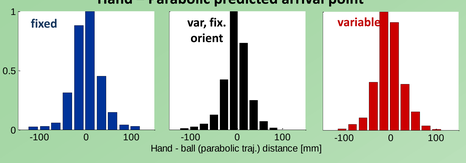
Hand – Tangent line predicted arrival point



Mean error always different from 0 ($p < 0.01$). The **straight line** is not a good predictor of final hand position.

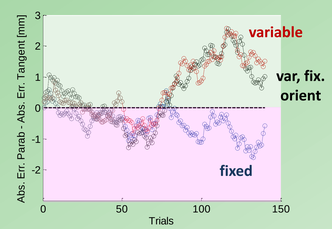
Hand – Parabolic predicted arrival point

Mean error not significantly different from 0 ($p = 0.21$) for the **fixed force field** case only. The real **parabolic arrival point** of the ball seems a good predictor of final hand position for the fixed case.



Hand nearer to the tangent straight arrival point

Hand nearer to the parabolic arrival point

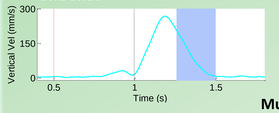


If there is complete **force field stability**, subjects direct their hand to the real (parabolic) arrival point of the ball. In the other cases they are nearer to a *tangential approximation* of the target arrival point.

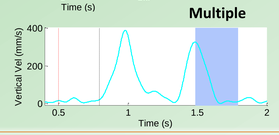
Motor strategies

Example of hand speed profiles

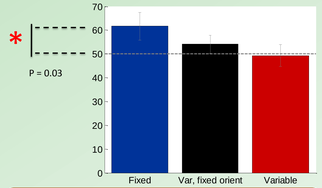
One Shot



Multiple



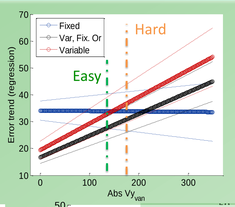
% of "one shot" hand speed profiles



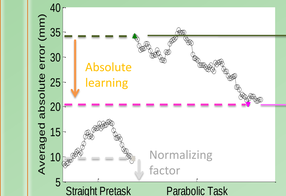
Only in the case of **force field stability**, the majority of interceptive actions is "**one shot**".

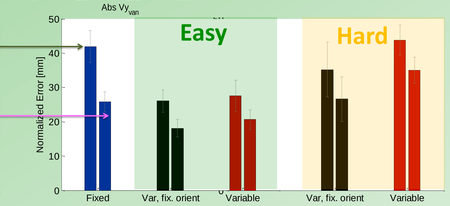
Performance

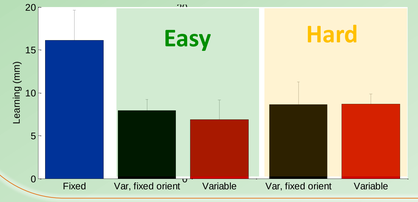
When there is **no force field stability**, the interceptive **performance** depends on the vertical vanishing speed of the target.



$Err = -0.001\ V_{yVan} + 34.08$
$Err = 0.081\ V_{yVan} + 14.39$
$Err = 0.099\ V_{yVan} + 16.02$

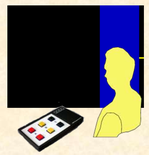


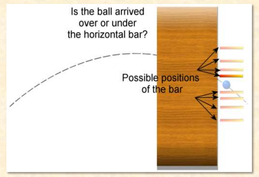


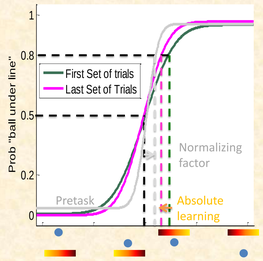


Learning seems instead to depend on **force field stability** only.

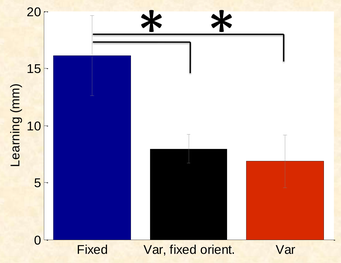
Visual Prediction



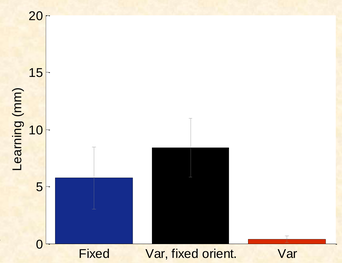




Motor Task



Visual Task



Learning in the motor task is significantly greater in the case of **acceleration** and **motion orientation stability**, while in the visual task no significant improvement due to stability could be observed.

REFERENCES

[1] Aglioti, S. et al., Current Biology, 1995, 5: 679-685
[2] Dubrowski, A. et al. Vision Research, 2002, 42: 1465-1473
[3] Zago, M. et al., Journal of Neurophysiology, 2004, 91: 1620-1634
[4] Hayhoe, M. et al. , In: From Reactive to Anticipatory Cognitive Embodied Systems., 2005
[5] McIntyre, J., et al., Nat Neurosci., 2001. 4(7): 693-694.
[6] Zago, M., et al., Vision Res., 2008, 48(14): 1532-1538.

ACKNOWLEDGMENTS

The work presented in this poster has been supported by the ROBOTCUB project (IST-2004-004370), and the ITALK project (ICT-214668) funded by the European Commission.

CONTACT: alessandra.sciutti@iit.it