Galvanic vestibular stimulation interferes with the selection of egocentric spatial navigation strategies. #260

Zavattaro C.[1,2], Gammeri R.[2], Cento S.[2], Cirillo E.[2], Serra H.[2], Berti A.[2], Ricci R.[2]

[1] Department of Physics, University of Trento
[2] Department of Psychology, University of Turin

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PhD SST
Space Science and Technology

INTRODUCTION

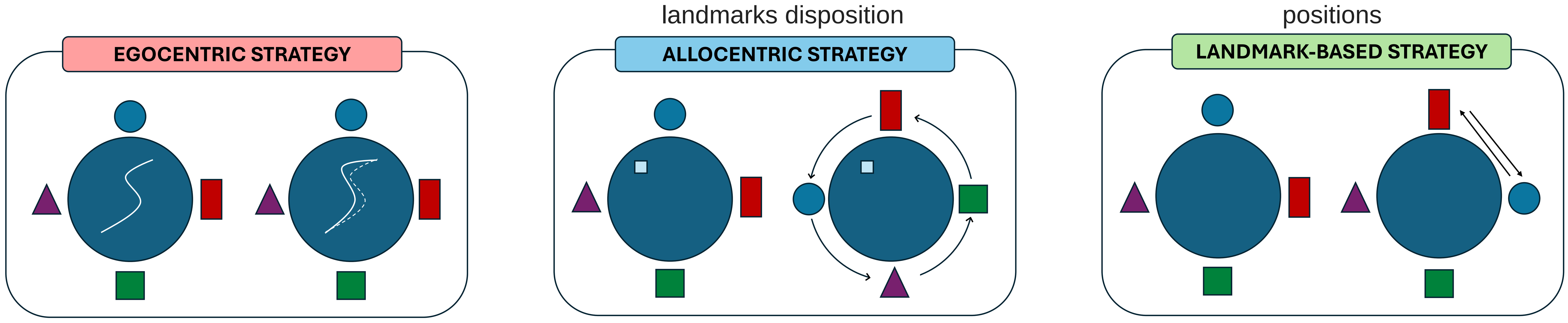
In space, changes of gravitational input strongly alter the functioning of the vestibular system, whose sensory information is important not only for postural balance, but also for relevant cognitive functions, such as **spatial navigation** [1]. During navigation, the surrounding environment may be encoded using **different reference frames**: **egocentric** (body-centered), **allocentric** (stimuli-centered), or **landmark-dependent** (landmark-centered) [2]. Alterations of vestibular input during parabolic flights have been recently linked to weakened egocentric reference frames [3]. However, no study has systematically investigated the selective influence of vestibular alterations on the use of **all spatial navigation strategies simultaneously.**

METHOD

Healthy participants (N=8) underwent bilateral bipolar sinusoidal **Galvanic Vestibular Stimulation (GVS),** with left-anodal (**LA-GVS**), right-anodal (**RA-GVS**) and sham (**S-GVS**) stimulations applied in counterbalanced order. For each GVS condition, participants performed an immersive **navigation task in virtual reality (VR)**.

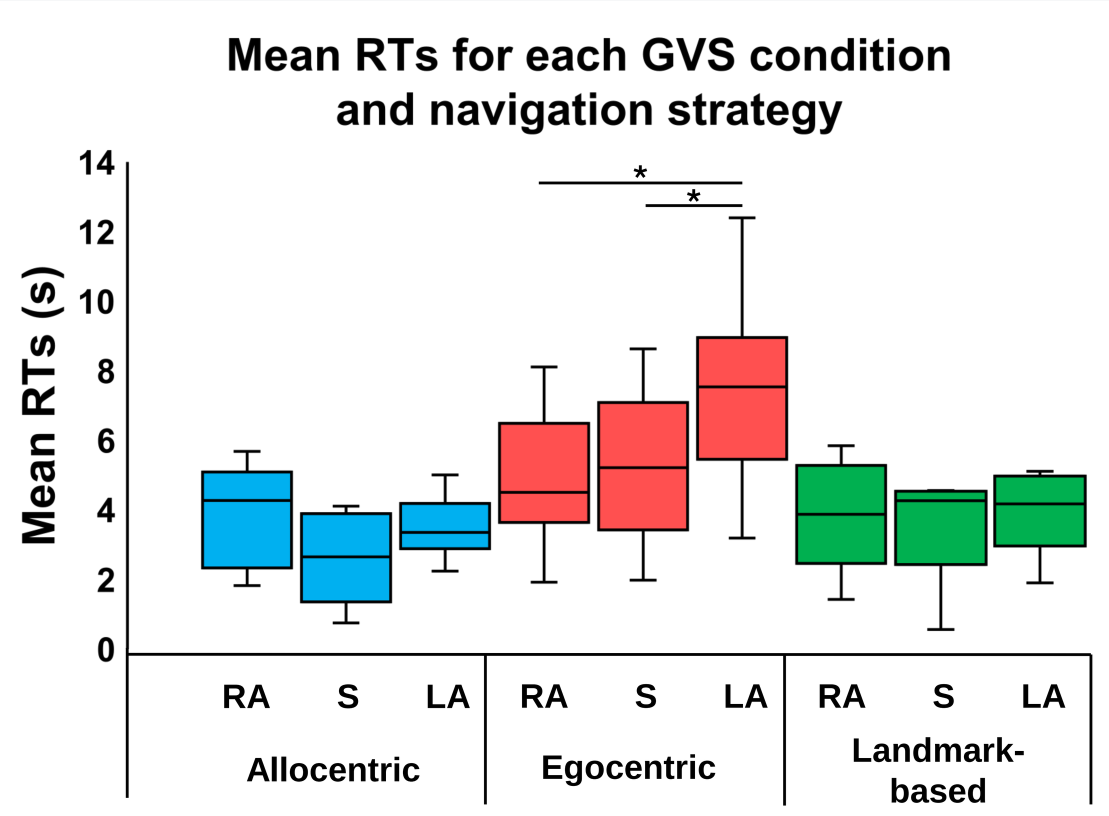
In a circular arena with four landmarks at cardinal points, they were asked to search and reach a target platform. At the end of each trial, using a two-alternative forced choice paradigm, they were asked to indicate:

the traveled path to reach the platform — the platform position with respect to the landmarks disposition — the arena spatial map based on landmark positions



Participants' **Response Times (RTs)** and **proportion of correct responses** for each navigation strategy were recorded.

RESULTS



Participants had significantly slower RTs in LA-GVS compared to RA-GVS and S-GVS when using **egocentric** navigation strategies (Wilcoxon signed-rank test: $p<0.05$), while no differences were found for **allocentric** and **landmark-based** strategies.

No significant changes were found for the proportion of correct responses (chi-squared analysis).

DISCUSSION

GVS-induced vestibular alteration interfered with the selection of egocentric navigation strategies, while leaving allocentric or landmark-based strategies unaffected, in line with prior studies showing impaired egocentric spatial transformation during microgravity [4] and decreased use of egocentric strategies in patients with unilateral and acute vestibular disorders on Earth [5].

These results suggest that artificially-induced vestibular changes affect spatial navigation abilities, by hindering the integration of sensory stimuli with respect to the body orientation.

These findings enhance our understanding of the effects of altered gravity on human navigation and may offer relevant insights for the design of effective countermeasures to be applied in the space environment.

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