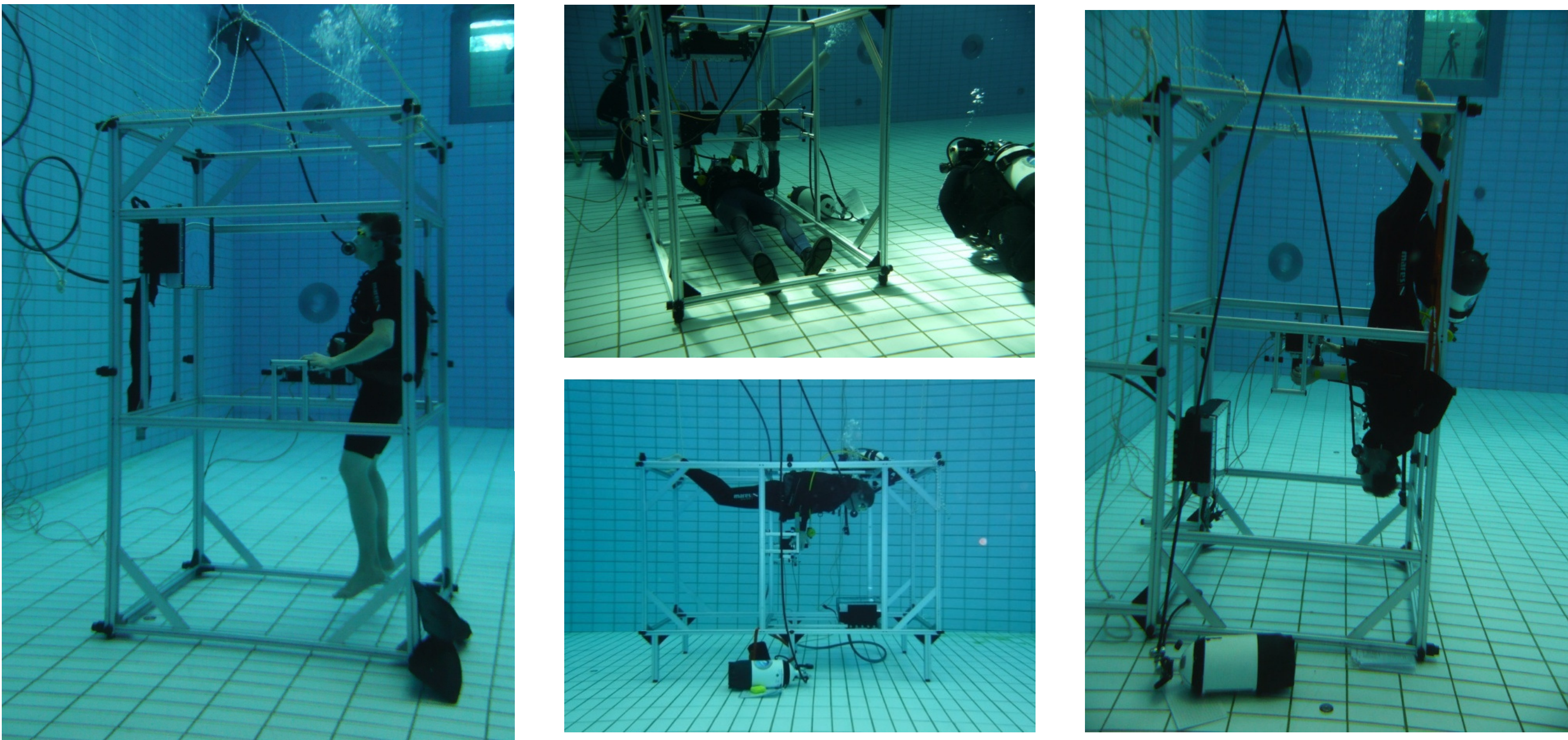


## INTRODUCTION

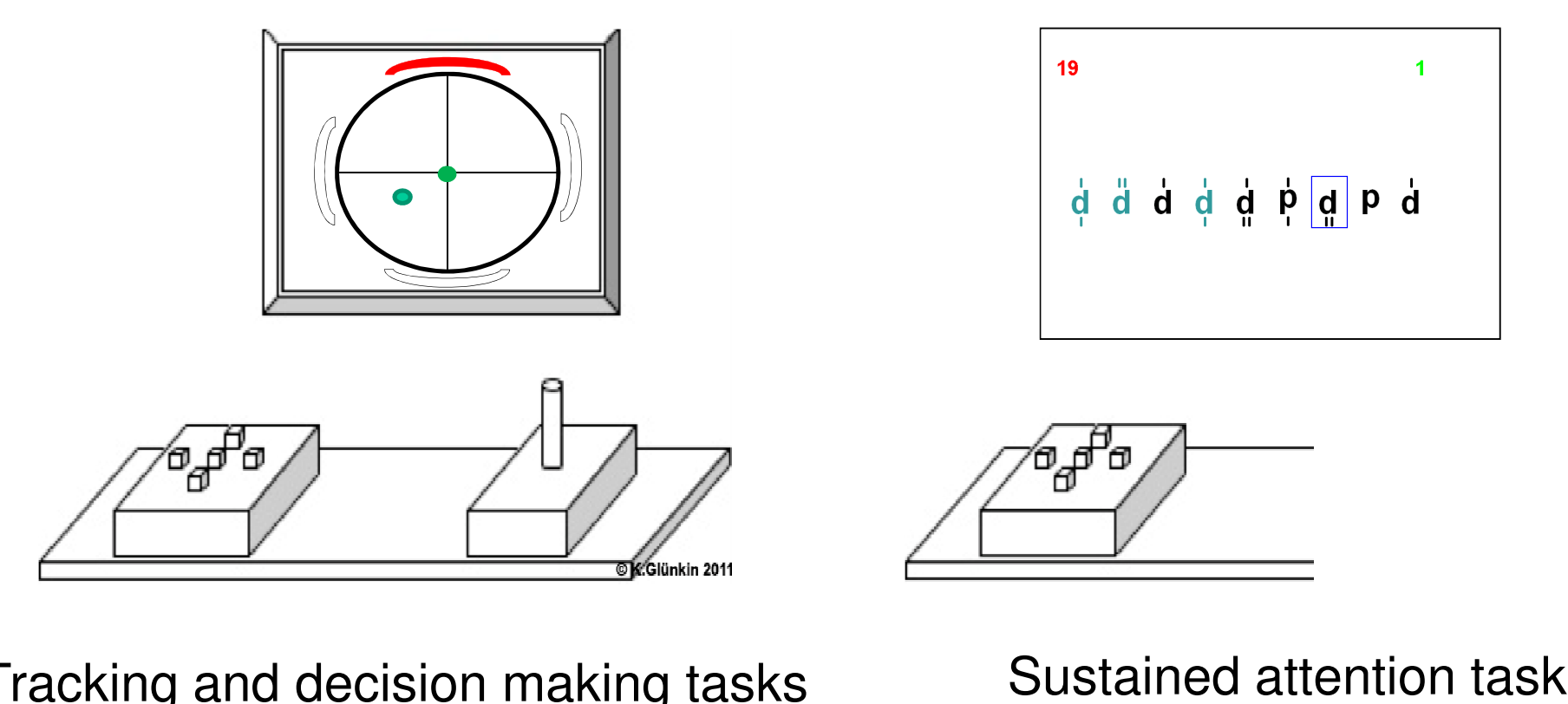
Astronauts in space have to perform fine motor and cognitive skills such as the control of spacecraft manoeuvres and of complex research instruments. They are prepared for this work by training under water. We therefore evaluated subjects' fine motor and cognitive skills under water, using the depth and body postures typical for astronaut training (4), with experiment setups that were already used in space before (2, 3, 5).

## MATERIAL AND METHODS



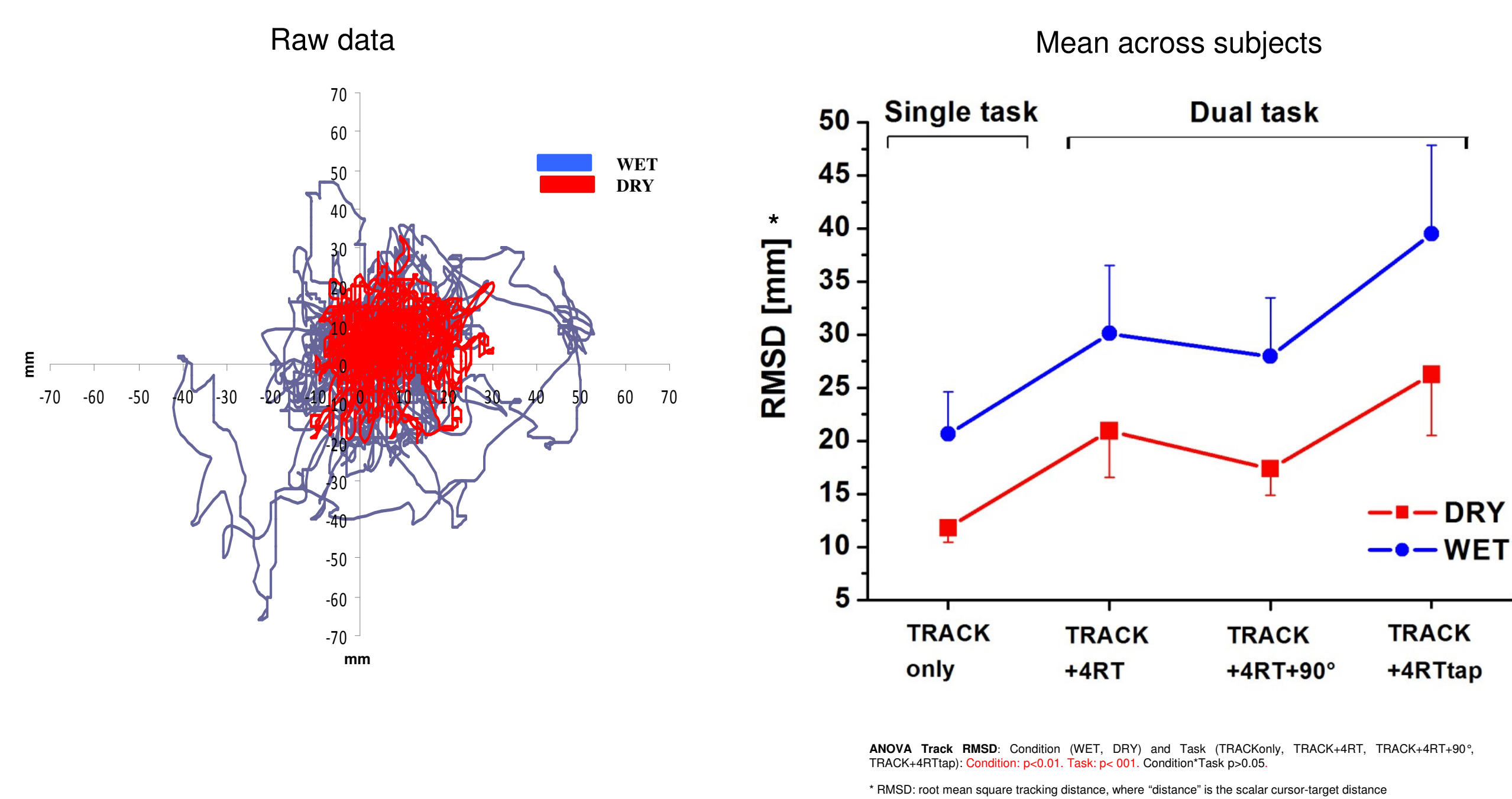
Under water, subjects were tested either in upright posture, horizontally facing down, horizontally facing up and vertically head-down. Control tests were conducted under dry conditions in an identical setup, but invariably in upright position.

Forty-eight healthy subjects were tested in 5 m water immersion (condition WET) and on dry land (condition DRY). Subjects performed an unstable motor **tracking task**, different **decision making tasks**, both either as single- or concurrently as dual task, and a **sustained attention task**. Responses were isometric, thus minimizing any effects of water's viscosity. Subjects performed the motor task with the right hand (joystick), and the cognitive tasks with the left hand (key-box). Targets were presented via screen.



## RESULTS

### Tracking

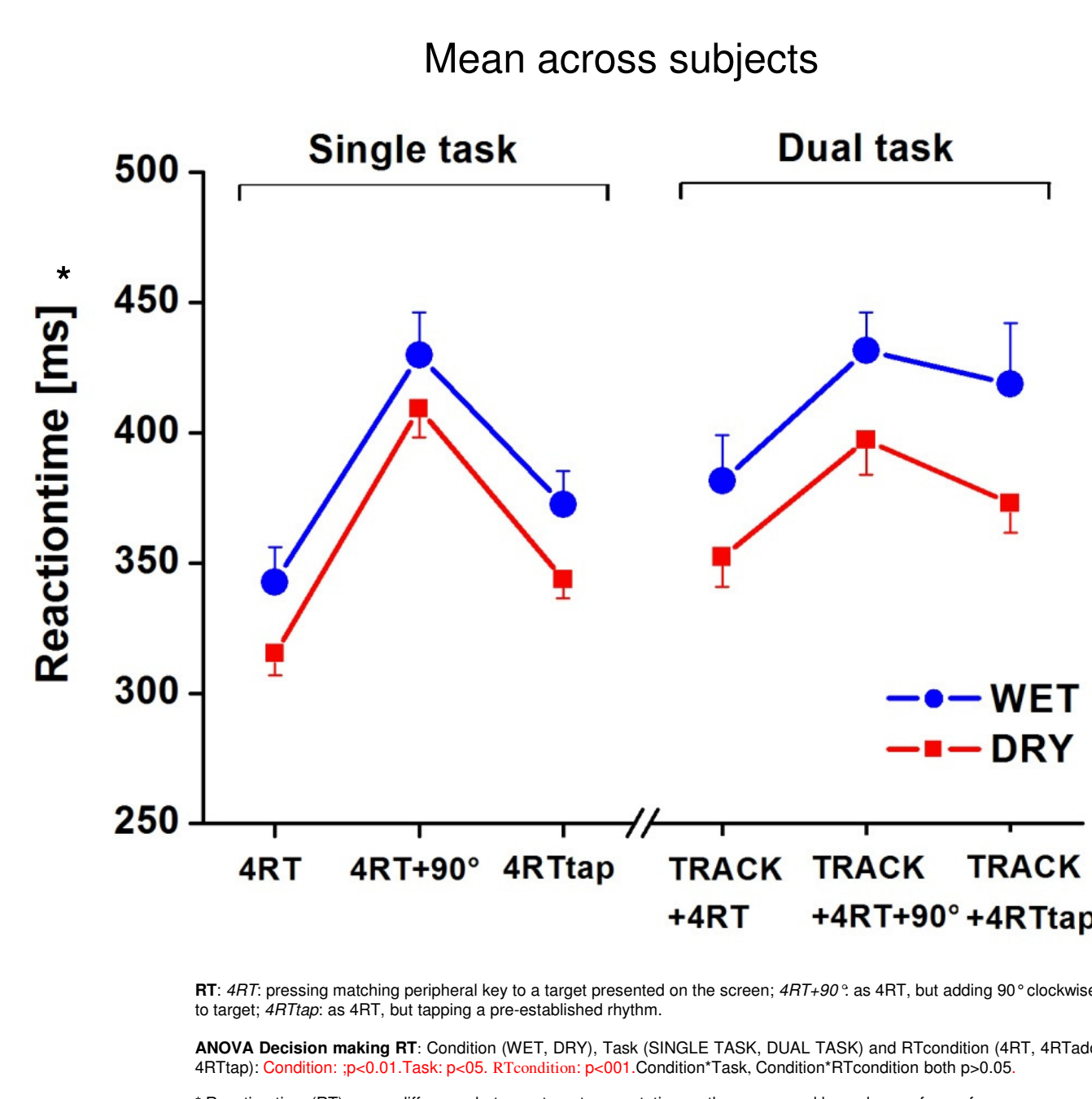


Percent changes - WET/DRY (present study)  
- 0G/1G (reference 2, 3, 5)

	[RMSD]
5m	+ 48 %
0 G Parabolic flight	+ 70 %
0 G ISS	+ 100 %

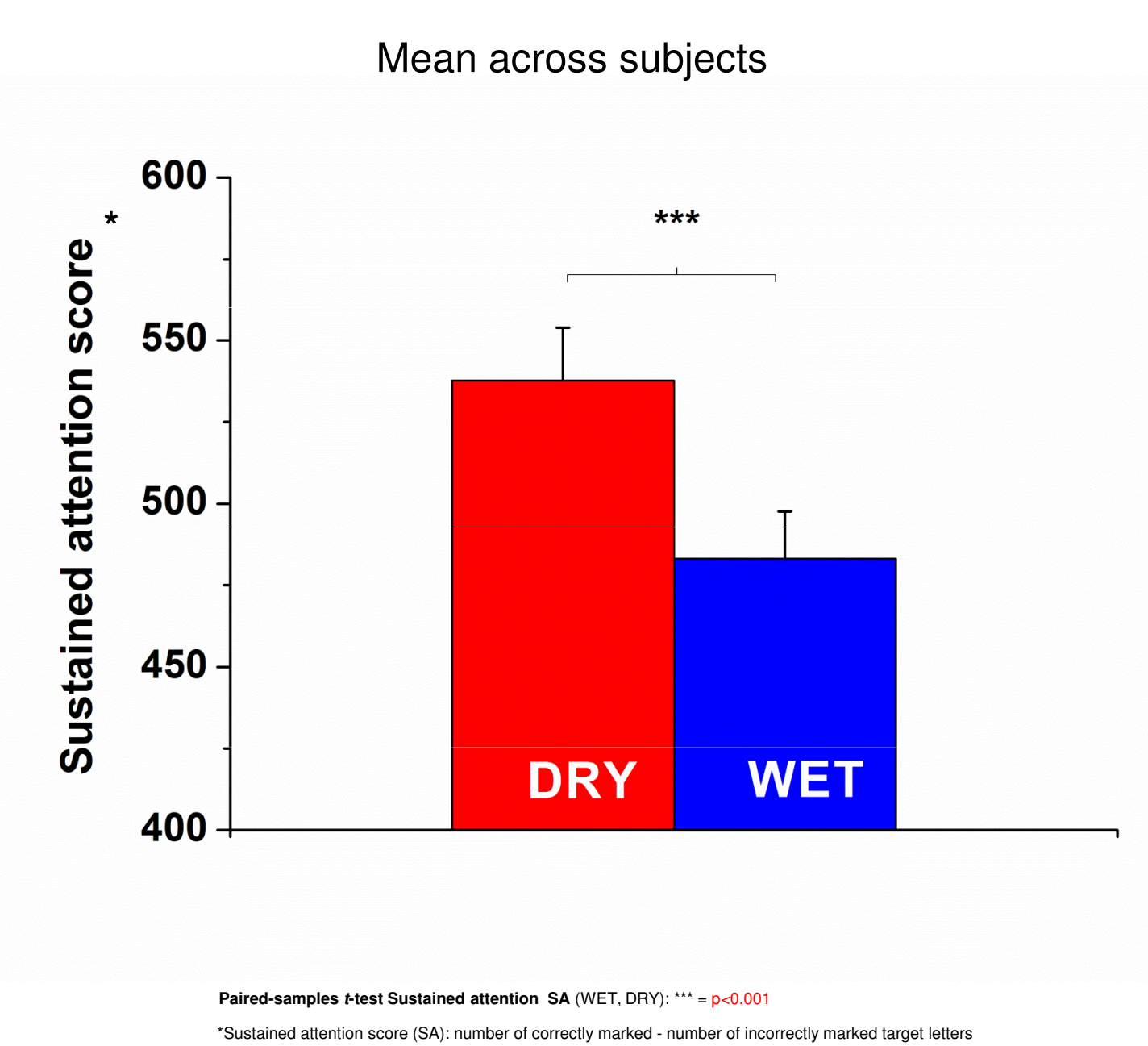
Square brackets = unit  
n.s. = no significant change

### Decision making



	[RT]
5m	- 9 %
0 G Parabolic flight	n.s.
0 G ISS	n.s.

### Sustained attention



	[SA]
5m	-11%
0 G	n.s.

Subjects' performance in WET was significantly degraded for **tracking error (+48%)**, **decision making (-9%)** and **sustained attention (-11%)**. Differences between WET and DRY were equal for all body postures. Fine motor as well as cognitive skills were affected under conditions used for astronaut training. Motor skills were less and cognitive skills were more affected compared to microgravity conditions.

## CONCLUSIONS

- Impairments under water are independent of body posture => not due to disorientation
- Fine motor skills are possibly impaired since higher ambient pressure reduces the muscle tone and thus degrades proprioception (1, 6, 7, 9)
- Cognition is impaired in 5 m (7) but not in 20 cm depth (6) since higher ambient pressure possibly induces a slight nitrogen narcosis
- Underwater training of astronauts (4) should take into account that cognition and motor skills are differently affected under water and in space (2, 3, 5, 7, 8)

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