CAVE DIVING AS A HIGH-FIDELITY ANALOG TO MANNED SPACE EXPLORATION

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Introduction: Mission simulations typically focus on the effects of confinement and isolation, or protocol and equipment testing and development. Most of these missions do not simulate manned space missions with high-fidelity, and the validity of scientific outcomes obtained from these missions is questionable when related to real manned space missions.
For example, low-risk mission simulations are rarely suitable to study decision-making and behavior in critical operations due to the simulations' predictability. Consequently, it is also questionable to what extent the data describing human factors obtained from one-off, low-fidelity and short simulations is reliable and skills acquired from such simulations are transferable and applicable to the real and significantly more complex space missions. Thus we believe more suitable contexts and facilities need to be developed so that the human factors relevant in space exploration can be studied thoroughly.
Despite the significant efforts, human factors in extreme contexts remain understudied, and several study outcomes are invalid or unreliable. Human factors continue to be usually mitigated with meticulous sampling and training processes. However, in the not too far future, human space exploration will impose new needs were the human factors may not be factored out" so easily.

Methods and outcomes: Aquanauta is a series of missions that studies the adverse effects of isolation, confinement, darkness on industrial and technical cave divers in various contexts.
In our cave diving expeditions, crews of six cave divers, or `aquanautas' will live in a habitat underground that is connected to a natural thermal cave with a diverse tunnel system completely under water, reaching out several kilometers in length. Our rationale to organize such high-fidelity mission simulations is that astronauts regularly train as divers in large artificial pools, where they can explore the effects of microgravity and practice specific protocols and skills later carried out or used on the International Space Station. Further, astronauts often train together in caves in order to get used to confined and isolated contexts and preparing for missions in the Moon's lava tubes.
In a similar, but less natural environment, we monitor teams of professional saturation divers to understand how they cope with living in pressurized environments (saturation systems on the surface, or in underwater habitats to carry out complex industrial tasks in the deep waters.

Our purpose is to provide valid and reliable research findings over the effects of isolation, confinement, darkness, risk and microgravity on humans, and to understand how human factors and the systems we can design can benefit teams in performing and/or living in extreme environments.

At this end, we utilize mixed-methods designs to explore the different psychological, behavioral and physiological variables that play important role in exploration cave diving.

Significance: The data and knowledge obtained regarding behavior health and operations informs space exploration and technical and industrial diving.