Towards the Affective Cognition Approach to Human Performance in Space

Nicola Mammarella

INTRODUCTION: In recent decades, there has been investigation into the effects of microgravity and microgravity-like environments on cognition and emotion separately. Here we highlight the need of focusing on emotion-cognition interactions as a framework for explaining cognitive performance in space. In particular, by referring to the affective cognition hypothesis, the significant interplay between emotional variables and cognitive processing in space is briefly analyzed. Altogether, this approach shows an interesting pattern of data pointing to a dynamic relation that may be sensitive to microgravity. The importance of examining interactions between emotion and cognition for space performance remains fundamental (e.g., stress-related disorders) and deserves further attention. This approach is ultimately interesting considering the potential effects that microgravity may play on human performance during long-term space missions and on return to Earth.

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Researchers have described emotions as a multiple-component process that comprises specific affective, cognitive, psychological, and behavioral elements.[2] Although emotional states (e.g., mood, emotions) can affect cognition in different ways, the effects of microgravity on human cognition and emotion have always been studied separately. Most published works focused either on the cognitive[3,4] or on the emotion/mood domain,[1,7] reflecting different approaches and research interests. The rationale is that a single-domain focus may help unravel microgravity effects in depth. However, the recent definition of cognition as "motivated" or "affective" highlights a strong influence of emotion and motivational factors over cognitive performance.[5,6] It is thus reasonable to assume that interactions between emotion and cognition may represent an interesting new avenue within the study of microgravity effects during space missions for the following reasons.

First, the spaceflight environment (e.g., microgravity along with other numerous environmental factors such as isolation, confinement, sleep problems, noise, diet, etc.) is an extreme condition that requires a long period of adaptation. This may affect emotion regulation processes that, in turn, may influence mental functioning.

Second, the affective cognition approach may help explain a series of mixed results typically found in the cognitive domain per se. In fact, it is still not clear whether microgravity impacts on cognitive functions. These contradictory findings, which have always been explained in terms of methodological pitfalls, may also be due to the fact that the emotion influence over cognition was not taken into account properly or, to say it differently, because cognition and emotional responses were measured separately.

Third, as typically shown in the aging literature, the affective cognition approach may help detect compensatory mechanisms that may arise under stressful or negative events (e.g., focusing attention to positive information and/or neglecting negative information).[11] These mechanisms may be ultimately useful for the development of affective and cognitive training programs before, during, and after spaceflight.

Although information on how microgravity affects interactions between emotion and cognition is limited, the available literature allows some preliminary conclusions and hypotheses to be developed on how microgravity may interact with motivated cognition. Some first evidence of the interaction between

From the Department of Psychological Sciences, Health and Territory, University of Chieti, Chieti, Italy.

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Address correspondence to: Prof. Nicola Mammarella, Department of Psychological Sciences, Health and Territory, University of Chieti, Via dei Vestini 31, Chieti, Italy; n.mammarella@unich.it.

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mood and cognition may be indirectly found in a series of studies using the Profile of Mood States (POMS) as a measure of mood changes during space missions. Kanas and Manzey, for instance, reviewed a series of Shuttle/Mir and International Space Station (ISS) studies about mood and crewmembers' social climate, and found that comparing preflight vs. in-flight moods, American crewmembers' moods were more positive during the missions than before launch.[8] This mood state was accompanied by a low work pressure perception during the missions. In addition, American crewmembers gave significantly higher mean scores in the earlier vs. later quarters for Task Orientation.[9] These data directly indicate the beneficial effects of positive moods on performance of the crewmembers. However, this would be expected to have an impact on cognitive performance as well, as indicated by a lower level of work pressure and a task-oriented behavior.

In another study it was found that impairments of performance were associated with alterations in perceived mood and workload.[10] In particular, during the first 3 wk in space and the first 2 wk after return to Earth, alertness and emotional balance were perceived as low, compared to preflight and most other in-flight sessions. Most importantly, a series of correlation analyses revealed a significant relationship between the reported changes of mood and cognitive performance measured in terms of tracking and dual-task performance. In addition, doing the different performance tasks was perceived as more effortful during these periods.

One of the richest sources of data about affective reactions during spaceflight can be found in Stuster's content analysis on the journals' records. The analysis showed that motivation and priorities between astronauts and controls may differ, for instance, in terms of positive and salutary aspects of space (e.g., viewing the Earth), high vs. low morale, and metacognitive skills.[14]

In line with numerous studies on the beneficial effects of positive mood on cognition, Solcova and colleagues showed that the MARS520 crew reported a greater number of adjectives related to mood and positive emotions, showing a stable predominance toward positive emotions throughout the mission (except for some isolated cases). In addition, participants claimed that they immediately expressed their positive emotions to others and tried to inhibit the negative ones.[13] In this regard, it is intriguing that Schneider and colleagues reveal no deterioration of cognitive function from the MARS520 study, pointing to a potential relationship between emotion and cognition in the crew.[12]

Interestingly, there is a study about MARS520 that used a set of stimuli typically adopted in the emotion-cognition literature.[17] The authors used the standardized photos of the International Affective Picture System (IAPS), which is a picture database divided by positive, negative, and neutral content. Crewmembers were required to evaluate each picture in terms of valence (positive, negative, and neutral). The results showed a positive bias in participants' ratings as evaluations of positive pictures were higher than the negative and neutral ones. It is noteworthy that these beneficial effects may derive first from visual and perceptual processes (e.g., from looking at the Earth with its beauty and fragility), as indicated by the type and frequency of pictures taken by astronauts on the ISS.[16]

To conclude, the lack of evidence regarding microgravity effects on affective cognition in the space environment represents an important issue. Here we posit that the affective cognition approach shows promise in explaining behavioral changes during spaceflight. We believe that inclusion of controlled studies on the ISS could greatly improve our understanding of the impact of microgravity on cognition-emotion interaction. Additional simulation experimental studies on the influence of emotional variables on cognitive functions may increase our understanding of how to better translate terrestrial effects to the context of microgravity. It will be relevant, for instance, to distinguish between the effects of the spaceflight environment on mood and emotion and, in turn, study the effects of both components on cognitive variables. In this regard, the recent development of affective cognition training programs and the use of humor and meditation techniques in Suedfeld's works may represent a relevant avenue for future research.[15] Moreover, recent progress in the genetics of affective cognition is introducing a new and more complete view of interpreting behavioral data: understanding genes and their polymorphisms may be relevant to the development of a new theoretical framework about the cognition-emotion interaction in microgravity. Finally, converging perspectives across behavioral approaches and neuroscience supports the hypothesis that important contributions to the explanation of microgravity effects on human performance are likely to emerge from research that considers the interplay between cognition and emotion at different levels of analysis.

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ORCID ID https://orcid.org/0000-0003-1240-702X.

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Author and affiliation: Nicola Mammarella, Ph.D., Department of Psychological Sciences, Health and Territory, University of Chieti, Chieti, Italy.

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