Whither the Third Quarter Phenomenon?

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INTRODUCTION: In 1991, Bechtel and Berning proposed that a decrement in morale and well-being affects people working in isolated and confined environments during the third quarter of their mission. Studies conducted during such conditions have suggested that whereas some people may experience such a phenomenon, it is not a typical occurrence in space or space simulation environments. Possible reasons for varying outcomes include demand characteristic bias, individual personality traits, training omissions, experimental methodological issues, and the impact of mission events on crewmember well-being. Research related to a future Mars expedition needs to investigate the impact of these factors.

KEYWORDS: third quarter phenomenon, Mars mission, Mars 500 simulation, ISS missions, Mir missions.

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In 1991, Robert Bechtel and Amy Berning described a time-dependent phenomenon that had been reported during the third quarter of polar missions.[3] There was a significant increase in negative social and emotional feelings, more accidents and assaults, increased marital counseling, and more absences from work. Some recovery occurred during the last quarter. This phenomenon seemed to be a general characteristic of finite-time stressful conditions, which would include other isolating environments on Earth and in space. Bechtel and Berning concluded: "Since the third quarter begins after the one-half mark and is centered near the two-thirds mark, let this be called the *third-quarter phenomenon*…"[3, p. 261] They argued for more research to verify the existence of the third quarter phenomenon. They also cautioned that this could produce a demand characteristic bias in future studies, whereby a subject who knows the length of time of their mission "produces the expected behavior before it is too late to disappoint the experimenter."[3, p. 264] A possible confound in Antarctic studies is that the third quarter of a winter-over mission typically coincides with the harsh austral winter, when the personnel are confined inside and can no longer go outside for recreation.

Despite anecdotal reports of third quarter problems in other isolated and confined environments, such as Biosphere 2,[9] this occurrence has not been universal. Alfano et al.[1] reported an analysis of publications "that specifically examined at least one emotion-based outcome (e.g., mood, anxiety) during spaceflight, polar expeditions/winter-over studies, or extended duration (i.e., >100 days) space simulation environments."[1, p. 292] Of the 26 reports in their analysis, 13 suggested no change in negative emotions over time, with negative emotions increasing or decreasing in the remainder. They concluded that "evidence for a third quarter effect is primarily limited to anecdotal reports and broad-based assessments of various domains of psychological functioning. As such, the presence of increased levels of emotional distress during this specific period, or any other for that matter, remains to be confirmed."[1, p. 296]

Studies of on-orbit missions in space are consistent with this assessment. Kanas and colleagues examined mood and team issues affecting orbiting astronauts and cosmonauts and their mission control support personnel during a series of missions to the Russian Mir[5] and International Space Stations.[4] In missions ranging from 4–7 mo in duration, 30 astronauts and cosmonauts were studied. Despite third quarter expectations, the researchers found no significant changes over time, or between any of the quarters, in subscales measuring mood or social environment in either space station environment. Mission duration had no effect. Rigorous statistical tests were applied, including longitudinal mixed-model regression analyses,

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two-way analyses of variance, and corrections to reduce the risk of Type I errors.

Stuster[13] content analyzed the personal journals of 20 astronauts during their ISS missions. He scored behavioral entries as being positive, negative, or neutral in tone or content. From this, a Net Positivity/Negativity (NPN) metric was calculated by subtracting the proportion of negative entries from the proportion of positive entries and plotting the results by quarter of the mission. By examining the plots for each subject, he concluded that 14 out of 20 subjects (70%) showed declines in average NPN during the third quarter. For the Adjustment category alone (which Stuster believed most closely approximated individual morale), this number rose to 17 out of 20 (85%). These findings were based on a visual inspection of the plots and no statistical analyses were reported.

Yusupova et al.[17] studied five crewmembers engaged in missions to the ISS lasting from 141 to 340 d. They content analyzed crew contacts with mission control personnel as indicators of coping strategies to mission stressors. They found patterns suggestive of an overall increase in stress-coping during the third and fourth quarters of the missions, especially as mission length increased. Although they performed statistical tests, they admitted that not all identified differences were significant and required further study. They also cited events that they believed affected crew-ground communication, such as high workload, increased number of visiting crewmembers, and changes in commander. In another study by this research team involving 15 cosmonauts,[18] there was preliminary evidence suggesting a relationship between individual communication styles in dealing with time pressures and the ending weeks of the mission.

In 2010–2011, a 520-d simulation of a Mars expedition was conducted at the Institute for Biomedical Problems in Moscow. Six male subjects participated and various aspects of a Mars mission were studied, including increasing communication delays with outside monitors and a midmission, three-man separation and landing on a simulated Martian surface. Several studies were conducted using a variety of psychological and behavioral measures that found little statistically significant evidence for the third quarter phenomenon.[2,10,12,19] Wang et al.[16] found no third quarter effects on their psychological measures, but they found elevated serotonin and norepinephrine levels that they believed resulted from novel stressors experienced during the simulated Mars activities. Other investigators also reported effects believed to be related to the Mars landing.[8,14,15,19]

In conclusion, despite over 30 yr of empirical work, there is little evidence suggesting that a time-dependent third quarter phenomenon typically affects people in space or in space simulation environments. Occasionally, factors other than time may produce decreases in crewmember well-being in the third quarter. Examples include the demand characteristic bias that Bechtel and Berning warned against; selection of crewmembers whose personality styles do not encourage the maintenance of team compatibility;[6] inadequate crew and mission control group dynamics training;[7] and experimental methodological factors (e.g., lack of statistical rigor, psychological and behavioral measures that are insensitive to time effects). In addition, little attention has been paid to the impact of mission events on crewmember well-being, which is very important for a future Mars expedition given its three distinct phases: outbound, Mars landing/exploration, and return to Earth. Each of these phases might have its own unique time characteristics or stressors (e.g., boredom, communication delay with Earth).[11] Future research needs to explore the impact of these factors over the course of a space mission.

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