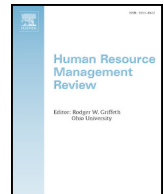


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Teams in extreme environments: Alterations in team development and teamwork☆

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ABSTRACT

We rely upon teams to perform complex tasks in highly demanding environments, ranging from space exploration to response to earth-bound disasters. In this article, we first briefly review the rich historical legacy of research on teams in extreme settings. Second, we orient our discussion of team performance in extreme environments by focusing on the contextual environment—the high demand, high-stress environment in which these teams operate. We discuss the mechanisms through which extreme demands or stress may impact team behavior, and discuss specific team processes and emergent states that may be impacted by these conditions. Finally, we address challenges in conducting research on extreme teams, and describe implications for application and practice.

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It is reasonable to imagine that people have always banded together in small groups under threatening or extreme conditions, not only because there is safety in numbers, but also because the power of the group can help attain desired outcomes. Whereas our prehistoric ancestors may have joined forces in a daily battle for survival, today we compose teams to meet the challenges of modern, high-demand task settings. This may include teams working in space, undersea, and in polar regions, but also teams operating in emergency rooms, in military contexts, and in disaster response, among other settings.

Teams are marshalled to tackle a myriad of tasks in a myriad of contexts. These contexts may range from relatively benign workday settings to the extreme contexts of spaceflight. However, we don't expect teams that perform in these extreme environments to function similarly to those in “normal” settings. That is, teams in extreme environments are under greater pressure stemming from the high-demand conditions under which they operate, and operate in a context in which there are heightened consequences for failure. Certainly, the potential exists that these factors will impact team functioning and performance.

In this article, we examine teamwork in extreme performance settings. We address three primary topics. First, we briefly review the rich historical legacy of research on teams in extreme settings. Second, we discuss the mechanisms through which high-stress task demands may impact behavior, and examine specific team processes and emergent states that may be impacted in extreme performance contexts. Third, we describe implications for further research and for application and practice.

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1. Teams in extreme environments

It is useful to first describe what we mean by the terms “team” and “extreme environments.” We define a team as two or more persons who interact in pursuit of a common goal (see Salas, Cooke, & Rosen, 2008). For our purposes, we will use the terms “team” and “group” interchangeably and further note that teams of interest may typically range in size from a dyad (e.g., the early studies of isolated and confined groups by Haythorn and colleagues; Haythorn, Altman, & Myers, 1966) to ten (e.g., the Navy Sea Lab program; Helmreich, 1966) to twenty or more (e.g., groups wintering-over in the Antarctic; Stuster, 1996).

Further, we define the term *extreme environments* as settings in which there are significant task, social, or environmental demands that entail high levels of risk and increased consequences for poor performance. According to Harrison and Connors (1984), extreme (or exotic) environments may be marked by (a) hostile environmental demands, (b) danger and physical risk to self or others, (c) restricted living or working conditions, and (d) social demands that may include isolation from those outside the setting and close confinement with those inside. Bell, Fisher, Brown, and Mann (2016) define extreme environments as (a) task contexts that are atypical in terms of the level of demands (e.g., time pressure) or the type of demands (e.g., confinement, danger), and (b) contexts in which ineffective performance has severe consequences. It is worthwhile to note that our working definition subsumes a large number of diverse types of settings. For example, Stachowski, Kaplan, and Waller (2009) define *crisis situations* as low-probability, high-impact events characterized by time pressure and ambiguity and that have significant consequences for the team (see also Yu, Sengul, & Lester, 2008). Harrison and Connors (1984) describe *exotic environments* as those marked by severe environmental conditions, danger, isolation, and enforced interaction with others. Gardner (2012) describes *performance pressure* as an external force imposed on the team that includes shared outcome accountability, heightened scrutiny of the team's work, and significant consequences for the team's performance; whereas Salas, Driskell, and Hughes (1996) define *stress* as a process by which environmental demands evoke an appraisal process in which perceived demand exceeds resources, and that results in undesirable physiological, psychological, behavioral, or social outcomes. These are all related terms that have been used to describe different types of high-demand task settings.

Moreover, we note that the main commonality among these various terms is that they all refer to a highly demanding performance context. Current research on teams in extreme environments include the study of teams in long-duration spaceflight (Salas, Tannenbaum et al., 2015), mountaineering teams in high-altitude settings (Wickens, Keller, & Shaw, 2015), teams in military settings (Driskell, Burke, Driskell, Salas, & Neuberger, 2014), teams in nuclear plant control rooms (Stachowski et al., 2009), and other teams in various high-demand, high-stress environments (Ellis, 2006; Kamphuis, Gaillard, & Vogelaar, 2011; Pearsall, Ellis, & Stein, 2009). Finally, we note that the task, environmental, and social demands that teams face in extreme settings are matters of *degree*—that is, we view “extreme teams” as those operating under task conditions that may vary on a continuum of very high demand to moderate demand. Thus, our view is that teams operating under demanding conditions may include combat teams as well as project teams.

Landmark research on small groups in isolated and confined environments was initiated in the early 1960's. This research was spurred by a confluence of several historical factors. One factor was the advent of the space program. The Soviet Union launched the first satellite in space, Sputnik 1, in 1957, and the space race was on. In response, the U. S. National Aeronautics and Space Administration (NASA; originally the National Advisory Committee for Aeronautics) was established in 1958, leading to the first solo Mercury missions and eventually to the first space missions involving crews comprised of dyads (Gemini), triads (Apollo), and 5–7 members (Space Shuttle). This, in turn, stimulated research on group performance in space and space-like (analog) settings.

A second factor was the military's interest in submarine habitability and crew performance. In WWII, diesel submarines could stay submerged for a maximum of three days. In contrast, the first nuclear submarines, such as the Nautilus, commissioned in 1954, could stay submerged for months (or, theoretically, until food or consumables ran out). Accordingly, research was initiated to examine social and psychological problems of crew members under prolonged marine submergence (Weybrew, 1963). This work also included research on small groups in underwater habitats such as the Navy's Sea Lab program (Helmreich, 1966).

A third impetus during this time period was the initiation of the 1957 International Geophysical Year program, an international research effort to advance polar research, among other topics. In preparation for this research, the US sent a crew to establish a research base in the Antarctic. One member of the crew experienced a severe psychotic episode and was incapacitated for the duration of the mission (Rasmussen, 1973; Stuster, 1996). Concerned with the stresses inherent in this environment, program managers initiated research to further examine small groups in isolation and, especially, the dynamics of groups that winter-over in Antarctic stations.

These events spurred a large body of research in the 1960s and 1970s on group functioning and performance in extreme environments. This resulted in a rich legacy of research on team performance in high-demand settings such as submarines and other undersea environments (e.g., Beare, Bondi, Biersner, & Naitor, 1981; Radloff & Helmreich, 1968; Weybrew, 1961), the Arctic and Antarctic (e.g., Gunderson & Nelson, 1963; Nelson, 1965; Taylor & McCormick, 1985), military field settings (Berkun, Bialek, Kern, & Yagi, 1962; Driskell & Olmstead, 1989; Torrance, 1954), isolated and confined environments (Altman & Haythorn, 1967; Palinkas, 2003; Smith & Haythorn, 1972), space exploration (Harrison & Connors, 1984; Helmreich, 1983; Kanas, 1998), aviation (Foushee, 1984; Milanovich, Driskell, Stout, & Salas, 1998), and in various laboratory and field simulations (Alluisi, Chiles, Hall, & Hawkes, 1963; Taylor, Wheeler, & Altman, 1968).

This elevated level of research activity inevitably subsided, and in a wide-ranging review of research on groups in high-stress environments published in the mid-1980s, Harrison and Connors (1984) stated that “behavioral research on groups in exotic

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