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ПСИХОСОЦИАЛЬНЫЕ АСПЕКТЫ КОСМИЧЕСКИХ ПОЛЕТОВ И СТАРЕНИЯ / PSYCHOSOCIAL ASPECTS OF SPACEFLIGHT AND AGING

Аннотация. *Статья посвящена рассмотрению возможности применения исследований старения, в частности, в области гериатрической психологии для решения задач, стоящих перед космической психологией. Речь идет о допустимости распространения результатов анализа психосоциальных аспектов поведения людей в домах престарелых на области, связанные с изучением поведения астронавтов, находящихся в замкнутом пространстве космического корабля во время длительного полета. Особое внимание в работе было уделено выявлению сходства стрессогенных факторов и психологических реакций обеих исследуемых групп. Для решения поставленных задач использовались методы наблюдения, анкетирования, сравнительного анализа, систематизации, принципы детерминизма и аксиологической рациональности, междисциплинарные подходы. В работе показано, что, несмотря на формальные различия исследуемых групп, сами по себе психосоциальные аспекты существования в замкнутых пространствах пожилых людей и астронавтов (особенности окружающей среды наборы факторов стресса, виды психологических реакций, используемые методы снижения стрессогенного влияния среды и повышения стрессоустойчивости личности и т.п.) в значительной мере схожи. Продемонстрировано, что результаты, полученные в области гериатрической психологии и социологии, могут иметь прогностическое значение для космической психологии, поскольку они позволяют идентифицировать еще не учтенные психологические риски, которые с большой вероятностью будут возникать с увеличением длительности космических полетов, и предложить практические решения для их профилактики.*
Ключевые слова: *Космическая психология, Старение, Психологическая реакция, Долговременный космический полет, Гериатрическая психология, Изолированное пространство, Раздражители, МКС, Нарушение сна, Депрессия/*

Abstract. *Many places on Earth have been used as analogs of space vehicles, with the goal of understanding the pressures and stresses of a long-duration spaceflight such as a round-trip voyage to Mars. One of these is the situation common to many of the aged, especially those who live in group housing: planned communities, assisted living centers, or nursing homes. This paper looks at the lessons that space psychology and geriatric psychology can teach each other. Traditionally, both the literature on aging and that on spaceflight have focused on the problems that their population of interest experiences, and on what can be done to alleviate the negative effects of those problems – or, more familiarly, on countermeasures. The problems are due to or mediated by, stress, which is a common factor in both literatures. There are many common factors related to successful aging and successful spaceflight. Increased cross-flow of ideas between the two research communities would be fruitful.*
Keywords: *Isolated Environment, Geriatric psychology, Long-duration spaceflight, Psychological reaction, Aging, Space psychology, Stressors, ISS, Sleep deprivation, Depression.*

Many places on Earth have been used as analogues of space vehicles, with the goal of understanding the pressures and stresses of a long-duration spaceflight such as a round-trip voyage to Mars. Some are basically laboratory *simulations* that confine experimental subjects to capsules that resemble the kind of space vehicles that may eventually make such a voyage through space [5]. Others have been purpose-built in natural environments selected for their remoteness, isolation, and terrain features, with living and working quarters designed to simulate some of the living conditions of space vehicles and of exploration on the surface of an extraterrestrial body [7]. Yet others differ from the

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foregoing by existing for other purposes but share some of the features of spacecraft and/or alien surfaces. These are inhabited by crews or teams engaged in ongoing scientific pursuits (for example, oceanographic or meteorological monitoring) and their support personnel. The most frequently studied of these *analogue* environments have been stations in Antarctica [19].

All of these are prototypes of ICEs: *Isolated, Confined Environments*. In addition, some are located in places where conditions are highly unusual and often very hazardous: *Extreme and Unusual Environments* (EUEs). Many environments share the characteristics of both categories. Most ICEs studied by psychologists are characterized by remoteness from highly populated communities, living with a small and relatively unvarying group isolated from the inhabitants' accustomed social *milieu*, and confined living and working quarters with reduced comfort, privacy, usable space, and amenities. In addition, many – which are also EUEs - impose reductions of mobility, usually because the outside environment is dangerous if not lethal. Salient examples are polar, especially Antarctic, stations; undersea habitats and nuclear submarines; long-journeying cargo vessels and tankers; resource extraction facilities such as logging, mining, and fishing camps or offshore oil rigs [19]. The crucial point is that they seem to approximate the psychosocial characteristics of living in a space vehicle [28]; [43].

But there are other, less dramatic and less drastic analogues as well. One of these is the situation common to many of the aged, especially those who live in group housing: planned communities, assisted living centers, or nursing homes [9]. Although details differ with regard to variables such as the client's health and mobility, the degree of assistance needed and the degrees of autonomy and self-help that are feasible, the fact remains that many such environments are, to a greater or lesser degree, isolated and confined. Many healthy and mobile people in late middle or early old age voluntarily choose to live in retirement communities designed to provide recreational opportunities, a congenial group of peers, and emergency medical care. At that stage, they do not confront the problems faced by residents who are dependent on more extensive care and assistance. Even when more physical constraints develop, some of the aged prefer to continue in their own home (perhaps with non-resident assistants) rather than to live with strangers or with their younger relatives, situations that raise their own sets of challenges.

The conditions of life in group homes offer a closer parallel to life in other ICEs. The residents are removed from their families and accustomed social circles, as well as from their former homes with their well-known layout, furniture, décor, memorabilia of their life, neighborhood, and so on. Their living space is limited, and in most cases so are their privacy, autonomy, and control over their social and physical environment. Their ability to partake in activities that they had previously enjoyed may be limited by the opportunities offered in the institution as well as by their own infirmity.

To varying degrees, all of these features are shared with the situation of long-duration astronauts. Can we learn how confined individuals can adapt to, enjoy, and benefit from these apparently negative factors? Can we learn how a confined group can develop a common culture that enhances their bonding and morale, and what the members can do to make their unique environment feel more like home? Can we then translate this learning to institutional residences for the elderly as well as space habitats to enhance the lives of their clients?

Not only are space capsules and nursing homes ICEs; perhaps not quite so obviously, so are many other environments in which elderly people live: more or less alone in small houses or apartments, which like group homes offer restricted space, monotonous surroundings, and a limited social circle. Although their physical environment has not changed, their social life usually has. Old friends may have died or moved away; the younger generations of their family have other demands on their time and may also have dispersed to other places.

Those living alone also face some problems that are similar to those in group living. Their declining health, strength, and energy may leave them increasingly confined. The limitations may be features not only of the physical environment, but result also from the diminished physical and mental fitness that can prevent old people from fully utilizing their environment and what it offers. For example, restricted mobility may prevent

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the use of some portions of the individual's home. Thus, although their life is less structured and may appear unchanged compared living in a group residence or in a space capsule, similarities persist.

Although at a quick glance no two groups seem more dissimilar than astronauts and the elderly (except for John Glenn, of course), there are subtle but profound philosophical and psychological parallels between the two groups. All space travelers, and many old people, live in what the Canadian sociologist Erving Goffman [18] called "total institutions": places where a number of "similarly situated people, cut off from the wider community for a considerable time, together lead an enclosed, formally administered round of life." We may add that external control over that "round" – i.e., loss of control over one's own circumstances and actions – exacerbates the psychological stresses of the situation.

Space capsules obviously fit that definition, and so do nursing homes. Of course, there are important differences. Astronauts are eager volunteers, stringently selected from a much larger number of applicants, highly trained and mission-oriented; they are engaged in a widely admired enterprise, collecting experiences open to only a tiny percentage of humanity. They have high expectations that at the end of their journey, they will return to their family, friends, colleagues, and activities with unique memories and a status that will affect their life from then on [37]. The journey of the aged can include positive experiences and memories [6], but their anticipation of the end of the journey is very different. Two other major differences: people are not trained in the best ways to be old, whereas astronauts undergo stringent and prolonged training; and the aging experience is shared by billions of people but at this point only by a few hundred elite space travelers.

In some ways, spaceflight can actually be thought of as accelerating the aging process. Astronauts have to guard against loss of muscle tone and bone density, as do elderly people at risk for, e.g., osteoporosis. Back pain, a common symptom among the elderly [23], has been reported by 52% of astronauts while adapting to microgravity and then re-adapting to gravity upon return to Earth [24]. Radiation in space may play a role in the development of cancer and heart disease [14]. Astronauts can experience difficulties in adjusting and orienting themselves in microgravity, just as problems of orientation and balance plague some elderly people. Cardiovascular issues in astronauts include changes in the shape of the heart, a reduction in its muscle mass, and stiffening of the arteries [10]. These, as well as visual problems such as cataracts [12], reported among some long-duration crewmembers, also resemble those of the old [29].

Little of this is new: NASA and the National Institute on Aging convened a meeting on the similarities between the effects of aging and spaceflight on "biosystems" as long ago as 1989. Agreements for joint research (no pun intended) followed, with the second spaceflight of John Glenn, at age 77 offering a unique collaborative opportunity. The research emphasis, however, has been on factors such as microgravity and radiation, which have direct effects on biological processes and conditions and at best indirect impact on psychosocial functioning if the physiological change evokes psychological effects as well.

This paper looks at the lessons that space psychology and geriatric psychology can teach each other. Traditionally, both the literature on aging and that on spaceflight have focused on the problems that their population of interest experiences, and on what can be done to alleviate the negative effects of those problems – or, more familiarly, on countermeasures. The problems are due to, or mediated by, stress, which is a common factor in both literatures. Table 1 shows some of the stressors encountered by both groups.

Table 1

Shared stressors of spaceflight and old age

Physical	Social/Psychological
Restricted mobility	Social monotony
Confinement	Separation from familiar surroundings
Reduced level of sensory input	Loss of autonomy

Physical	Social/Psychological
Sensory monotony	Lack of privacy
Need for exercise	Reduced ‘ownership’
Sleep disturbances	Interpersonal conflict
Existential danger	Cultural heterogeneity

As one might expect, such stressors can have adverse psychological consequences (see Table 2).

Table 2

Shared negative psychological reactions

Anxiety
Depression
Impulsive behavior
Cognitive decline
Boredom
Reduced energy & mobility
Irritability
Social withdrawal

For both astronauts and the elderly, there is a complex interplay between stressors and environmental features on the one hand and social support structures on the other: for astronauts, their families, colleagues, and the space agency and its staff; for the aged, family, friends, caregivers, and volunteer support organizations.

In both groups, the negative impact of stressors can be offset by personal resilience, appropriate environmental design, and good social support. It should also be remembered that the effects of stress are not all negative. Personal and societal crises can lead to the development of more adaptive behaviors, attitudes, and coping skills, including increased wisdom (both practical and transcendent) and self-reflection.

Implications of space psychology for research on aging

Space agencies have recognized the psychosocial problems associated with spaceflight and the unwanted effects of those problems (see Table 3). These issues were initially laughed off by believers in “the Right Stuff,” who dismissed concerns that astronauts might develop psychological and social problems [38]. Decades of accumulating evidence have shown that they can, and do, especially as crews grow in size and diversity and multi-month missions become the norm. The problems are likely to get worse as “multi-month” missions give way to “multi-year.” NASA has responded by intensifying attention to three aspects of “Behavioral Health and Performance” risks: behavioral medicine (mood, cognitive functioning, and other individual behavioral reactions); team (team performance, crew cohesion and communication); and sleep (countermeasures to the problem of sleep disturbances and insomnia). To quote the relevant NASA website, “The end result is to provide technologies and tools that will optimize the adaptation of the individual and crew to the space environment, and maintain motivation, cohesion, communication, morale, wellbeing, and productivity” (NASA Human Research Program, 2013). It is worth noting that the goals of optimization reach significantly beyond mere countermeasures designed to make life in space safer.

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Table 3

Implications of spaceflight for aging: Important issues

Loss of agency and autonomy
Sleep deprivation, insomnia, disrupted sleep
Boredom and monotony vs. meaningful activity and stimulation
Proxemics, privacy, and ownership
Social relationships
Individual differences

Geriatric psychologists have also begun to focus on the sources and effects of environmental and psychosocial stressors, and have noted their exacerbation as an increasing number of aged citizens need assisted care, nursing homes, or other special support systems. Although the elderly have many unique risk factors involving physical and mental health and earlier lifestyle, among those shared with long-duration astronauts are: lack of autonomy and meaningful activity, boredom, cognitive impairment, depression, limitation of limb mobility, insufficient exercise, and impaired vision [8]; [25]; [36].

Countermeasures and optimization initiatives instituted or being developed by space agencies are pointing the way to strategies that can be applied to communal living for the elderly to ameliorate the negative aspects of their situation. Table 4 summarizes the areas where space psychology has particular resonance with geriatric psychology: agency and autonomy; sleep deprivation and insomnia; boredom and monotony; proxemics, privacy, and ownership; social relationships; and insufficient attention to individual differences. These are aspects of both of these total institutions that add to the level of stress experienced by the inhabitants, and that can be addressed by applying the results of past and future research to the design and procedures of the environment. The following sections discuss each of these problems and suggest ways of solving them.

Table 4

Psychosocial "countermeasures" in both ICEs

Increased autonomy over schedules, clothing, personal space, etc.
Intervention to improve sleep hygiene
Design for higher social and sensory stimulation
Available communication with family and friends elsewhere
Changeable illumination, temperature, furnishings, clothing, meals, etc.
Provisions for enjoyable physical activity
Stress-reducing micro-environments: plants, animals
Time out when desired
Development of on-site ingroup culture
Meaningful and interesting tasks and free-time activities

Agency and autonomy. Successful aging is linked to the ability of individuals to exercise agency over their daily activities, especially during stressful times and within the boundaries of social settings and institutions. Loss of independence is reported as one of the greatest stressors [11]. This can be mitigated by encouraging the inhabitants to retain their mastery of existing life skills by providing scope to exercise those wherever possible, and with the development of new ones, either to improve coping or for enjoyment and satisfaction.

In spaceflight, mastery of technical, intellectual, and emotional factors is, of course, critical to success. The ability of astronauts to exert appropriate control over specific mission activities and goals and over their individual responsibilities with respect to those, is equally so. Autonomy improves personal satisfaction and willingness to accept the strictures of the demanding schedules of the mission. Autonomy is now being seriously studied, in view of the communication lag and other constraints of ground control for deep space exploration such as a possible mission to Mars [22].

Sleep deprivation and insomnia. Sleep deprivation and impaired sleep quality are common in both the astronaut and aging populations. Sleep problems among astronauts are likely to be caused by changes to circadian rhythms, lack of natural light cues, microgravity, high workloads, lack of privacy, interruptions, and a noisy environment. In space, lack of sufficient duration or quality of sleep may lead to performance errors, interpersonal problems, and emotional distress.

A number of improvements to spacecraft living quarters, such as arrangements for increased privacy and better soundproofing, have been developed to alleviate these problems. Sleep medication is also used, although differences in medication effects between space and Earth is another area needing research. There is also the suggestion that improved upper respiratory airflow may assist sleep.

For the aged, sleep disorders may be due to physiological and neurological changes, while others derive from psychological stressors such as anxiety or interpersonal conflict. Sleep disturbances in the aged, as in astronauts, may affect learning, cognition, health, and well-being. There are suggestions that some age-related medical issues may arise from poor sleep [35]; [17]; [46]. For sleep disorders that arise from environmental conditions, lessons learned from spacecraft design and respiratory function studies may help.

Boredom and monotony, vs. meaningful activity and keeping busy. Both the astronaut and the aged communities can suffer boredom, often brought about by monotony in the physical, social, and sensory environments, lack of stimulation, and lack of meaningful activity. For astronauts, boredom and monotony become increasingly pertinent as missions become longer. Among measures to alleviate these stressors are the development of more complex and modifiable environments, more varied sensory experiences, virtual reality environments, and the creation of semi-natural garden spaces in space stations and exploration spacecraft. The astronauts themselves often devise ways to overcome these problems, for example through games, contests, ceremonies, as well as preparing novel and unusual cuisine. "Keeping busy" is important to maintaining morale.

Many of these lessons are already being applied to assist the aging community, and research shows that providing stimulating and meaningful activities to seniors has a positive impact on their functioning and well-being [2]. Within these factors, social activities and intimacy appear to be of most importance [15]; [2 6]; [27]; [31]; [45].

Proxemics, privacy, and ownership. Both the spaceflight and the aging literatures show the significant impact of the nature and use of individual and group living space. The proxemics concepts of body territory, home territory, public territory, and interaction distance, are readily applicable to both situations, and inappropriate or unwanted violations of interpersonal distance norms cause problems for members of both the space and the group home communities. Other problems relate to inability to efficiently use the space, which may be designed or arranged without reference to the individual's preferences; others to loss of privacy (intrusive visual, auditory, or tactile stimulation from others, or the inability to keep one's own behavior from being seen or heard by others. Another shared issue is lack of "ownership" – of places that a person can call his or her own, which can be accessed by others only with the owner's consent and where owners can retreat when they feel the need for a period of solitude. Acceptable levels of crowding under different circumstances remain unknown.

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Both communities attempt to resolve these issues with a range of strategies, for example through methods to improve privacy and ownership of personal and work stations in spacecraft, and through improved design of assisted living facilities or adapted home design for the old [33]; [34]. For example, clear and respected boundaries around private space are important, as is the ability to bring and arrange private possessions that remind one of home. Privacy in all sensory modalities needs to be guaranteed as much as possible, taking into account cultural, gender, and individual differences as to preferred levels of privacy. These appear to be interesting areas for collaborative research, especially if integrated with studies of the related topics of density, crowding, and the methods that individuals use to control social interactions.

Although some of these issues are obvious, there are two subtle findings in space with equally important implications for aging. These are related, first to the tremendous role of interpersonal interactions in mediating mission success, and second, to the importance of investigating impact at the level of individuals, not only groups.

Interpersonal relations. Research has shown that astronauts mention social support as the most frequently used coping strategy in space [39]. Recently, when cosmonaut Mikhail Kornienko was asked what he liked best about his 342-day mission on ISS, he replied “Scott Kelly”, his American fellow crewmember [21]. Similarly positive comments were made by American astronaut Shannon Lucid about her Russian teammates on a Shuttle-*Mir* mission. Commanders emphasize the maintenance of group harmony and morale as their key coping strategy, even more than mission accomplishments. These highly-skilled individuals, trained to cope with critical mission threats, have by implication identified the personal and interpersonal reactions of their colleagues as being, not just important, but potentially *the* most important factors in success.

There are two implications for aging. Space crews and aging population share issues related to the physical environment, privacy, sleep disorders, and the like, but social health may be the most critical to successful aging, as it is in space. The emphasis on psychosocial health supports the integrative perspective now popular in aging research [16]. It perhaps suggests one way of developing research priorities in the aging field, as it does in space psychology. Of course, the immediate challenges to astronauts are quite different from those that threaten the aged, and so the factors mediating success may be different too. Both communities, however, are faced with the ultimate threat of incapacitation and death, and in many instances may not survive without a strong and healthy social network. Thus the high-intensity crucible of spaceflight may allow us to see more clearly the social network’s enormous importance, even against the backdrop of myriad critical technical factors.

Individual differences. Another subtle connection is the importance of individual differences in outcomes, which have often been ignored by both space and seniors’ living administrations. Astronaut selection, training, and experience are focused on small numbers of individuals who have highly individual skills, problems, cultures, coping mechanisms, and interpersonal/social styles. The strategies of space agencies and astronauts must address idiosyncratic individuality, using flexible approaches tailored to each person and to the unique way each interacts with the others (and, no doubt, with individuals in mission control on the ground). Research on the reactions of “foreign” astronauts flying as a minority of one among an otherwise monocultural crew documents the discomfort that they experience from being treated in terms of nationality as opposed to their individual skills and personality [42].

Numerous clinical studies have found that the individual therapeutic relationship between client and practitioner is far more important to success than the specific counseling technique used, although the technique chosen must take into account the client’s social and environmental context. What we learn from the experiences of “foreign” astronauts may be applicable to the minority living in a multi-cultural residence. In the aging context, this supports the importance of tailoring problem-solving to individual requirements rather than to those of the cohort as a whole, but the research is rarely explicit in this regard. Of course, individualized support plans would have notable implications in terms of the expertise, time, effort, and resources that would need to be expended.

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Implications of aging research for space psychology

The literature on aging demonstrates several theoretical underpinnings that are not immediately evident in space psychology (Table 5). Chief among these is the need to view aging through a complex lens that is multivariate and interactive, and takes into account the interplay of biological, psychological, social, and cultural factors [16]; the importance of the life course for successful aging [32]; and a focus on positive aspects of the aging experience.

Table 5

Implications of aging research for space psychology: Important issues

Integrated study of relevant variables
Enhancement of social relationships both in and outside the ICE
Life review
Resilience and salutogenesis

Researchers have recognized the need to develop a more multidimensional and integrated way to address the capabilities and responses of the aged. This requirement surely resonates in understanding how astronauts respond to stressful missions. Earlier, shorter missions were driven mainly by the exigencies of physics and engineering. Longer ones, by contrast, will increasingly depend for their success on the far less predictable behaviors of the crews, both as a unit but also those of the individual. The literature on aging strongly suggests that the ability to foster successful journeys depends on a richer and more multidimensional understanding of the underlying human variables, not just a piece-by-piece refinement of moderating factors [1]. The literature also suggests some of the variables that may be important in such an endeavor, such as active engagement and personal agency [2]. Many of these variables are relevant across the disciplinary divide. While these factors remain under active investigation within the aging sphere, there are opportunities for collaborative projects between the two research communities.

A related issue is the usefulness of the life review. The review can help people understand their experiences as an interconnected, dynamic, and meaningful whole, and viewing old age as one stage in a complex and multidimensional life can help the individual and the family to avoid an exclusive focus on current problems and fear of the future (Population Change and Lifecourse Cluster http://sociology.uwo.ca/cluster/en/index.html).

The relevance of investigating the life course appears at first glance to be less important for astronauts than for seniors. The rigorous selection and training of astronauts likely mean a somewhat more predictable course of their life histories: the individuals are self-selected, and further selected by space agencies, to have certain shared traits of ability and resilience. However, viewing the active space career as one component in a multidimensional life *Gestalt* implies the importance of helping astronauts and their families to prepare for merging that experience into the totality of past, current, and planned future individual and family life and preparing for the post-astronaut life.

Space and aging psychology research share a growing emphasis on positive effects [16]. The positive impacts of aging and spaceflight are in many cases similar to each other – for example, a sense of accomplishment, concern for future generations, and an appreciation of life's beauty and of the fragility of life and the Earth itself [20]; [41].

There are many common factors related to successful aging and successful spaceflight. Increased cross-flow of ideas between the two research communities would be fruitful. For example, the growth of positive psychology has made inroads in many areas, from childrearing to military training, and neither space psy-

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chology nor geriatric psychology has been unaffected. Two concepts have taken on increasing importance in both fields: resilience and salutogenesis.

Resilience refers to the ability to rebound after stress to previous levels of functioning. Research on resilience includes the investigation of cognitive processes, emotional stability, and appropriate coping strategies [30]. Resilient individuals show high levels of self-esteem, optimism, altruism, and humor; they retain or can restore effective intellectual functioning, appropriate social behavior, and emotional stability.

The factors influencing resilience in space studies have clear similarities to those identified in the aging literature. These factors are important in daily life, but are especially so in the presence or aftermath of stress and trauma. Resilience is fostered through resources such as education, health, and economic security, facilitated by various sources like families and communities, but is also dependent on the individual's personality. An extension of the idea is that resilience is tied to the development of wisdom, self-actualization, altruism, and spirituality – to salutogenesis, our last topic.

Salutogenesis refers to positive mental and emotional health enhancement beyond simple recovery from stress and trauma [3]; [4]. Spaceflight examples include post-experience growth, value changes in a socially positive direction, increased self-confidence, an increase in spiritual values, close and warm relationships with others, and concern for the collective good of humanity and the Earth itself. These have analogues to current approaches that emphasize positive aging experiences for individuals, including effects such as generativity [8] that provide a legacy to society more generally, especially if older individuals are given more scope to pursue it. Table 6 shows some of the salutogenic effects found in studies of spaceflight and aging.

Table 6

Salutogenic outcomes

Spaceflight	Aging
Self-confidence	Self-concept coherence
New skills and knowledge	Wisdom, judgment
Decision-making	Selective control
Giving and getting social support	Social networks
Universalism: Earth and people as one	Care for future generations
Spirituality	Spirituality
New opportunities	Life review: Valuing one's past
Appreciation of others	Benevolence

One interesting aspect of this table is that each positive aspect in either column has a close analogue in the other. Thus we see that the relevance of space psychology to geriatric psychology is not only in the shared difficulties and possible countermeasures relevant to both populations, but also in the shared enhancement of the personal growth of their subjects. Better communication and more contact between specialists in the two areas may lead to reduced stress and a growth of positive effects for astronauts and the aged, and by extension perhaps to inhabitants of other total institutions and isolated, confined environments.

Author notes

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