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Personality and Coping Strategies During Submarine Missions

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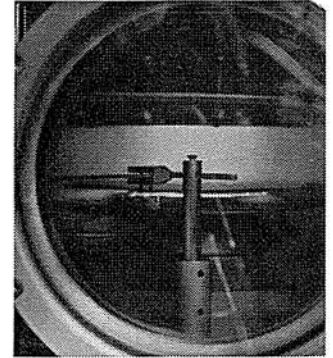
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Relations between personality profiles, measured by the Personality Characteristics Inventory (PCI), and habitual coping strategies, measured by the Utrecht Coping List (UCL), were investigated in a sample of submarine personnel and office employees. The predictive validity of these instruments were examined for reported stress, health complaints, and salivary cortisone measures during 3 submarine missions. PCI and UCL were completed before the missions, and questionnaires and saliva were collected weekly. The results showed no significant relations between PCI profiles and coping strategies. Interpersonal orientation, achievement motivation, and habitual coping strategies were predictors for coping during the submarine missions. Problem-directed strategies and interpersonal sensitivity combined with strong achievement motivation were related to low indicated stress from social factors (lack of privacy, interpersonal tension, and crowding) and homesickness. The findings suggest that interpersonal characteristics need to be considered in the selection of submariners and personnel for other military settings in which units are exposed to prolonged stress and isolation.

It is well recognized that the adverse performance and health consequences of prolonged exposure to stress depend largely on the individual's strategies to cope with the situation. Recent research has tried to identify personality tests associated with coping under stress (Antonovsky, 1979; Kobasa, Maddi, & Kahn, 1982; McCrae & Costa, 1986), which may be useful for the purpose of selection for high-risk occupations (Santy, 1994; Suedfeld, 1991). Personality Characteristics Inventory (PCI; Chidester, Helmreich, Gregorich, & Geis, 1991), a battery developed at the National Aeronautics and Space Administration (NASA), has received extensive validation in a variety of situations in which groups have collaborated under stress, such as pilots (Chidester & Foushee, 1988; Chidester et al., 1991), spaceflights (McFadden, Helmreich, Rose, & Fogg, 1994), personnel in simulated spaceflights (Sandal, Bergan, Warncke, Vaernes, & Ursin, 1996), and those in military training (Sandal et al., 1998). Superior coping ability and performance have consistently been linked to a personality profile typified by strong instrumentality and achievement motivation combined with interpersonal sensitivity. This personality profile has therefore been referred to as the "Right Stuff" (Wolfe, 1979) in stressful team environments, a label frequently used to refer to psychological attributes considered optimal in aerospace settings (King & Flynn, 1996). Poorer performance has been linked to personality profiles typified by a hostile, competitive interpersonal orientation (the "Wrong Stuff") or to low achievement motivation combined with passive-aggressive characteristics ("No Stuff"). The PCI personality profiles have been evaluated in the selection of astronauts for the European Space Agency (Maki et al., 1990) and NASA (McFadden et al., 1994). Despite the empirical evidence, the mechanisms by which these characteristics modulate resistance to stress are still unexplored. This article examines



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whether the PCI profiles are related to use of coping strategies in stressful situations and whether they influence the interpretation of environmental stressors and coping during submarine missions. Given that the Right Stuff profile, which is referred to as the Positive Instrumental-Expressive profile here, seems to be beneficial for adaptation in a variety of stressful group settings (McFadden et al., 1994; Sandal et al., 1996), these characteristics were also expected to predict coping in a submarine environment.

This article distinguishes between coping strategies and coping as a cognitive process, which is defined as positive response outcome expectancies (Levine & Ursin, 1991). According to the latter definition, coping is reflected by the individual's expectations of being able to control the situation. Positive response outcome expectancies or superior (more effective) coping are associated with reduced activation (stress response) in the central nervous system and in the accompanying responses in the motor, autonomic, endocrine, and immune systems. Another type of less effective coping, generalized negative response outcome expectancies, may lead to sustained physiological activation that may represent a health risk (Levine & Ursin, 1991). In a previous study, it was found that Positive Instrumental-Expressive individuals showed lower endocrine activation under stress than others (Sandal et al., 1998). This finding was interpreted as indicative of positive response outcome expectancies— or superior, more effective, coping ability.

An individual's expectancies of control over the situation are likely to affect the ways in which he or she deals with stressful encounters. Coping strategies are often classified into problem-focused and emotion-focused coping (Lazarus & Folkman, 1984). Emotion-focused coping acts to reinterpret or redefine a stressful situation, whereas problem-focused coping tackles the situation directly. Habitual strategies focused at actively handling the stressful situations will probably be combined with positive response outcome expectancies, and both have been found to characterize successful expedition members to the North Pole (Leon, McNally, & Ben-Porath, 1989) and military personnel (Rachman, 1982). On the other hand, although coping strategies differ in their efficiency to reduce stress (Olf, Brosshot, & Godaert, 1983), the adaptiveness of a strategy seems to depend on the individual situation. Problem-focused coping strategies can be used to prevent or resolve stressful events, but they may lead to sustained physiological activation in unchangeable situations (Holroyd & Lazarus, 1982). It is therefore reasonable to assume that such strategies are not always optimal when people are exposed to inescapable and uncontrollable stressors, such as those that

occur during military combats, polar expeditions, and spaceflights.

Because personality might also have a significant influence on the coping strategies used to deal with stressors (McCrae & Costa, 1986), exploring the relations between personality and coping strategies may shed light on the mechanism by which personality influences resistance to stress. The first part of this article reports correlations between the profiles and scales in the PCI and the coping strategy scales on the Utrecht Coping List (UCL). Based on the assumption that both the Positive Instrumental-Expressive profile and problem-focused coping are associated with positive response outcome expectancies, we expected high correlations. In previous work, we suggested that the Positive Instrumental-Expressive profile might be associated with the ability to give and receive social support (Sandal et al., 1998; Sandal, Vaernes, & Ursin, 1995), a factor that has been found to counteract the negative impacts of severe stressors such as military combat (Foy, Sippelle, Rueger, & Carroll, 1984) and polar expeditions (Palinkas, 1990). Because it is assumed that Positive Instrumental-Expressive individuals interact comfortably with other people (Chidester & Foushee, 1988), it was expected that they also would tend to seek social support as a coping strategy.

The first part of this article is based on data from submariners and office personnel employed by the Royal Norwegian Navy. The second part deals with how personality profiles and coping strategies influence coping during submarine missions lasting for both 10 days and 40 days. Given the assumed intercorrelations between personality and coping strategies, we first examined the predictive power of the PCI personality profiles. Second, the additional variance explained by coping strategies was tested. It was hypothesized that the Positive Instrumental-Expressive profile and problem-focused coping strategies would be positive predictors of coping ability, whereas it was thought that avoidant and passive coping strategies would be related to a poor ability to cope.

A relation between lack of coping and poor health has been established both in animal experiments and in human epidemiological studies (e.g., Olf et al., 1983), so the prevalence of health complaints was therefore used as an indicator of coping. It was also expected that coping would be indicated by the perceived stress that the submariner reported in relation to the environment (Levine & Ursin, 1991). In the literature that deals with work tasks and human performance, one discriminates between physical impacts (e.g., noise and workload) and psychological pressures (e.g., homesickness and feeling isolated; Levine & Ursin, 1991). One basic difficulty in defining psychological pressures is that such factors

might be regarded in part as stressors and in part as symptoms of poor coping. Stressors, coping, and stress responses interact and form complex systems and feedback circuits (Levine & Ursin, 1991). Unpleasant emotional reactions, resulting from the individual's interpretation of the environment, may increase activation through positive feedback loops. These reactions, sometimes referred to as secondary stressors (Weybrew, 1992), have been found to be the most frequently reported stress stimuli (Levine & Ursin, 1991). Because there are no well-established measures of the extent or intensity of stressors or of coping methods during submarine missions (e.g., Weybrew, 1992), a questionnaire was constructed to cover a range of both physical and psychological issues shown to be related to perception of stress in the submarine setting (Helmreich & Wilhelm, 1985; Weybrew, 1992) as well as in other isolated, restricted environments (Rivoliier, Goldsmith, Lugg, & Taylor, 1988; Sandal et al., 1995). Such factors include crowding, noise, heavy workload, homesickness, adverse social factors, feeling isolated, and lack of or poor leadership.

Because subjective reports are prone to the problem of self-deception and other forms of response biases, there is a need for more objective indicators of the two types of coping. Positive response outcome expectancies are associated with reduced activation (stress response); therefore, endocrine parameters might represent physiological indicators of this type of superior coping (Levine & Ursin, 1991). Due to practical considerations related to sampling, saliva concentrations of cortisone were measured based on the fact that cortisone increases under stress

(Levine & Ursin, 1991). It was therefore assumed that the superior (more effective) form of coping would be associated with reduced values.

It has been assumed that there are long-term physical and psychological costs of adapting to chronic stressors associated with confined and isolated operational environments. For example, the length of stay in long-term confined and isolated environments has been expected to be associated with increases in blood pressure, catecholamines, and negative moods (S. Cohen, Evans, Stokols, & Krantz, 1986). On the other hand, findings from Russian spaceflights (Gushin, 1995), polar expeditions (Rohrer, 1961; Sandal et al., 1996), and European Space Agency space simulation studies (Sandal et al., 1995) indicate that psychological stress reactions are linked to different phases of the isolation. Independent of the actual duration of the isolation, crucial periods, characterized by a marked decline in team functioning, mood, and morale, have been found to occur approximately halfway through and toward the end of the stay. These findings indicate that the most important determinant for psychological

stress reactions is the knowledge, or expectancy, regarding the end of the situation. Due to this finding, analyses were based on data for the first and last week for both the 10-day and the 40-day submarine missions. Actual mission duration was included as a control variable.

Method

Participants

Sample 1. The first sample consisted of personnel on three NATO standard submarines with crews of 20 members. One submarine participated in a 40-day exercise, and two submarines took part in missions lasting for 10 days. On the 10-day mission, 4 individuals refused to take part in the study, and 5 individuals did not participate for practical reasons. The final sample consisted of 19 participants from the 40-day mission, ranging in age from 21 to 38 years ($M = 27.11$, $SD = 4.97$), and 31 participants from the 10-day missions, ranging in age from 21 to 38 years ($M = 28.30$, $SD = 3.78$). Only 1 woman took part in the 40-day mission, whereas the crews on the 10-day mission consisted of men only.

Sample 2. The second sample consisted of male office workers ($n = 25$) employed at the Royal Norwegian Navy, with ages ranging from 22 to 43 years ($M = 32.23$, $SD = 5.61$).

Control group. Norwegian male military recruits ($n = 121$), with ages from 19 to 27 ($M = 20.30$, $SD = 4.30$), were used as a control group for the personality and health measures.

Instruments

PCI. Personality was tested with PCI, which consists of three tests: the Extended Personal Attribute Questionnaire (Spence & Helmreich, 1978; Spence, Helmreich, & Holahan, 1979), the Work and Family Orientation Questionnaire (Helmreich & Spence, 1978), and the Revised Jenkins Activity Scale (Jenkins, Zyxanski, & Rosenman, 1971). A total of 10 scales and 73 items are included in the battery. Table 1 shows the definitions, number of items, and Cronbach's alpha for each scale. (The Norwegian translation of the battery was used. Responses to PCI have been found to be relatively unaffected by cultural or language factors; Maki et al., 1990.) A scoring key program classified the participants into the three personality profiles that were identified through cluster analysis on scores from U.S. pilot populations (Chidester et al., 1991), and recently the same clusters were found in a sample of Norwegian military cadets (Sandal et al., 1998). The first cluster, labeled "Negative Instrumental," or the "Wrong Stuff," is marked by above average scores on Competitiveness, Negative Instrumentality, and Positive Instrumentality, and below average scores on Positive Expressivity. The second cluster, called "Positive Instrumental-Expressive," or

TABLE 1
Definitions, Number of Items, and Cronbach's Alphas for the Scales
in the Personality Characteristics Inventory

<i>Scale Names</i>	<i>Definitions</i>	<i>No. of Items</i>	<i>Cronbach's α</i>
Extended Personal Attribute Questionnaire			
Positive Instrumentality (I+)	A cluster of positive attributes reflecting goal orientation and independence (active, self-confident, can stand up to pressure)	8	.75
Positive Expressivity (E+)	A cluster of positive attributes reflecting interpersonal warmth and sensitivity (gentle, kind, aware of the feelings of others)	8	.76
Negative Instrumentality (I-)	Negative characteristics reflecting arrogance and hostility, and interpersonal invulnerability (boastful, egotistical, dictatorial)	8	.77
Negative Communion (EC-)	Self-subordinating, subservient, or unassertive characteristics (gullible, spineless, subordinates self to others)	4	.56
Verbal Aggressiveness (EVA-)	Verbal passive-aggressive characteristics (complaining, nagging, fussy)	6	.65
Work and Family Orientation Questionnaire			
Mastery	A preference for challenging tasks and striving for excellence ("If I am not good at something, I would rather keep struggling to master it than move on to something I may be good at")	6	.66
Work	A desire to work hard and do a good job ("I find satisfaction in working as well as I can")	6	.76
Competitiveness	A preference for tasks with clear winners and losers and a desire to outperform others ("It annoys me when other people perform better than I do")	6	.75
Revised Jenkins Activity Scale			
Achievement Striving (AS)	A cluster of characteristics related to hard work, activity, and seriousness in approaching work tasks ("How much does your job stir you into action?" "Compared to others, how much effort do you put forth?")	6	.60
Impatience/Irritability (I/I)	("How easily do you get irritated?" "When a person is talking and takes too long to come to a point, how often do you feel like hurrying the person along?")	6	.58

Table 1: Definitions, Numbers of Items, and Chronbach's Alphas for the Scales in the Personality Characteristics

the "Right Stuff," is marked by above average levels of Positive Instrumentality, Positive Expressivity, Mastery, and Work, and below average levels of Negative Instrumentality and Verbal Aggressiveness. The third cluster, labeled "Low Motivation," or "No Stuff," is characterized by below average scores on Positive Instrumentality, Positive Expressivity, Mastery, Work, and Competitiveness, and above average scores on Negative Communion and Verbal

Aggressiveness. Participants who did not fall clearly into any clusters remained unclassified (McFadden et al., 1994).

Using the cluster solution developed by Chidester et al. (1991), 19.6%, 21.6%, 43.1 %, and 15.7% of the submarine crew members were classified as Positive Instrumental-Expressive, Negative Instrumental, Low Motivation, and "Unclassified," respectively. The corresponding frequencies for military recruits were 13.2%, 24.0%, 49.6%, and 19.7%.

TABLE 2
Definitions, Number of Items, and Cronbach's Alphas for the Scales in the Utrecht Coping List

Scale Names	Definitions	No. of Items	Cronbach's α
Active Problem Solving	Views the situation calmly from all angles; sorts things out; sets about solving the problem purposefully and with confidence	7	.75
Palliative Reaction	Looks for diversions and occupies oneself with other things so as not to think about the problem; tries to feel better by relaxing, smoking, or drinking	8	.68
Avoidance and Passive Expectancies	Lets the problem run its course; avoids the situation or waits and sees what will happen	8	.64
Social Support Seeking	Seeks comfort and understanding from others; shares one's anxieties with another person or asks for help	6	.91
Depressive Reaction Patterns	Lets oneself be totally immersed in the problems and the situation; withdraws fretfully into oneself, incapable of doing anything about the situation; frets about the past	7	.71
Disclosure of Emotions	Shows annoyance or anger; works off the tension	3	.31
Comforting Cognitions	Consoles oneself with the thoughts that things will get better, which others will have difficulties, or that even worse things will happen	5	.68

Table 2: Definitions, Number of Items, & Chronbach's Alphas for the Scales in the Utrecht Coping List

UCL. The UCL was used to measure coping strategies (Schreurs, Tellegen, Van der Willige, & Brosshot, 1988; Schreurs, Van der Willige, Brosshot, & Grau, 1993). Here the Norwegian version of the test was used (Eriksen, Olff, & Ursin, 1997). UCL consists of 47 statements about how one would cope with problems, to be answered on a 4-point scale ranging from 1 (never or seldom) to 4 (very often). Seven scales measuring different coping strategies are included in the UCL. Table 2 presents the definition, number of items, and Cronbach's alpha for each scale.

Health Inventory. Ursin's Health Inventory (UHI; Ursin, Endresen, & Ursin, 1988) consists of items concerning subjective somatic and psychological problems experienced during the last 30 days. Five scales were used: Psychological Problems (eight items), Pain (six items), Cold-Influenza (two items), Allergy (three items), and Gastrointestinal Problems (seven items). A sum score of all the complaints is also computed.

Submarine Stress Questionnaire. This questionnaire consists of seven items describing physical, social, and emotional factors that might act as stressors during submarine missions. The items refer to stress from social relationships, leadership, workload, crowding, loneliness, feeling isolated, and homesickness. The participant indicates whether he or she has experienced the factor as stressful during the last week on scales ranging from 1 (not at all stressful) to 5 (very stressful).

Scales were constructed based on principal component analysis and reliability testing with Cronbach's alpha.

Principal component analysis with varimax rotation yielded three factors with eigenvalues exceeding 1. A scree plot before the analysis supported the three-factor solutions. These factors accounted for 75.9% of the variance. Bartlett's test of sphericity was large, and the Kaiser-Meyer-Olkin Measure of sampling was acceptable (.70). The magnitude of these residuals indicates that the model fits the data rather well. Three interpretable factors of stressors emerged (see Table 3). The first factor covers social relations, crowdedness, and loneliness and is referred to as "Social Factors." The second factor comprises leadership and workload and is labeled "Leadership and Workload." The third factor covers feeling isolated and homesickness and is labeled "Feeling Isolated and Homesickness." Testing the internal consistency of the three factors yielded Cronbach's alpha values of .72, .76, and .55, for the first, second, and third factors, respectively. Because of the low internal consistency of the third factor, the two items included were treated separately in all subsequent analyses. Scales based on the first two factors (Social Factors, and Leadership and Workload) were formed by adding the values with the highest loadings.

Cortisone. Concentrations of cortisone in saliva were analyzed at the laboratory of the Department of Biological and Medical Psychology at the University of Bergen, Norway. Samples were analyzed with ultraviolet detection (Dawson, Kontur, & Monjan, 1984). Extraction, cleaning, and concentration were performed in one step by means of C18 solid phase columns. Dexamethasone was used as

TABLE 3
Factor Loadings in a Principal Component Analysis (Varimax Rotation) on the Items
in the Submarine Stress Questionnaire

<i>Stressors</i>	<i>Factor 1</i>	<i>Factor 2</i>	<i>Factor 3</i>
Interpersonal relationships	.83	—	—
Crowding	.83	—	—
Loneliness	.73	—	—
Relationship to leader	—	.87	—
High workloads	—	.84	—
Homesickness	—	—	.84
Feeling isolated	—	—	.71
Eigenvalue	2.91	1.33	1.08
Percentage of variance	41.5	19.0	15.4

Table 3: Factor Loadings in a Principal Component Analysis (Varimax Rotation) on the Items in the Submarine Stress

an internal standard. This assay was examined for linearity ($R^2 = 0.9943$) and inter- and intraday variation (coefficient of variance < 5.5).

Procedure

The study was approved by the Regional Medical Committee concerning ethical issues and for data storage in Norway. All participants were fully informed as to the nature of the experiment and were told of their rights, such as the right to withdraw from the experiment at any time, and signed a Declaration of Consent Form, which provided this information.

Sample 1. The exercises started in September 1994. Assignment of crews for the exercises was based on practical considerations. The exact duration of the 40-day mission was not determined before the mission commenced, but the crew was informed that food and fuel supply would limit the duration to 40 days. The duration of the 10-day missions was decided in advance. Three to 4 days before the missions, PCI and UCL were completed. Baseline data for the UHI, the Submarine Stress Questionnaire, and cortisone saliva measures were collected at 0800 the day before the mission started. Data collection, which included the Submarine Stress Questionnaire, the UHI, and cortisone measures, was performed once a week during the 40-day mission, and at Day 3 and Day 7 for the 10-day mission. Saliva was collected at 0800, and the tubes were stored in the freezing rooms in the submarines. Questionnaires and tubes of saliva were marked with individual codes, and the completed questionnaires were enclosed in sealed, anonymous envelopes. One crew member was given the responsibility for the data collection.

Sample 2. The office personnel were recruited through one of their colleagues, who was given the responsibility for the data collection. The participants received PCI,

UCL, and UHI and were asked to answer the questionnaires privately and return them in sealed envelopes.

Control group. The military recruits were tested with PCI and UHI as part of a more extensive data collection process during their military duty 3 years earlier in 1991. The questionnaires were completed in a classroom setting.

Data Analysis

Data analyses were conducted by means of the SPSS 6.0 for Windows (Norusis, 1993) statistical package. Due to possible inherent gender differences in the relations examined, the data from the one woman were not included in the analysis. Only PCI and UCL scales with Cronbach's alpha exceeding .65 were used in the analyses. One-tailed tests were used to examine differences between personality clusters in cortisone because the directions of these findings were predicted by theory and previous findings (Levine & Ursin, 1991; Sandal et al., 1998). For all other analyses, two-tailed tests were used. A significance level of $p < .05$ was chosen.

Most of the crew members worked 1 week on day shifts or 1 week on night shifts. Due to circadian variations in cortisone, only values for the participants on day shifts were used. About 25% of the saliva samples were not accepted because they had not been collected and stored correctly.

Results

Personality and Use of Coping Strategies

Pearson product-moment correlations were used to examine interrelations between scales in PCI and UCL based on data from submariners and office personnel working for the Royal Norwegian Navy. Several scales in the PCI and the UCL correlated significantly (see Table 4). There was a definite but small relation between Positive Instrumentality (PCI) and Active Problem Solving (UCL),

TABLE 4
Pearson Correlations Between Scales in the Personality Characteristic Inventory
and the Utrecht Coping List

Scale	Active Problem Solving	Palliative Reaction	Avoidance and Passive Expectancies	Social Support Seeking
Positive Expressivity	.06	-.07	-.07	.30*
Positive Instrumentality	.34*	-.03	-.29*	.02
Negative Instrumentality	-.11	.09	.14	-.07
Negative Communion	-.30*	-.01	.34*	-.07
Negative Verbality	-.13	.10	.04	-.02
Work	.14	-.24*	-.20*	.04
Mastery	.18	-.29*	-.24*	.04
Competitiveness	-.03	-.26*	-.17	.03
Achievement Striving	.11	-.24*	-.22*	.11
Impatience/Irritability	-.13	-.04	.02	.04

Note. $N = 75$.

* $p < .01$.

Table 4: Pearson Correlations Between Scales in the Personality Characteristic Inventory and the Utrecht Coping List

a coping strategy involving behavior such as direct intervention and considering problems as challenges in response to stress. Negative correlations were found between Positive Instrumentality (PCI) and Avoidance and Passive Expectancy (UCL). Negative correlations also appeared between several of the PCI scales reflecting achievement motivation, habitual use of Avoidance and Passive Expectancy (UCL), and Palliative reactions (UCL). Habitual use of Avoidance and Passive Expectancy (UCL) was positively related to self-subordinating characteristics reflected in Negative Communion (PCI). Finally, Positive Expressivity was related to Social Support Seeking (UCL) in response to stress. Despite high inter-correlations between scales in the PCI and UCL, participants in the three personality clusters did not differ significantly on the UCL coping strategy scales.

Predictors for Coping During Submarine Missions

Group differences in personality and health. A one-way analysis of variance (ANOVA) was performed to test differences in personality and health complaints between the crews on the 10-day and 40-day missions, and between the submariners and the military recruits. The crew members on the 10-day and the 40-day missions were comparable with respect to personality and habitual coping strategies. The only significant difference between the groups was found for Verbal Aggressiveness (e.g., "nags a lot" and "very complaining"). Comparisons between the submariners and the military recruits revealed that the submariners scored higher on Positive Instrumentality (e.g.,

Independent, Active, and Goal-Oriented) and Mastery (e.g., "I find satisfaction in working as well as I can"). On the other hand, the submariners scored lower than the military recruits on Positive Expressivity (e.g., "gentle ... kind," and "aware of the feelings of others") and Negative Communion (reflecting subordinating qualities).

Baseline values on the health scales for submariners were significantly lower for Cold-Influenza, Pain, and Psychological problems compared to the control group. On all measurements, submariners reported very low frequencies of health complaints. Therefore, only the sum score was used in all subsequent statistical analyses.

Time effects on coping. Repeated multivariate analyses of variance (MANOVAs) were used to examine the effects of mission duration (10 days vs. 40 days) and time of measurement (the first week vs. the last week) in relation to subjective health complaints and reported stress. Time effects in the cortisone measure were tested with paired sample t tests. Table 5 presents means and standard deviations for the coping indicators. Compared with baseline, the crew members had higher cortisone values and reported more stress related to Social Factors, Homesickness, and Feeling Isolated during the missions. From the first to the last mission week, all crews showed a significant reduction in health complaints and cortisone values. The crew members on the 10-day mission reported significantly more health complaints, $F(1, 43) = 5.18$, $p < .03$, and had higher cortisone values than the personnel

TABLE 5
Means and Standard Deviations for the Coping Indicators

Indicator of Coping	Mission	Baseline			First Week			Last Week		
		M	n	SD	M	n	SD	M	n	SD
Social Factors	10 day	4.10	31	1.63	4.45	29	1.48	4.20	30	1.45
	40 day	3.00	19	1.57	4.83	18	1.34	5.47	17	2.48
	Total	3.68	50	1.67	4.60 ^a	47	1.42	4.66 ^b	47	1.96
Leadership and Workload	10 day	4.35	31	1.60	4.31	29	1.49	3.80	30	1.58
	40 day	5.11	19	1.45	4.17	18	1.54	4.12	17	1.69
	Total	4.22	50	1.59	4.38	47	1.33	4.13	47	1.39
Homesickness	10 day	1.42	31	0.76	1.83	29	0.85	1.83	30	0.87
	40 day	1.37	19	0.68	1.67	18	0.69	2.94	17	1.09
	Total	1.40	50	0.73	1.77 ^a	47	0.79	2.23 ^b	47	1.09
Feeling Isolated	10 day	1.13	31	0.43	1.79	29	0.86	1.60	30	0.86
	40 day	1.37	19	0.77	1.61	18	0.85	2.06	17	0.97
	Total	1.24	50	0.59	1.72 ^a	47	0.85	1.77 ^b	47	0.91
Subjective health complaints	10 day	3.53	32	2.68	3.28	29	3.51	1.69	29	1.87
	40 day	2.63	19	2.31	1.44	18	1.50	0.63	16	1.15
	Total	3.20	51	2.56	2.58	47	3.03	1.31 ^{bc}	45	1.72
Cortisone (ng/ml)	10 day	32.64	12	15.15	41.92	12	14.50	33.56	12	12.57
	40 day	15.00	13	4.84	21.23	15	6.82	32.07	14	19.19
	Total	22.76	25	13.72	30.23 ^a	27	13.67	32.66 ^{bc}	26	17.27

^aSignificant difference ($p < .05$) between baseline and the first week. ^bSignificant difference ($p < .05$) between baseline and the last week. ^cSignificant difference ($p < .05$) between the first and the last week.

Table 5: Means and Standard Deviations for the Coping Indicators

on the 40-day mission: first week, $F(1, 18) = 4.53$, $p < .05$; last week, $F(1, 22) = 5.00$, $p < .05$.

A significant interaction effect between mission duration and stress due to homesickness was found, $F(1, 44) = 22.23$, $p < .05$, and reported stress due to homesickness increased over time during the 40-day mission, although no significant time effect was found for the 10-day missions. Submariners on the 10-day and 40-day missions did not differ significantly in reported stress from Social Factors, Leadership and Workloads, and Feeling Isolated. In addition, there were no significant differences between scores from the first and last weeks of the mission for any of the crews.

Relations among personality, coping strategies, and coping. Regression analysis with forced entry was performed with personality clusters and coping strategies as independent variables and scores on the Stress Factors and health sum score as dependent variables. The PCI personality profiles were transformed into dummy variables before they were entered in the regression analysis. For the health sum score, the deviation between the score in Week 1 and the last week was used. The regression analyses were performed in three steps. To control for mission duration and previous experience, these factors were entered first. In Step 2, the PCI profiles were entered. Finally, in Step 3, the

UCL scales were entered to test the additional variance explained by coping strategies.

Results for the regression analysis are given in Tables 6 and 7. For each step, the increases in explained variance (multiple correlation squared change) are shown, with total multiple correlation squared and adjusted multiple correlation squared shown on the bottom of the tables. Table 8 summarizes the significant results from the regression analyses. Previous experience from submarine missions consistently explained a significant portion of variance in Leadership and Workload stress. Consistent with the results from the MANOVA analysis, reported Homesickness increased as a function of mission duration. In the first week, the PCI personality profiles contributed significantly in explaining an increase in reported stress from Social Factors (23%) and Leadership and Workload (15%). The Low Motivation profile was related to low scores on both factors. The Positive Instrumental-Expressive profile showed a negative relation to high levels of stress from Social Factors in both first and last weeks and from Feeling Isolated in the last week.

In both weeks, coping strategies accounted for a significant portion of the variance in Homesickness, explaining 18% and 20% of the total variance, respectively, for the

TABLE 6
Results From Hierarchical Multiple Regression Analyses Based on Reported Stress 3 Days After the Submarine Missions Started

	Social Factors			Leadership and Workload			Homesickness			Isolation		
	B	SeB	β	B	SeB	β	B	SeB	β	B	SeB	β
Step 1												
Mission duration	0.07	0.19	0.06	0.36	0.41	0.12	0.10	0.22	0.07	0.16	0.24	0.09
Experience	-0.39	0.41	-0.14	-0.42	0.19	-0.31*	0.08	0.10	0.12	0.02	0.11	0.03
Step 2												
Positive IE	-2.06	0.58	-0.61*	-0.84	0.61	-0.23	-0.28	0.36	-0.15	-0.57	0.38	-0.28
Low Motivation	-1.34	0.49	-0.50*	-1.53	0.51	-0.54*	-0.29	0.30	-0.19	-0.61	0.32	-0.37
Negative I	-0.96	0.58	-0.29	-0.73	0.61	-0.21	-0.54	0.36	-0.30	-0.83	0.38	-0.42*
R ² change		.02			.09			.02			.01	
Step 3												
Active	-0.38	0.47	-0.12	0.12	0.53	0.04	-0.48	0.28	-0.28	-0.26	0.32	-0.14
Avoidance	-0.20	0.51	-0.06	-0.46	-0.57	-0.13	0.75	0.31	0.40*	0.15	0.35	0.07
Palliative	0.56	0.57	0.14	0.96	0.64	0.23	0.76	0.34	0.35*	-0.22	0.39	-0.09
Social Support	0.97	0.38	0.35*	-0.08	0.42	-0.03	0.30	0.23	0.20	0.39	0.26	0.24
R ² change		.23*			.15*			.06			.10	
Total												
R ² change	.12	.37		.04	.29		.18*	.25		.05	.17	
Adjusted R ²			.23			.14			.09			-.01

Note. Mission duration was coded as 1 (10 days) or 2 (40 days). Positive IE = Positive Instrumental-Expressive; Negative I = Negative Instrumental; Active = Active Problem Solving; Avoidance = Avoidance and Passive Expectancies; Palliative = Palliative Reaction; and Social Support = Social Support Seeking. *p < .05.

Table 6: Results from Multiple Hierarchical Regression Analyses Based on Reported Stress 3 Days After the Submarine Missions Started

TABLE 7
Results From Hierarchical Multiple Regression Analyses Based on Reported Stress 3 Days Before the End of the Submarine Missions

	Social Factors			Leadership and Workload			Homesickness			Isolation		
	B	SeB	β	B	SeB	β	B	SeB	β	B	SeB	β
Step 1												
Mission duration	-1.00	0.53	-0.26	-0.06	0.44	-0.02	0.93	0.27	0.44*	-0.31	0.25	-0.17
Experience	-0.26	0.24	-0.15	-0.43	0.20	-0.30*	-0.12	0.13	-0.13	-0.19	0.11	-0.23
Step 2												
Positive IE	-1.51	0.83	-0.32*	-0.11	0.69	0.25	-0.11	0.44	-0.04	-0.83	0.38	-0.38*
Low Motivation	-0.56	0.70	-0.15	-0.25	0.58	-0.08	-0.36	0.37	-0.17	-0.43	0.32	-0.25
Negative I	-0.03	0.83	-0.01	0.91	0.69	0.25	-0.58	0.44	-0.23	-0.00	0.38	-0.00
R ² change		.11			.09			.24*			.10	
Step 3												
Active	0.57	0.72	0.13	-0.17	0.59	-0.05	-1.29	0.33	-0.54*	-0.11	0.32	-0.06
Avoidance	0.74	0.78	0.16	-0.54	0.64	-0.14	-0.40	0.36	-0.15	0.49	0.34	0.22
Palliative	-0.38	0.87	-0.07	1.18	0.72	0.26	0.50	0.40	0.16	0.25	0.38	0.10
Social Support	0.44	0.58	0.12	0.31	0.48	0.10	0.33	0.27	0.16	0.16	0.25	0.09
R ² change		.08			.08			.04			.13	
Total												
R ² change	.04	.24		.06	.23		.20*	.25		.08	.17	
Adjusted R ²			.07			.07			.36			-.01

Note. Mission duration was coded as 1 (10 days) or 2 (40 days). Positive IE = Positive Instrumental-Expressive; Negative I = Negative Instrumental; Active = Active Problem Solving; Avoidance = Avoidance and Passive Expectancies; Palliative = Palliative Reaction; and Social Support = Social Support Seeking.

Table 7: Results from Multiple Hierarchical Regression Analyses Based on Reported Stress 3 Days Before the End of the Submarine Missions

TABLE 8
Summary of Results From the Regression Analyses

<i>Predictor</i>	<i>Results</i>
Personality profiles	
Positive Instrumental-Expressive	Negatively related to high levels of stress from Social Factors in both weeks and from Feeling Isolated in the last week
Low Motivation	Negatively related to high levels of stress from Social Factors and Leadership in the first week
Negative Instrumental	Negatively related to high levels of stress from Feeling Isolated in the first week
Coping strategies	
Active Problem Solving	Negatively related to high levels of Homesickness in the last week
Avoidance and Passive Expectancies	Positively related to high levels of Homesickness in the first week
Palliative Reaction	Positively related to high levels of Homesickness in the first week
Social Support Seeking	Positively related to high levels of stress from Social Factors in the first week

Table 8: Summary of Results from the Regression Analyses

first and last weeks. In the first week of the mission, Palliative Reaction and Avoidance and Passive Expectancies were related to high scores on Homesickness, whereas in the last week, Active Problem Solving became a significant negative predictor. Social Support Seeking was related to high stress from Social Factors in the first week. Neither the personality profiles nor the coping strategies contributed significantly in explaining subjective health complaints, but there was a tendency for the Positive Instrumental-Expressive profile to be associated with few health complaints, $t = 1.69$, $p < .09$.

Cluster differences in cortisone values were tested with one-way ANOVAs. Due to a limited number of cortisone values, cortisone levels were only used to test differences among individuals fitting the Positive Instrumental-Expressive profile and those fitting the Negative Instrumental profile during the 40-day mission. In the last week, Positive Instrumental-Expressive individuals showed significantly lower values than those with a Negative Instrumental profile, $F(1, 11) = 6.50$, $p < .05$. The mean cortisone values for the Positive Instrumental-Expressive participants ($n = 6$) were 56.00 ng/ml (SD = 65.05) and 14.33 ng/ml (SD = 4.16), respectively, for the first and last mission weeks. The Negative Instrumental participants ($n = 6$) had a

mean of 66.80 ng/ml (SD = 38.73) for the first week and 22.83 ng/ml (SD = 4.92) for the last week.

Discussion

Part 1

Personality and use of coping strategies. One purpose of this study was to gain more knowledge about the mechanisms by which personality affects the ability to cope under stress. The first part of the study examined interrelations between the profiles and scales in PCI and the coping strategies scales in the UCL. The most consistent finding from these analyses was the “clustering” of the instrumental mastery-oriented scales in the two instruments. Positive Instrumentality (PCI) was related to habitual use of Active Problem Solving (UCL) and negatively related to Avoidance and Passive Expectancies (UCL; e.g., “resigning oneself to the situation”). In addition, several achievement motivation scales in the PCI correlated negatively with Avoidance and Passive Expectancies (UCL) and Palliative Reactions (UCL; e.g., “trying to think better through drinking or relaxation”). The pattern of correlation is consistent with the conception of instrumental, active, and goal-oriented coping in contrast to more passive avoidance. The dimension seems to reflect the individual’s belief that one’s own behavior is efficacious. This dimension also seems to be related to

the concept of "locus of control" (Rotter, 1966), referring to the general belief that events in life are either controlled by one's own actions (an internal orientation) or by outside forces (an external orientation).

Despite correlations between scales in the two instruments, there were no straightforward relations between the PCI personality profiles and the way in which the individual habitually dealt with stressful situations. This does not necessarily indicate that such strategies do not mediate the link between personality and coping. It might not be important whether individuals use one coping strategy rather than another, but whether they can draw on very different ones adaptively, depending on the requirements of the situation (F. Cohen et al., 1982). Several studies have found that androgynous people, characterized by strong instrumentality and interpersonal sensitivity, are more behaviorally flexible than others (Helmreich & Spence, 1978). This suggests that positive instrumental-expressive individuals might be more capable of changing coping strategies adaptively in response to situational demands.

Part 2

Predictors for coping during submarine missions.

The second part of this study dealt with how personality characteristics and habitual coping strategies affected the perception of stress and coping during submarine missions lasting for 10 days and 40 days. The submarine environment was assumed to represent a stressful setting because it is isolated, potentially hazardous, and restricted in area, raising problems of privacy, territoriality, and conflicts over use of resources (Helmreich & Wilhelm, 1985). Therefore, the first examination was whether this situation induced change in cortisone levels and subjective reports of stress. Compared with baseline, the crew members showed higher levels of cortisone and reported more stress during the mission, which confirmed that the submarine missions were experienced as stressful. Consistent with previous studies of isolated groups (e.g., Gushin, 1995; Sandal et al., 1995), the two types of coping were found to be relatively unaffected by mission duration. Except for a more marked increase in homesickness during the 40-day mission, there were no significant differences in the outcomes of the two types of coping between the crews participating on the 10- and 40-day missions.

The identification of crucial time periods during the missions, however, seems to be one of the most important recent findings in the area of human performance in outer space and polar geographical areas. Knowledge about these critical periods might have important implications for the development of countermeasures for mastering problems due to human nature. Prediction of when psychological and interpersonal problems are most likely

to occur might enable both crew members and outside personnel to better prepare for them and to intervene before they result in operational degradation or health problems. If participants are aware that incidents are to be expected, then problems might be handled impersonally and with greater tact.

Factor analysis identified three categories of stressors during the mission. The first factor covered Social Stressors that might be assumed to result from the forced interaction with other crew members, such as lack of privacy and interpersonal tension. The second factor comprised Leadership and Workload and might reflect issues such as assignment of duties, scheduling, and leadership style. The third factor comprised Homesickness and Feeling Isolated, which might be considered both as psychological stressors and coping responses.

Personality profiles seemed to influence the responsiveness of the submariners to social stressors. In line with theoretical assumptions (Chidester & Foushee, 1988), crew members with the Positive Instrumental-Expressive profile seemed to cope better with the social demands of the missions, as suggested by lower indicated stress from social factors. Interpersonal sensitivity might have reduced the likelihood that they experienced interpersonal tension and probably increased the tolerance for the constant proximity and contrasting needs of other crew members. Particularly, the Positive Instrumental-Expressive profile was found to predict the degree of coping toward the end of the mission, indicating that these individuals might be less vulnerable to long-term stress. In the last week of the mission, they reported less stress from feeling isolated. At the end of the 40-day mission, they also had lower saliva cortisone values than others. Although endocrine analyses were based on a small sample ($n = 12$) and had relatively low reliability, the validity of the result is supported by previous findings (Sandal et al., 1998). The associations between personality and endocrine activation support the validity of the more subjective coping indicators.

Crew members classified as Low Motivation, characterized by low achievement motivation combined with passive-aggressive attributes, seemed to cope well in the initial part of the mission. In the first week, the Low Motivation profile was a negative predictor for stress from social factors, leadership, and workload. The result is apparently inconsistent with findings from previous studies showing that Low Motivation participants had higher cortisol values before and after military training (Sandal et al., 1998), reported lower well-being, and experienced higher anxiety during prolonged isolation in hyperbaric chambers (Sandal et al., 1996) compared to others. The results are also unexpected because the need for close interaction with other people is assumed to represent an

essential stressor for individuals deficient in interpersonal skills. One possible explanation for this finding is that the individual's low sensitivity and self-awareness when interacting with other people might have reduced his or her perception of the stressfulness of the situation in the initial part of the mission.

Another finding was that habitual coping strategies contributed significantly in predicting reported stress, even when the variance explained by the personality profiles was controlled. Strategies, covering what Lazarus and Folkman (1984) described as emotion-focused coping, were related to stress due to homesickness and social factors. These are strategies aimed at regulation of the negative emotions or distress by intentionally distracting oneself, by communicating distress, or by withdrawing from the situation. Reliance on such strategies might be impossible in the submarine environment due to limited opportunities to withdraw or to regulate negative emotions through distracting behavior (such as using drugs or sleeping). Withdrawal from the stressful situations might also be linked to negative response outcome expectancies or to lack of coping. In contrast, active, problem-focused strategies were negatively related to homesickness in the last week of the mission, suggesting that confidence in one's own coping ability is important for the ability of individuals to tolerate separation from family and previously established networks.

Seeking social support as a coping strategy seemed to predict increased responsiveness to social stressors in the initial part of the mission. The need for social support might be related to dependency and low self-esteem, reflecting lack of trust in one's own ability to succeed. Furthermore, although social support may act as a "buffer" against stress (Palinkas, 1990), such strategies might not be effective when interpersonal relationships are poor, when social interaction does exacerbate existing stress (Hobfoll, 1989), or when the group is not attentive to the emotional needs of its members. These point to the need to interpret the personality-coping relations contextually. Considering that the military has been known for competitive, highly charged environments that tend to deemphasize interpersonal sensitivity, it might not encourage the sharing of personal concerns.

Subjective health was not predicted by personality characteristics or coping strategies, probably due to the low frequency of reported complaints. Frequencies of health complaints among the submariners were below those of the military recruits, although it should be noted that there were age differences between the two samples that may have explained this. Reports of health complaints might also be influenced by differences in neuroticism, which is sometimes referred to as negative

affectivity (Watson & Pennebaker, 1989). Highly neurotic individuals tend to exaggerate somatic concerns and have frequent somatic complaints, although their actual health is normal. Neuroticism has been associated with PCI scales reflecting self-subordinating attributes and is inadvertently related to instrumental attributes (Spence et al., 1979). The differences in scores between submariners and military recruits on these scales indicate that the military recruits might be more neurotic. On the other hand, it also is possible that submariners might tend to underreport health complaints due to the high social value given to physical strength and mental capacity in this setting. In comparison, the more frequently reported stress from Social Factors as well as Leadership and Workload, in comparison to Feeling Isolated and Homesickness, might reflect a tendency of the submariners to attribute stress to factors outside their own control.

Conclusions

Contemporary research on stress emphasizes how the individual determines that a situation is threatening. Focusing on how individuals tend to perceive and respond to difficult, unusual, hazardous, and challenging situations contributes to the body of knowledge concerned with the link between personality and resistance to stress that might have operational implications for personnel selection. This study investigated submarine crew members who went on a short 10-day exercise and a longer 40-day exercise and identified the following relations among personality, habitual coping strategies, and actual coping during the missions:

1. Interpersonal orientation, motivation, and habitual coping strategies were predictors for how individuals coped in this stressful group setting.
2. Crew members who coped well experienced less discomfort from being in the constant close proximity of other people and had higher tolerance for being separated from family and friends at home.
3. Problem-focused coping strategies and interpersonal sensitivity combined with strong achievement motivation were associated with superior coping during the submarine missions.

Apart from the effects on individual coping, interpersonal sensitivity among crew members is also likely to be important for maintenance of group harmony. Heightened frictions and social conflicts, expected correlates of life under demanding conditions (Rivolier et al., 1988; Sandal et al., 1995), might seriously affect individual health and performance as well as the ability of the crews or units to act in a cohesive manner (Foushee & Manos, 1981).

The results of this study suggest that considering interpersonal characteristics as part of selection might

prove to be highly beneficial to group performance and individual coping in military settings involving prolonged exposure to stress, especially with smaller units of crew members. Any application of these findings are limited to men since only one woman was studied in the short- and long-stress periods.

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