

PSYCHOLOGICAL CORRELATES OF IMMUNOLOGICAL INDICES

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SUMMARY

Most psychoimmunological studies have focused on the effects of short-term situation-bound stress. This study was designed to explore the effects of different short- and long-term psychological factors on immunity, as reflected in the state of leukocyte adhesiveness/aggregation (LAA) in the peripheral blood, the white blood cell count (WBCC) and the erythrocyte sedimentation rate (ESR). The subjects were 91 healthy men and women, aged 18–69 years. They were administered the tests for LAA, WBCC and ESR, the Life Experiences Survey (Sarason *et al.*), the Questionnaire of Personal Problems (Kreitler and Kreitler), three measures of emotions, scales of neuroticism (Eysenck), stress susceptibility (Tellegen), strength of excitation, inhibition and mobility of nervous processes (Strelau), and the cognitive orientation (CO) of health. The results showed that the state of LAA in the peripheral blood correlated with 21.3 per cent of the psychological variables and that in a regression analysis these accounted for 38.2 per cent of the variance in LAA, the major predictors being specific personal problems and a constituent of the CO of health. The former alone accounted for 22.8 per cent of the variance and the latter for 26.6 per cent. The major predictor in men was personal problems and in women CO of health. WBCC and ESR were related to psychological factors to a lesser degree and to other predictors, mainly emotional. The conclusions emphasize the relatedness of LAA to specific sources of stress of short (*viz* problems) and long (*viz* deficient means of reducing stress) duration.

KEY WORDS—Leukocyte adhesiveness/aggregation, cognitive orientation of health, stress, psychoimmunology.

A growing body of studies shows that psychological factors may affect immunological indices.^{1–3} Most psychoneuroimmunological research focused on the role of psychological stress as an immunosuppressive agent.⁴ Stressors shown to adversely affect various immunological indices included, for example, examination,^{5,6} unemployment,⁷ bereavement,^{8,9} marital divorce or separation,¹⁰ acting as a long-term caregiver to an Alzheimer patient,¹¹ negative event-dependent mood states,¹² strenuous physical exercise¹³ and even waiting for the results of tests for AIDS.¹⁴ Also emotional distress factors, such as anxiety or depression, are related to decline in immunity in healthy^{15,16} or sick individuals.¹⁷

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Note: Dr. Hans Kreitler died on 7 January 1993

Positive effects on immunity were demonstrated by various guided imagery techniques in healthy¹⁸ and sick individuals.¹⁹

Notably, stress, emotional distress and guided imagery are situation-bound factors. There are very few studies relating more stable personality dispositions and immunological indices. There is some evidence that immunity is affected positively by the affiliation motive and negatively by motivation for power^{20,21} and repressiveness (namely, high defensiveness coupled with high anxiety)²² in healthy individuals, and the response style of helplessness in cancer patients.¹⁷ The findings in regard to more stable emotional factors such as depression are contradictory.^{16,23}

This study focused on exploring the relative effects of long-term and short-term psychological factors from different domains on some immunological variables in healthy individuals. The psycho-

logical domains were: (a) life events — their number and assessed quality (positive or negative); (b) problems the individual has — their nature, duration, difficulty, disturbingness, personal control over their solution, and pressure for solution; (c) emotional profile — including both positive and negative emotions; (d) personality dispositions — including susceptibility to stress and excitability; and (e) cognitive orientation for health — the non-conscious and non-voluntary motivation for maintaining physical health.

The selected domains represent both situation-bound (a,b) and personality-bound (c,d,e) factors, emotional (c) and non-emotional (d,e) variables, stressors (a,b) and non-stressors (c), more externally induced (a) and more internally guided (b,d) processes. As noted earlier, previous studies showed that three of the five domains (a,c,d) include variables related to immunity, such as the life events bereavement or divorce, the emotional factors anxiety and depression, and the personality disposition of excitability. However, all five domains have been found to be related to health, for example life events,^{24,25} emotions²⁶ and the cognitive orientation of health.^{27,28} Hence it was reasonable to expect that all would contribute to accounting for at least some of the variance in the level of immunity.

Three immunological factors were included in the present study, namely, the state of leukocyte adhesiveness/aggregation (LAA) in the peripheral blood, the total white blood cell count (WBCC) and the erythrocyte sedimentation rate (ESR). Numerous studies have initially shown LAA to be a highly reliable marker of inflammation, sensitive to disease severity.^{29,33-35} Subsequent studies showed that LAA was a reliable indicator for stress when inflammation is excluded.^{30-32,36,37} The role of adhesiveness for various leukocytic functions was elucidated mainly by studies from Springer's laboratory.³⁸ It became clear that leukocyte adhesive glycoproteins are essential for adhesion to the endothelium, aggregation, natural killer cytotoxicity, polymorphonuclear leukocyte antibody-dependent cytotoxicity, protection against herpes simplex virus cytotoxicity, adhesion of cytotoxic T lymphocytes to their target cells, and granulocyte migration and phagocytosis. The essential role of the adhesive glycoproteins was also revealed in a rare inherited disease — 'leukocyte adhesion deficiency' — typified by their absence. It is manifested by recurrent, often life-threatening infections caused by bacterial or viral microorganisms.³⁹

In addition to LAA, WBCC and ESR were determined, as the former was shown to be an independent predictor of all-cause mortality⁴⁰ and because elevated ESR values may indicate an early stage of illness without clinical manifestations.⁴¹

Thus, the major objective of the study was to explore the interrelations between a set of long-term and short-term psychological variables representing major domains of psychological functioning and a set of immunological variables representing major areas of physiological functioning.

METHOD

Subjects

The subjects were 91 healthy adults, 48 women and 43 men, aged 18–69 years ($M = 43.22$, $SD = 14.53$), selected randomly from the adult population of two collective settlements (kibbutzim) in Israel. None was ingesting anti-inflammatory drugs in the course of the study. Their freedom from disease was established both by self-report and by medical examinations.

Assessment instruments

Immunity indices. WBCC and the differential count were performed in a Technicon H1 Autoanalyzer. The ESR was determined by Westergren's⁴² method. The state of LAA in the peripheral blood was assessed by means of a simple slide test:⁴³ blood was drawn in a syringe that contained sodium citrate (1 vol 3.8 per cent sodium citrate and 3 vol whole blood). Several large drops of blood were placed on a slide that was held for 2–3 s at a 45-degree angle so that the blood could slip down by gravity, leaving only a fine film. The slides were then dried in a completely horizontal position in an incubator at room temperature. The dried slides were placed for 10 min in -18°C in order to effect haemolysis. Fixation was done with absolute methanol and staining with haematoxylin. The percentage of aggregated leukocytes on the slides was determined by counting 300 white blood cells at random (eg the percentage was 10 per cent if, say, there were 30 aggregates out of 300 cells or three aggregates out of 30 cells or two aggregates out of 15). The criterion for aggregation was that three or more nuclei were placed less than one cell diameter apart. For microscopic examination we put a drop of immersion oil on the stained slide and

covered it with a cover glass. The $\times 40$ objective was used for examination. The focus had to be adjusted often because due to the relative thickness of the blood film not all the leukocytes were on the same level. Like the differential white blood count, the aggregates consist mainly of neutrophils in cases of neutrophilia or lymphocytes in cases of lymphocytosis. Mixed aggregates of polymorphonuclear and mononuclear leukocytes are often seen. Two slides were prepared from each subject. The final result was a mean of both. Variation between duplicates did not generally exceed 20 per cent, which is also the variation noted for two independent observers examining slides of the same subject. The test-retest differences of the same sample did not exceed 15 per cent. The intra-assay coefficient of variation (calculated from 15 slides prepared from the same subjects) was 0.2 and the inter-assay coefficient of variation (calculated when the same normal subject was examined on 15 successive days) was 0.3.

Life events. We used the Life Events Survey (LES),⁴⁴ which asked the subject to state whether the stated events had happened in the preceding year, and if yes to rate the degree to which they were viewed as positive or negative at the time of their occurrence. The scores were the total number of stated events for the whole year, the number of events evaluated as positive (ie rated as slightly, moderately or extremely positive), the number of events rated as negative (ie somewhat, moderately or extremely negative) and their proportions out of the total number of events.

Personal problems. These were assessed by means of the Personal Problems Questionnaire (PPQ), which has been pretested and prevalidated in different samples.⁴⁵ The subjects were requested to state whether they were bothered by some problem, and if yes to describe it or state its general domain (eg work, family), duration (days, weeks, months, years), difficulty, disturbingness, the degree to which its solution depended on the individual and degree of perceived pressure to solve it (the latter four were rated on a four-point scale from low = 1 to high = 4).

Emotions. Three instruments were used for assessing affective states. One was the Profile of Mood States (POMS),⁴⁶ which provides scores concerning tension-anxiety, depression-dejection, anger-hostility, vigour-activity, fatigue-inertia

and confusion-bewilderment. The second was the Multiple Affect Adjective Check List (MAACL),⁴⁷ which provides scores of anxiety, depression and hostility. The third was the Positive Emotions Check List (PECL),²⁷ which assesses love-affection, curiosity-interest, happiness-joy and contentment-satisfaction.

Personality tendencies. Included were the following two measures of susceptibility to stress: the Multidimensional Personality Questionnaire⁴⁸ (MPQ; Scale No. 5, full version including 26 true/false items) and Eysenck's neuroticism scale⁴⁹; and the following three measures of personality traits: strength of excitation, strength of inhibition and mobility of nervous processes, all three assessed by Strelau's Temperament Inventory⁵⁰ (STI).

Attitudes towards health. We used the questionnaire of the cognitive orientation (CO) of health, which provides a measure of the overall non-conscious motivation supporting health.²⁷ The assessment is in terms of four types of beliefs (beliefs about self, beliefs about goals, beliefs about rules and norms and general beliefs about 'how things actually are') referring to a set of themes found to be related to health, such as expressing emotions, feeling in control, trusting others, feeling strong enough to deal with the daily hassles, etc. The score based on this questionnaire was related to various aspects of health, such as risk factors for coronary heart disease, severity of the myocardial infarction, susceptibility to infections following an operation and frequency of flu.²⁷

Procedure

All subjects were administered the LAA test and the questionnaires in random order, after having given their informed consent. Coffee, smoking and physical activity were not allowed prior to the tests. The tests were administered in the framework of the routine annual health care checkups in the settlements. The subjects were told they would participate in a study including both LAA and psychological measures. Rejection rate was lower than 2 per cent.

Statistical methods applied for the analysis of the data included mean comparisons by *t*-tests (between subsamples and between the sample as a whole and other samples), Pearson product-moment correlations, and stepwise as well as non-stepwise regression analyses for analysing the rela-

Table 1—Means and SDs of all variables examined in the study

Variable	<i>M</i>	<i>SD</i>
Age	43.219	14.535
<i>Immunological measures</i>		
LAA	5.286	3.793
WBCC	6755.555	1799.320
ESR	17.494	14.170
<i>Life events</i>		
Number of events	8.956	1.744
Product of number & evaluation	14.178	2.621
Number of negative events	2.480	0.897
Proportion of negative out of total	0.270	0.132
Number of positive events	3.969	1.232
Proportion of positive out of total	0.443	0.204
<i>Personal problems</i>		
In the domain of work	0.143	0.352
In the domain of family	0.187	0.392
In the domain of health	0.066	0.250
In the domain of interpersonal relations	0.121	0.328
In the domain of studies	0.066	0.250
In the domain of living quarters	0.110	0.314
In the domain of kibbutz management	0.066	0.250
In the domain of security & politics	0.022	0.147
In the domain of bereavement	0.011	0.105
In the domain of economics & finances	0.011	0.105
Total number of problems	2.342	0.775
Characteristics of problems		
Duration	3.532	0.695
Difficulty	3.125	0.745
Disturbingness	3.219	0.845
Solution dependent on individual	2.790	0.994
Feeling pressured to solve	3.229	0.902
<i>Emotions</i>		
(POMS) Tension — anxiety	24.292	5.172
(POMS) Depression — dejection	39.258	6.324
(POMS) Anger — hostility	37.454	6.843
(POMS) Vigour — activity	30.790	3.651
(POMS) Fatigue — inertia	21.649	4.791
(POMS) Confusion — bewilderment	22.236	4.362
(MAACL) Anxiety	3.281	2.751
(MAACL) Depression	16.963	4.618
(MAACL) Hostility	3.361	2.059
(PECL) Love — affection	31.524	3.602
(PECL) Curiosity — interest	31.044	5.008
(PECL) Happiness — joy	29.802	4.617
(PECL) Contentment — satisfaction	30.625	4.314
<i>Personality traits</i>		
Stress susceptibility (Tellegen)	8.756	6.034
Neuroticism (Eysenck)	8.301	5.681
Strength of excitation (STI)	43.929	10.475
Strength of inhibition (STI)	53.472	7.635
Mobility of nervous processes (STI)	51.405	7.427
<i>Cognitive orientation of health</i>		
General beliefs	62.396	5.146
Beliefs about self	59.286	5.908
Beliefs about goals	57.756	6.652
Beliefs about rules and norms	61.615	4.485

tions between the psychological variables and the immunological indices.

RESULTS

Control analyses

Control analyses showed that the two kibbutzim differed significantly only in two of the tested variables (which form 4.2 per cent of the total number of variables, 47). This number does not exceed the 5 per cent expected by chance. The genders, however, differed significantly in six (12.76 per cent) variables: women scored higher in problems in the family, neuroticism, stress susceptibility, anxiety (MAACL), fatigue-inertia (POMS) and lower on sedimentation rate. This number deviates from the 5 per cent expected by chance. Though the deviation from chance was not significant ($CR = 1.33$, NS), the major analyses were performed not only on the sample as a whole but also on the gender subsamples separately.

Representativeness of sample

Table 1 presents the means and SDs for all the variables involved in the study. In order to determine how representative the sample was, whenever available we compared the mean values observed in this sample with those obtained in other samples. The compared means included those of the immunity measures, emotions, personality traits and attitudes toward health (25 variables). In no case did these means differ significantly from those in other samples drawn from the Israeli healthy adult population. The means for immunity measures, emotions and personality traits were compared also with those based on international samples. Again, there were no significant differences. Hence, the sample can be viewed as representative of a normal healthy adult population.

Relations of psychological variables to LAA

The relations of psychological variables to LAA were determined in two stages. In the first stage a correlation matrix was set up between the psychological variables and LAA; in the second stage a regression analysis was performed with the psychological variables that correlated significantly with LAA serving as predictors and LAA as the dependent variable.

Table 2 shows that LAA was correlated significantly with 10 psychological variables, which constitute 22.73 per cent of the total. This number deviates significantly from the 5 per cent expected by chance ($CR = 2.419$, $p < 0.05$). The correlation coefficients were low and ranged from $r = 0.17$ to $r = 0.35$, which indicate 2.9–12.25 per cent of common variance. The list includes variables from five of the six examined domains (all except personality tendencies). LAA was correlated positively with the number of negatively evaluated recent events; the number of problems one has — specifically, interpersonal, those concerning the kibbutz, security and politics, and bereavement — especially if they are of recent duration, and if one feels that their solution depends on oneself; anxiety; and two of the belief types comprising the CO of health (general beliefs and beliefs about rules and norms).

The regression analysis with LAA as the dependent variable shows that in a non-stepwise analysis (Table 4) the whole set of predictors accounted for 38.19 per cent of the variance in LAA ($R = 0.6180$). The predictors with the largest contributions to the prediction were the sum of the specific problems one has, general beliefs (of the CO of health) and feeling that the solution of one's problems depends on oneself. In contrast, the variables with the lowest contributions were the proportion of negatively evaluated recent events out of the total number of events and the duration of the problems one has. The stepwise regression analysis (Table 3) indicates that the best predictors alone (the sum of the specific problems one has and general beliefs)

Table 1 (footnote)

Note: In regard to life events, all three degrees of evaluation relating to negative or positive events were collapsed into one evaluation degree; the proportions of negatively and positively evaluated events do not add up to 1.00 because 28 per cent of the checked events were evaluated as 'neutral'. In regard to personal problems, duration was rated on 1–4 corresponding to days, weeks, months and years, respectively, whereas the remaining characteristics were rated on 1–4 corresponding to 'not at all', 'a little', 'medium' and 'very much', respectively. Problems in regard to security and politics refer mainly to the worries elicited by the Gulf War.

Table 2—Significant Spearman product — moment correlations of the three immunity measures with the psychological variables

Immunity measures	Psychological variables
LAA	Proportion of negatively evaluated life events 0.17*; duration of personal problems -0.20*; experiencing solution of problem as dependent on self -0.27*; no. of interpersonal problems 0.34***; no. of problems in regard to kibbutz 0.17*; no. of problems in regard to security and politics 0.27**; no. of problems concerning bereavement 0.35***; total no. of problems 0.19*; general beliefs -0.33***; beliefs about rules and norms -0.17*
WBCC	Proportion of positively evaluated life events 0.17*; experiencing solution of problem as dependent on self 0.32**; depression-dejection (POMS) -0.19*; fatigue-inertia (POMS) -0.30**; depression (MAACL) -0.34***; no. of problems in regard to family -0.17*; no. of problems concerning bereavement -0.42***; total no. of problems -0.19*
ESR	No. of problems in regard to health 0.22*; total no. of problems 0.23*; neuroticism 0.22*; stress susceptibility 0.22*; strength of excitation 0.18*; tension-anxiety (POMS) 0.29**; anger-hostility (POMS) 0.28**; fatigue-inertia (POMS) 0.17*; confusion-bewilderment (POMS) 0.19*; anxiety (MAACL) 0.24*; general beliefs -0.17*; beliefs about goals -0.20*

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 3—Results of stepwise multiple regression analyses with the psychological variables as predictors and immunity measures as dependent variables

Sample	Predictors	R^2	R-square	Beta
<i>Dependent variable: LAA</i>				
Whole	Sum of specific problems	0.4539***	0.2060	0.4539
	General beliefs (CO of health)	0.5374***	0.2888	0.2713
Men	Sum of specific problems	0.4652*	0.2164	0.4652
Women	General beliefs (CO of health)	0.4740**	0.2246	0.4740
	Sum of specific problems	0.5918***	0.3503	0.3636
<i>Dependent variable: WBCC</i>				
Whole	Depression (MAACL)	0.3451**	0.1190	-0.3451
	Sum of specific problems	0.4232***	0.1791	0.1256
	Fatigue-inertia (POMS)	0.4562***	0.2081	0.1064
Men	Depression (MAACL)	0.4581*	0.2099	-0.4581
Women	Fatigue-inertia	0.4238*	0.1796	-0.4238
<i>Dependent variable: ESR</i>				
Whole	Tension-anxiety (POMS)	0.2894*	0.0838	0.2894
	Anger-hostility (POMS)	0.3042*	0.0925	0.1853
Men	Anger-hostility (POMS)	0.3245*	0.1053	0.3245
Women	Tension-anxiety (POMS)	0.3741*	0.1399	0.3741

Note: R-square (multiplied by 100) provides the percentage of the variance accounted for. 'Sum of specific problems' is the sum of the scores of the problems correlated with the specific immunity measure (see Table 1).

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

account for 28.88 per cent of the variance ($R = 0.5374$).

The findings for men and women separately showed that in both subsamples psychological variables were related to LAA; in men they accounted for 35.03 per cent of the variance and in women

for 21.64 per cent (the difference is not significant, $CR = 1.424$, NS). The only difference was that in men the major predictor was problems and in women beliefs of the CO of health questionnaire.

In order to determine which domain of predictors (recent events, emotions, etc) is most clearly

Table 4—Results of non-stepwise regression analyses with the psychological variables as predictors and immunity measures as dependent variables

Sample	R^2	R -square	Predictors (ordered as in the prediction equation)
<i>Dependent variable: LAA</i>			
Whole	0.6180**	0.3819	Sum of specific problems, gen. beliefs (CO), solution depends on oneself, norms (CO), beliefs about self, no. of negative life events, duration of problem, goals (CO), no. of problems
Men	0.5940	0.3555	Sum of specific problems, solution depends on oneself, beliefs about self (CO), gen. beliefs (CO), no. of negative life events, norms (CO), goals (CO), duration of problem, no. of problems
Women	0.6245	0.3900	Gen. beliefs (CO), norms (CO), sum of specific problems, no. of negative life events, solution depends on oneself, beliefs about self (CO), goals (CO), duration of problem, no. of problems
<i>Dependent variable: WBCC</i>			
Whole	0.6180**	0.3819	Depression-dejection, sum of specific problems, fatigue-inertia, solution depends on oneself, no. of positively evaluated life events
Men	0.5539*	0.3068	Solution depends on oneself, depression-dejection, no. of specific problems, no. of positively evaluated life events
Women	0.4938	0.2438	Fatigue-inertia, sum of specific problems, solution depends on oneself, no. of positively evaluated life events, depression-dejection
<i>Dependent variable: ESR</i>			
Whole	0.5115	0.2616	Tension-anxiety, anger-hostility, anxiety (MAACL), no. of problems, neuroticism, stress susceptibility, confusion-bewilderment, excitation, goals (CO), gen. beliefs (CO), fatigue-inertia
Men	0.7027	0.4938	(Same as for whole sample)
Women	0.5142	0.2644	(Same as for whole sample)

Note: R -square ($\times 100$) provides the percentage of the variance accounted for. 'Sum of specific problems' is the sum of the scores of the problems correlated with the particular immunity measure (see Table 1).

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 5—Results of stepwise and non-stepwise multiple regression analyses with the belief types of CO of health and specific personal problems as two sets of predictors and LAA as dependent variable

Predictors	R^2	R -square	Beta
<i>CO of health (stepwise)</i>			
General beliefs	0.3306***	0.1093	-0.3306
Beliefs about rules & norms	0.4452***	0.1982	-0.2296
Beliefs about self	0.5163**	0.2665	-0.1043
<i>CO of health (non-stepwise)</i>	0.5594*	0.3129	Gen. beliefs, norms, beliefs about self, goals
<i>Personal problems (stepwise)</i>			
Bereavement	0.3553**	0.1263	0.3553
Interpersonal	0.4773***	0.2278	0.3188
<i>Personal problems (non-stepwise)</i>	0.5063	0.2563	Bereavement, interpersonal, security & pol., kibbutz

Note: R = square ($\times 100$) provides the percentage of the variance accounted for. For non-stepwise analyses, the column of 'beta' presents the predictors in the order in which they were entered in the prediction equation.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

related to LAA regression, analyses were performed in regard to LAA as the dependent variable with the predictors of each domain separately. The results (Table 5) showed that only the domains of personal problems and health attitudes yielded significant results. The CO of health questionnaire alone accounted for 26.65 per cent of the variance in LAA, and problems for 22.78 per cent.

Relations of psychological variables to WBCC and ESR

WBCC and ESR are two lowly interrelated indices ($r = 0.22$, $p < 0.05$), each of which is related to LAA positively but moderately: WBCC $r = 0.51$, $p < 0.001$ and ESR $r = 0.29$, $p < 0.01$. Thus, the variance they share with LAA ranges from 8.41 per cent to 26 per cent. Hence, it may be expected that their relations with psychological variables would differ from those found for LAA.

Table 2 shows that — like LAA — WBCC and ESR are each correlated with a number of psychological variables that exceeds significantly the 5 per cent expected by chance: WBCC with eight variables, ie 18.18 per cent of the total ($CR = 1.94$, $p < 0.05$), and ESR with 12 variables, ie 27.27 per cent of the total ($CR = 2.85$, $p < 0.01$). The differences in the numbers of psychological variables related to LAA, WBCC and ESR are not significant (chi-square = 0.800, $df = 2$, NS). The correlations of WBCC and ESR with psychological variables range from $r = 0.17$ to $r = 0.32$. Thus they resemble those obtained for LAA in being generally low and in their range.

Table 2 shows that WBCC is correlated with variables from four of the six examined domains: it is correlated positively with the number of positively evaluated recent events and the feeling that the solution of the personal problems depends on oneself; it is correlated negatively with the number of personal problems — especially problems in the family and bereavement — depression (as measured by the POMS and the MAACL) and with fatigue-inertia.

The regression analysis with WBCC as a dependent variable (non-stepwise analysis; Table 4) shows that the whole set of predictors accounted for 27.41 per cent of the variance in WBCC. The predictors with the largest contributions were depression (MAACL), the sum of the specific personal problems and fatigue-inertia (POMS), and those with the lowest contributions were the feeling that the solution of the problems depends on one-

self and the number of positively evaluated recent events. The stepwise regression analysis (Table 3) indicates that the best predictors alone (ie depression, the sum of the specific personal problems and fatigue-inertia) account for 20.81 per cent of the variance in WBCC. The percentages in men and women separately are similar to that obtained for the sample as a whole: for men 30.68 per cent (non-stepwise) or 20.99 per cent (stepwise) and for women 24.38 per cent (non-stepwise) and 17.96 per cent (stepwise). In no case are the gender differences significant. However, the major predictors in the two genders differ: depression in men and fatigue-inertia in women.

Concerning ESR, Table 2 shows that it is correlated with variables from five of the six examined domains (all except life events): it is correlated positively with neuroticism, stress susceptibility, excitation, anger-hostility (POMS), tension-anxiety (POMS), fatigue-inertia (POMS), confusion-bewilderment (POMS), anxiety (MAACL) and number of personal problems, specifically interpersonal and security-political; it is correlated negatively with two of the belief types of the CO of health (general beliefs and beliefs about goals).

The regression analysis shows that the whole set of predictors (non-stepwise analysis; Table 4) accounted for 26.16 per cent of the variance in SED (but was non-significant) and the stepwise analysis (Table 3) accounted for 9.25 per cent of the variance, with tension-anxiety (POMS) and anger-hostility (POMS) as best predictors.

In the non-stepwise analyses (Table 4) the findings for men and women separately were non-significant, but for the stepwise analyses (Table 3) the percentages obtained in these subsamples were similar to those obtained for the sample as a whole. The two subsamples differed, however, in the major predictors: anger-hostility in men and tension-anxiety in women.

The predictors of the two domains — personal problems and health attitudes — that yielded significant predictions for LAA (Table 5) did not yield significant results for WBCC and SED.

DISCUSSION

The affinity between the state of LAA in the peripheral blood and psychological factors was documented by studies showing its responsiveness to stress of various kinds.³⁸⁻⁴¹ The present study served to broaden the range of psychological determinants

liable to affect the state of LAA. The identified factors are characterized by the following features: (a) they represent four different domains — recent life events, personal problems, emotions and CO of health; (b) they are specific variables within these domains, namely, in the sphere of life events the negatively evaluated events; in the sphere of personal problems mainly problems that concern interpersonal relations, security-politics and bereavement, especially if they are of recent duration and if one feels that the solution depends on oneself; in the emotional sphere mainly anxiety; and in the sphere of the CO of health general beliefs and beliefs about self; (c) they are related to LAA moderately, accounting for 29–38 per cent of the variance; and (d) they are specific to LAA as compared to the variables related to WBCC or ESR.

The major variables related to the state of LAA are personal problems and CO of health. Problems represent situation-bound factors whereas health attitudes represent a more stable disposition of the individual. The finding about problems conforms to expectations. Problems could be viewed as a special though by no means uncommon phenomenon, obviously related to stress, especially when one feels that one ought to have solved them, namely that it lies within the range of one's possibility and responsibility to have resolved them.

More surprising is the finding about the CO of health. It alone accounts for almost the same amount of variance (27–31 per cent) as all the other factors. It signifies that LAA is lower in individuals who hold beliefs supporting, for example, the expression of emotions, dealing without rancour with daily hassles, assuming the optimistic outcome of events, keeping generally in a good mood, avoiding undue guilt and remorse, trusting others, or not being obsessive about cleanliness and order. The beliefs crucial in regard to LAA are those that refer to the general state of affairs — the existing one and the desired one, rather than those that refer to oneself and one's goals. Hence, it is the relatively impersonal beliefs and not the personal ones that affect LAA.

Previous findings indicate that the CO of health probably assesses a general tendency to maintain health when threatened by pathogenic factors and recovering it rapidly when it is impaired. As such it seemed likely that it represents psychological stamina or sturdiness, being perhaps the counterpart of physiological immunity. The finding that CO of health is related to the state of LAA in the peripheral blood reinforces the hypothesis about its

affinity to immunity and raises the possibility that it represents or is mediated by the psychological ability to withstand stress or keep it at a low, non-harmful level.

From the viewpoint of LAA, these findings indicate that LAA is not only a marker for acute stress but is sensitive also to those personality tendencies that foster chronic sources of stress (viz personal problems) or enable such sources to persist (viz CO of health).

Notably, the psychological factors affecting the state of LAA differ from those affecting WBCC and ESR. Apart from the fact that the effects for LAA are on the whole higher than for WBCC and ESR, the major difference is that WBCC and ESR are much more susceptible to effects of emotions: WBCC is sensitive to depression and fatigue-inertia, and ESR to tension-anxiety and anger-hostility. However, LAA resembles ESR more than WBCC. Like ESR, it is related to negative psychological factors, such as personal problems, negatively evaluated life events and lower CO of health. In contrast, WBCC is related mainly to positive psychological factors and the absence of negative determinants.

The close relation between LAA and ESR might stem from the fact that a plasma protein, namely fibrinogen, that has a control role in accelerating the sedimentation rate might affect directly the state of LAA in the peripheral blood.⁵¹

Finally, the finding that in men and women different psychological factors were found to be the salient predictors in regard to the three immunity indices serves to underline the importance of the gender variable in psychoimmunological studies.

In sum, this study highlighted specific psychological factors affecting specific immunological indices in specific samples of men and women. The findings indicate that in future attempts to unravel the knots of psychoimmunology, special care should be taken to consider specific psychological variables, in regard to specific immunology indices in specific gender samples.

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