EMPIRICAL CONTRIBUTIONS

Psychosocial Enhancement of Immunocompetence in a Geriatric Population

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This study assessed the enhancement of immunocompetence by relaxation and social contact in 45 geriatric residents of independent-living facilities. Subjects were randomly assigned to one of three protocols: (1) relaxation training, (2) social contact, or (3) no contact. Subjects in the relaxation and social-contact conditions were seen individually three times a week for a month. Blood samples and self-report data were obtained at baseline, at the end of the intervention, and at a 1-month follow-up. At the end of the intervention, the relaxa-
tion group showed a significant increase in natural killer cell activity, and significant decreases in antibody titers to Herpes simplex virus and self-rated distress; the other two groups showed nonsignificant changes. There was a general increase in the T-lymphocyte response to phytohemagglutinin stimulation at the end of the intervention, with greater change at lower mitogen concentrations. These data suggest that cellular immunocompetence may be enhanced by psychosocial interventions.

Data from a number of laboratories suggest that a variety of stressors may affect the immune response, presumably through the mediation of the central nervous system (Ader, 1981). These alterations in immunity are thought to increase susceptibility to infectious and malignant disease (Cohen, 1980).

Research from our laboratory has addressed the effects of relatively commonplace stressful events on the immune response in humans, in conjunction with potentially important moderator variables such as loneliness. In one study, blood was drawn twice from 75 first-year medical students. The baseline sample was taken 1 month before final examinations; the stress sample was drawn on the first day of final examinations. Natural killer (NK) cell activity decreased significantly from the baseline to the stress sample. Moreover, subjects who were above the median on a loneliness measure had significantly lower levels of NK activity than those below the median (Kiecolt-Glaser, Garner, Speicher, Penn, Holliday, & Glaser, 1984). These data may have important implications for health, given the functions of NK cells; it is thought that NK cells have an important role in the prevention and spread of tumors, comprising part of an antitumor surveillance system. NK cell activity is also important for control of infectious diseases, particularly those diseases of viral etiology (Herberman, 1982).

A similar pattern was observed in a psychiatric inpatient population. Lonelier inpatients had significantly lower levels of NK activity, as well as a poorer response to phytohemagglutinin (PHA) stimulation. No differences were observed in the lymphocyte response to pokeweed mitogen (PWM) stimulation (Kiecolt-Glaser, Ricker, Messick, Speicher, Garner, & Glaser, 1984).

The lymphocyte response to stimulation by mitogens (termed blastogenesis) such as PHA is thought to provide an in vitro model of the body's response to challenge by an infectious agent, such as a bacteria or a virus. Because different mitogens stimulate different subpopulations of lymphocytes, multiple assays using different mitogens can provide information on the ability of various lymphocyte subpopulations to respond to a foreign substance. For example, PHA stimulates only T-lymphocytes. The T-lymphocyte subpopulations include (a) helper cells, which prompt B-lymphocytes to syn-
thesize different antibodies; (b) suppressor cells, which act on helper cells to suppress antibody production; and (c) cytotoxic T-cells, which destroy cells having characteristics that are recognized as foreign or nonself. In contrast, PWM stimulates the proliferation of both T- and B-lymphocytes.

We also found changes in immunocompetence when we examined antibody titers to three herpesviruses in blood samples obtained from medical students during final examinations, in comparison to samples obtained after their return from summer vacation (Glaser, Kiecolt-Glaser, Speicher, & Holliday, in press); there were significantly higher antibody titers to Epstein-Barr virus (EBV), Herpes simplex virus (HSV), and cytomegalovirus (CMV) during final examinations. Lonelier medical students had significantly higher antibody titers to two different EBV antigens. It is thought that the cellular immune response is important for control of latent herpesviruses, and that activation of latent virus results in an increase in antibody titers; reestablishment of control over virus replication and latency is ultimately followed by a concomitant drop in antibody titers (Glaser & Gottlieb-Stematsky, 1982).

The data from these two very different populations — medical students and psychiatric inpatients — provide strong support for the association between higher levels of loneliness and poorer cellular immunocompetency. Moreover, the stress-related changes in immunocompetence in the medical student population suggest that the cellular immune response can be significantly affected by the relatively mild increased distress associated with examinations, even in a young and otherwise healthy population with substantial prior exposure to this stressor.

Based on these medical student and psychiatric inpatient data, we reasoned that interventions that reduced distress and/or loneliness might lead to an enhancement of immunocompetence. We used geriatric residents of local independent-living facilities as subjects, because previous research indicated that increased attention reliably produces small but consistent positive effects in institutionalized older adults (Schulz, 1980). Brief interventions such as regular visits by college students have been associated with significant decreases in urinary cortisol, and significant increases in residents’ level of activity, positive moods, short-term memory, and self- and physician ratings of mental and physical health (Langer & Rodin, 1976; Langer, Rodin, Beck, Weinman, & Spitzer, 1979; Rodin, 1980; Schulz, 1980).

In order to evaluate the relative efficacy of relaxation and social-contact interventions, subjects were randomly assigned to one of three protocols: (1) relaxation training, (2) social contact, or (3) no contact. Natural killer cell activity, antibody titers to HSV, and lymphocyte response to mitogen stimulation (PHA and PWM) were measured because of their previously described responsiveness to stress and loneliness (Glaser et al., in press; Kiecolt-Glaser, Garner et al., 1984; Kiecolt-Glaser, Ricker et al., 1984). It was expected that
both relaxation training and social contact would produce significant increases in NK activity and mitogen responsiveness, and significant decreases in HSV antibody titers at the end of the intervention, in contrast to little or no change in the no-contact group. A similar pattern was expected for the distress self-ratings. However, it was expected that the changes would persist only in the relaxation group, which had presumably learned a new method of controlling distress; research with institutionalized geriatric populations (Rodin, 1980) and undergraduates (Glass & Singer, 1972) suggests that perceptions of control can moderate stress-related physiological arousal, whether or not control is actually exercised.

METHOD

Subjects, Groups, Timing of Samples

Selected geriatric residents of four local independent-living facilities were approached for participation, following clearance from the relevant administrative and medical personnel at the site. In addition to adequate orientation, criteria for selection included the following: (a) the resident was ambulatory and able to take care of personal needs; (b) the resident was able to communicate verbally; (c) the resident was not experiencing any major physical or psychiatric symptoms that seriously interfered with routine daily functioning; and (d) the resident's medical problems did not include any that had an immunological component, or that might have had immunological consequences (e.g., cancer, autoimmune diseases, recent surgeries, strokes, hormonal disorders, etc.). Residents meeting these criteria were identified by the medical staff at the facilities, who introduced a member of the experimental team to each potential participant. The residents were asked to participate in a study of the immune response in older adults involving three blood draws, as well as brief interviews and questionnaires. They were told that the study concerned the extent to which moods or feelings might affect certain immunological components.

After the subjects gave permission for the blood draws and questionnaires, the experimenter consulted a random number list and subjects were asked if they would be interested in (a) learning different methods of relaxation three times a week for a month, or (b) having a college student who was interested in learning more about older people visit three times a week for a month. A third group was not asked at that time for additional involvement. The three subjects who were not interested in their randomly assigned visitation or relaxation condition were not included in the data analysis. We never suggested to subjects that there was any connection between either type of visitation and the blood draws and questionnaires when the study was under way, and no subject ever asked. Those subjects who were not initially assigned to the
relaxation-training protocol were asked if they were interested in learning different methods of relaxation at the end of the data-collection period.

Seven first- or second-year medical and graduate students trained in the appropriate relaxation methods visited subjects individually three times a week for a month; the visits lasted approximately 45 minutes. The students taught the residents progressive relaxation and guided imagery (Borkovec, Grayson, & Cooper, 1978). Relaxation was presented as an active coping skill through which residents could exert personal control. Such an orientation can produce significantly greater reductions in anxiety than identical training that is presented as a more "automatic" procedure for passively controlling distress (Goldfried & Trier, 1974).

During the social-contact visits, which were the same length and frequency as the relaxation visits, the visitor and the resident discussed whatever they wished. Eight undergraduates enrolled at various times in a geriatric research course comprised the social-contact group. The students were juniors or seniors who were selected on the basis of their interpersonal skills. No student visited more than two subjects. The same student always visited the same subject individually in both the relaxation and social-contact groups throughout the intervention period.

In order to minimize problems when the contacts were terminated, residents were clearly informed initially that the students would be visiting only for one month, because their schedules for the upcoming academic quarter would preclude further visitation. The students then arranged at least one visit to residents at the end of the quarter, shortly after the intervention ended, to make sure that the residents were doing well and to minimize the abruptness of the terminations. The students were encouraged to continue visiting any resident if they had formed a strong relationship and wished to do so.

Complete data were collected from 45 subjects, 9 males and 36 females, with 15 subjects (3 males and 12 females) per group. The average age was 74, with a range from 60 to 88. Five subjects were unavailable because of illness, vacations, or lack of interest at one or more sample points, and were replaced by further random assignments. Subjects were run in four cohort groups that began at four different time periods: midsummer, early autumn, midwinter after the holidays, and late winter.

Blood was obtained from all subjects at baseline, at the end of the intervention 1 month later, and at a follow-up 1 month after the end of the intervention. Blood draws took place at the same time of day, to exclude variation due to diurnal changes.

Self-Report Measures

The Hopkins Symptom Checklist (HSCL), the Life Satisfaction Index-Z, and the Desired Control Interview have been recommended for use with
older subjects for the evaluation of the effects of psychological interventions (Levy, Derogatis, Gallagher, & Gatz, 1980). These three measures were given at all sample points, in addition to the survey version of the UCLA Loneliness Scale.

Two self-report measures were used to assess changes in adaptational outcomes. The HSCL (Derogatis, Rickels, Uhlenhuth, & Covi, 1974) provided information on psychological symptoms, whereas the Life Satisfaction Index-Z (Wood, Wylie, & Sheafor, 1969) provided data on morale. The HSCL has five symptom dimensions: depression, anxiety, somatization, obsessive-compulsive symptoms, and interpersonal sensitivity, as well as a total average symptom rating. Respondents rated the degree of distress associated with each symptom “during the previous week (including today)” from 0 to 4. The HSCL provided data on the baseline level of distress, as well as any changes in distress.

The Life Satisfaction Index-Z (Wood et al., 1969) was developed specifically for the measurement of morale or life satisfaction in geriatric populations. Respondents indicate whether they agree, disagree, or are not sure of their agreement or disagreement with 13 statements such as “As I grow older, things seem better than I thought they would be.”

The short survey form of the UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980) was used to assess the effects of increased interpersonal contact. It provided information on possible changes in the subjective adequacy of interpersonal relationships that might occur as a function of the increased interpersonal contact in the intervention conditions.

The Desired Control Interview (Reid, Haas, & Hawkins, 1977) provided a situationally specific measure of locus of control. Developed for use with geriatric populations, it provided information on the subjects’ perceptions of environmental constraints or circumstances, as well as the subjects’ desire for control. It was included to assess the effects of the intervention on perceptions of control.

Subjects were also asked to evaluate their sleep and appetite at each sample point. They used a four-point scale: excellent (4), good (3), fair (2), and poor (1).

NK Assay

A microtiter $^{51}$chromium release cytotoxicity method was used to determine NK activity as previously described (Kiecolt-Glaser, Garner et al., 1984). Briefly, mononuclear cells were obtained by Ficoll-Hypaque separation of whole blood. The target cells used in the assay were K562 cells, a myeloid cell line.

Triplicate (0.1 ml) aliquots of lymphocyte and labeled target cell suspensions were placed in wells of 96-well plates (Linbro, CN) resulting in effector
to target cell ratios of 40:1, 20:1, and 10:1. In addition, triplicate wells with target cells and media only, and target cells and detergent (1% sodium dodecyl sulfate), were prepared in order to determine spontaneously released radioactivity and maximal lysis. Supernates were counted in a Beckman 9000 gamma counter. Results are reported as percent lysis using the formula:

\[
\frac{\text{experimental CPM} - \text{spontaneous release CPM}}{\text{maximal CPM} - \text{spontaneous release CPM}} \times 100
\]

The Enzyme Linked Immunoabsorbance Assay (ELISA)

Vero cells were infected with HSV-1 and were used to prepare the antigen for the ELISA. A protein assay (Bio-rad) determined the amount of protein present in each antigen preparation. Antigen was added to 96-well plastic substrate plates (0.3 ml/well) and incubated at 4°C overnight to allow the soluble antigen to adsorb to the plastic. Plasma dilutions were added to the test wells. Previously characterized HSV-1+ human sera were used to titrate each antigen as a control. An HSV-1- human serum was always used as a control. Goat antihuman IgG was added to each of the wells, the wells were washed, and then 2-2-azino-di-(3-ethyl-benzthiazolin sulfonate) (ABTS), to which 3% hydrogen peroxide had been added (0.3 ml to each well), was added. A dark green color change indicated a positive reaction. The highest dilution of antibody detected to HSV-1 was determined by color change as compared to the negative serum control (Glaser et al., in press).

Although we used HSV infected cells as the antigen, the specificity of the HSV antibody titer (HSV-1 versus HSV-2) is not known because there is cross-reactivity between the two stains. Any changes in HSV antibody titers, therefore, may reflect changes in antibody to either or both strains.

Blastogenesis

Two mitogens were used in this study, PWM and PHA. PWM stimulates proliferation of both T- and B-lymphocytes, whereas PHA stimulates only T-lymphocytes. Mitogens were used at a final concentration of 2.5, 5.0, and 10 μg/ml for PWM and 0.25, 0.5, 1.0, and 2.0 μg/ml for PHA. Each assay was performed in triplicate. Complete medium was used for baseline controls. One-tenth of a ml of mitogen was added to 1 \times 10^5 lymphocytes (in 0.1 ml medium) in 96 well plates and incubated at 37°C for 48 hours. Fifty microliters of tritiated thymidine (10 μCi/ml, specific activity 82 Ci/mM) were added to each well, and the plates were incubated at 37°C for 4 hours. Cells were harvested onto GFIA filters. Radioactivity was measured by a Beckman LS7000 scintillation counter.
The PWM and PHA data were expressed as the difference in counts per minute (CPM) between the stimulated and unstimulated cultures (Δ CPM). A base 10 logarithmic transformation was used to reduce the variance, as is customary with blastogenesis data (Monjan, 1984). All immunologic data were blind coded.

RESULTS

Initial baseline analyses using demographic (age, education, and years in residence), self-report, and immunologic measures assessed possible differences among residents as a function of facility and group assignment, to assess the adequacy of randomization. There were no significant initial differences as a function of either variable.

The self-report and immunologic data from the three sample points were then analyzed using a repeated-measures analysis of variance (ANOVA). This 3 × 3 repeated measures ANOVA provided information on possible differences as a function of group membership, change across the three sample points, and the interaction between these two variables.

Self-Report Data

There was a significant interaction between the two independent variables on the HSCL total score, \( F(4, 84) = 4.03, p < .01 \). There was also a significant change over the sample points, \( F(2, 84) = 7.64, p < .001 \), with the lowest levels of distress found at the end of the intervention. The HSCL means are shown in Table 1. Planned post hoc within-group comparisons (Waller & Duncan, 1969) were used to assess the significance of the changes within each group. There were significant differences within the relaxation group when total mean distress at the end of the intervention was compared with the baseline mean, \( p < .05 \); the follow-up also differed significantly from the end of the intervention, \( p < .05 \).

Following the same pattern as the total HSCL score, individual analyses of three of the HSCL scales showed significant interactions between group membership and change over sample points on interpersonal sensitivity: \( F(4, 84) = 5.56, p < .01 \), somatization, \( F(4, 84) = 3.55, p < .01 \), and obsessive-compulsive symptomatology, \( F(4, 84) = 2.56, p < .05 \). As was the case for the total HSCL score, post hoc comparisons within each group showed significant differences when the mean at the end of the intervention was compared with baseline or follow-up (interpersonal sensitivity, \( p < .01 \); somatization and obsessive-compulsive symptomatology, \( p < .05 \)), with the other groups not showing significant changes. In addition, there were significant overall decreases across trials in interpersonal sensitivity, \( F(2, 84) = \)
### TABLE 1
Mean HSCL Scores as a Function of Group Assignment and Sample Point

<table>
<thead>
<tr>
<th>Group</th>
<th>Relaxation</th>
<th>Social Contact</th>
<th>No contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0.98</td>
<td>0.65</td>
<td>0.77</td>
</tr>
<tr>
<td>End of intervention</td>
<td>0.53</td>
<td>0.63</td>
<td>0.78</td>
</tr>
<tr>
<td>Follow-up</td>
<td>0.90</td>
<td>0.55</td>
<td>0.67</td>
</tr>
</tbody>
</table>

**Interpersonal Sensitivity**

<table>
<thead>
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<th>Group</th>
<th>Baseline</th>
<th>End of intervention</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relaxation</td>
<td>1.01</td>
<td>0.58</td>
<td>0.45</td>
</tr>
<tr>
<td>End of intervention</td>
<td>0.28</td>
<td>0.37</td>
<td>0.55</td>
</tr>
<tr>
<td>Follow-up</td>
<td>0.93</td>
<td>0.32</td>
<td>0.63</td>
</tr>
</tbody>
</table>

**Anxiety**

<table>
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<th>Group</th>
<th>Baseline</th>
<th>End of intervention</th>
<th>Follow-up</th>
</tr>
</thead>
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<tr>
<td>Relaxation</td>
<td>0.85</td>
<td>0.77</td>
<td>0.61</td>
</tr>
<tr>
<td>End of intervention</td>
<td>0.49</td>
<td>0.52</td>
<td>0.39</td>
</tr>
<tr>
<td>Follow-up</td>
<td>0.77</td>
<td>0.44</td>
<td>0.53</td>
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**Somatization**

<table>
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<th>End of intervention</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relaxation</td>
<td>1.01</td>
<td>0.55</td>
<td>0.82</td>
</tr>
<tr>
<td>End of intervention</td>
<td>0.58</td>
<td>0.62</td>
<td>0.98</td>
</tr>
<tr>
<td>Follow-up</td>
<td>0.90</td>
<td>0.51</td>
<td>0.65</td>
</tr>
</tbody>
</table>

**Obsessive-Compulsive Symptomatology**

<table>
<thead>
<tr>
<th>Group</th>
<th>Baseline</th>
<th>End of intervention</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relaxation</td>
<td>1.05</td>
<td>0.73</td>
<td>0.83</td>
</tr>
<tr>
<td>End of intervention</td>
<td>0.63</td>
<td>0.68</td>
<td>0.75</td>
</tr>
<tr>
<td>Follow-up</td>
<td>1.05</td>
<td>0.47</td>
<td>0.78</td>
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</table>

6.64, $p < .01$, anxiety, $F(2,84) = 6.37$, $p < .01$, and obsessive-compulsive symptoms, $F(2,84) = 3.78$, $p < .05$. There were not significant changes in depression as a function of group assignment, change over trials, or the interaction of these variables.

There was a significant increase in subjects' self-rated quality of sleep at the end of the intervention, $F(2,84) = 5.15$, $p < .01$. The mean rating at baseline was 2.61, compared to 3.18 at the end of the intervention, and 2.79 at follow-up. Neither the group effect, $F < 1$, nor the interaction between group membership and change over sample points reached significance, $F(4,84) = 1.87$. 
There were no significant main effects or interactions on appetite, life satisfaction, or loneliness. Similarly, neither the subjects' desire for control nor their perceptions of environmental constraints were significantly related to group assignment, change over time, or their interaction.

Immunological Data

An additional within-subjects factor, effector to target cell ratio, was included in the repeated measures ANOVA for the analysis of NK cell data. The inclusion of the three NK cell ratios produced a $3 \times 3 \times 3$ factorial design. The NK cell data were not available on seven subjects for the third sample point due to technical problems, leaving 12 subjects in the relaxation condition, and 13 in each of the other two conditions for this analysis. There was a significant interaction between group membership and change over the sample points, $F(4,70) = 2.61, p < .05$. There was also a significant change across the sample points, $F(2,35) = 3.63, p < .05$, with the highest percentage lysis of target cells occurring on the second sample point. There was not an overall effect as a function of group membership, $F < 1$. The expected effect for differences across the three target to effector cell ratios was significant, $F(2,70) = 402.80, p < .0001$.

The expected effect for differences across the three target to effector cell ratios was significant, $F(2,70) = 402.80, p < .0001$.

The data for the 40:1 effector to target cell ratio are shown in Fig. 1. Means for the 20:1 ratio were, in order, 22.28, 39.16, and 25.81 for the relaxation group; 27.96, 30.32, and 25.61 for the social-contact group, and 27.58,
23.88, and 22.53 for the no-contact group. The means for the 10:1 ratio, in order, were 14.59, 26.29, and 17.55 for the relaxation group; 17.50, 19.89, and 16.84 for the social-contact group, and 20.48, 15.71, and 14.43 for the no-contact group. Post hoc within-group comparisons within each target to effector ratio showed significant changes in the relaxation group between the baseline and the end of the intervention, and between the end of the intervention and follow-up, all $p < .05$. There were no significant changes within the social-contact and no-contact groups.

There was a similar significant interaction between group membership and change over trials in the HSV antibody data, $F(2,42) = 2.53$, $p < .05$, as shown in Fig. 2. Post hoc comparisons within the relaxation group showed significant differences when the baseline sample was compared with the end of intervention and follow-up samples, both $p < .05$. There were no significant changes associated with either the end of the intervention or follow-up in the other two groups, although the social-contact baseline and follow-up comparisons approached significance, $p < .10$. There was a significant change across the three sample points, $F(2.84) = 6.76$, $p < .01$, with declining mean antibody titers across the three sample points. There was not a significant group effect, $F < 1$.

An additional factor, concentration of mitogen, was included in the repeated measures ANOVA for the analysis of PWM and PHA stimulation data. The inclusion of the three concentrations of PWM and four of PHA produced $3 \times 3 \times 3$ and $3 \times 3 \times 4$ designs, respectively.

![FIG. 2 Changes in the mean Herpes simplex versus type I antibody titers, HSV GMT (± S.E.M.) across sample points as a function of group assignment.](image-url)
Analysis of PWM data showed a significant interaction between change across sample points and pokeweed concentration, $F(4,168) = 4.12$, $p < .003$, with maximal change in lower mitogen concentrations. These data are shown in Table 2. There were the usual significant differences associated with different mitogen concentrations, $F(2,84) = 5.35$, $p < .01$, with greater responsiveness associated with higher mitogen concentrations. Neither the main effect for group assignment nor the interaction between group membership and change over trials was significant, $F < 1$.

The PHA stimulation data, shown in Table 3, followed a pattern similar to that of PWM. The significant interaction between change over sample points and mitogen responsiveness, $F(6,246) = 8.43$, $p < .0001$, reflected the larger changes associated with the second sample point in the lower concentrations of PHA, in contrast to little difference on the second sample point in the highest concentration. There were again the expected differences in mitogen responsiveness associated with the different concentrations of PHA, $F(3,123) = 7.64$, $p < .0001$. Neither the main effect for change across sample points, $F(2,82) = 2.08$, $p < .14$, nor the interaction between group membership and change over trials, $F < 1$, was significant.

### TABLE 2

Mean Lymphocyte Response (Δ CPM, log₁₀) to PWM Stimulation Over Sample Points

<table>
<thead>
<tr>
<th>Group</th>
<th>2.50</th>
<th>5.00</th>
<th>10.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relaxation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>2.95</td>
<td>2.89</td>
<td>2.90</td>
</tr>
<tr>
<td>End of intervention</td>
<td>2.90</td>
<td>3.07</td>
<td>3.41</td>
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<tr>
<td>Follow-up</td>
<td>3.28</td>
<td>3.17</td>
<td>3.20</td>
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<td>Social Contact</td>
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<tr>
<td>Baseline</td>
<td>2.82</td>
<td>3.12</td>
<td>3.20</td>
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<tr>
<td>End of intervention</td>
<td>2.26</td>
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<td>2.90</td>
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<td>Follow-up</td>
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<tr>
<td>Baseline</td>
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<td>End of intervention</td>
<td>2.43</td>
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<td>2.71</td>
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<tr>
<td>Follow-up</td>
<td>2.93</td>
<td>3.00</td>
<td>2.85</td>
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TABLE 3
Mean Lymphocyte Response (Δ CPM, log₁₀) to PHA Stimulation
Over Sample Points

<table>
<thead>
<tr>
<th>Group</th>
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<th>2.00</th>
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<td>Baseline</td>
<td>3.66</td>
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<td>4.02</td>
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<td>Follow-up</td>
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<td>3.89</td>
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<td>Social Contact</td>
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<tr>
<td>Baseline</td>
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<tr>
<td>Follow-up</td>
<td>2.90</td>
<td>3.74</td>
<td>3.78</td>
<td>3.10</td>
</tr>
<tr>
<td>No Contact</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>3.60</td>
<td>3.35</td>
<td>3.49</td>
<td>3.42</td>
</tr>
<tr>
<td>End of intervention</td>
<td>3.42</td>
<td>3.83</td>
<td>3.73</td>
<td>3.64</td>
</tr>
<tr>
<td>Follow-up</td>
<td>2.53</td>
<td>3.34</td>
<td>3.38</td>
<td>2.87</td>
</tr>
</tbody>
</table>

DISCUSSION

The relaxation intervention was associated with significant changes in both NK cell activity and HSV antibody titers. These data suggest that relaxation may have a significant impact on immunocompetence, and thus perhaps ultimately on health. These data are consistent with the extensive documentation on the psychological and physiological benefits of relaxation (Borkovec et al., 1978; Goldfried & Trier, 1974; Surwit & Feinglos, 1983).

The finding that enhanced NK cell activity is associated with relaxation is of particular interest because of the previously described antitumor and antiviral functions associated with NK cells. It is therefore possible that the regular, long-term practice of relaxation might provide important immunological benefits.

As described earlier, the decrements in HSV antibody titers found in the relaxation group presumably reflect improved control of virus replication and latency by the cellular immune response. These data may have implications for health; although HSV is most commonly associated with the induction of cold sores, it is multipotential, and can also produce generalized infections, encephalitis, and death (Glaser & Gottlieb-Stematsky, 1982).
Despite the growing evidence that interpersonal relationships are significantly related to a variety of both physical and mental-health indices (Glaser et al., in press; Kiecolt-Glaser, Garner et al., 1984; Kiecolt-Glaser, Ricker et al., 1984; Kiecolt-Glaser, Speicher, Holliday, & Glaser, 1984; Wallston, Alagna, DeVellis, & DeVellis, 1983), including mortality in the elderly (Blazer, 1982), we did not find consistent significant change associated with the social-contact intervention. However, the low HSCL scores at baseline suggest that these subjects were not noticeably distressed before the intervention, so there may have been minimal room for change in response to this brief intervention; other data suggest that more dramatic changes in immunocompetence might be found when social-contact interventions are used with more distressed populations (e.g., Coe, Wiener, Rosenberg, & Levine, in press; Kiecolt-Glaser & Greenberg, 1984). In addition, our subjects were ambulatory residents of independent-living facilities, rather than the nursing-home residents used in previous studies (Rodin, 1980; Schulz, 1980). Social-contact interventions may be more potent with those subjects who have greater environmental restrictions.

Despite significant changes in the immunological and self-report data of the relaxation group, we did not find significant changes in feelings of control, life satisfaction, or loneliness. The absence of significant changes in these dimensions may be related to both the initial high functional level of our sample as well as to the relative brevity of the interventions. Moreover, perceptions of control, life satisfaction, and loneliness may be more stable and enduring than distress-related psychological symptoms (e.g., Gerson & Perlman, 1979), especially in an older population.

The global improvements in both lymphocyte response to mitogen stimulation and self-reported sleep quality suggest that there may have been some nonspecific positive effects in the subject group as a function of participation in the research. Decrements in mitogen responsiveness in response to various stressors are well documented (Monjan, 1984), particularly mitogens that stimulate T-lymphocyte proliferation; these geriatric data suggest that the effects may be bidirectional, and that positive experiences may produce an enhancement. Because four different facilities and four different time periods were sampled, it is likely that these more global changes reflect the impact of experimental participation, rather than simply irrelevant changes at a particular facility, or seasonal fluctuations in activities.

We expected the subjects to utilize the relaxation exercises after the intervention ended, given their obvious enjoyment of them. Although most relaxation-group subjects spontaneously reported being much more aware of tension and utilizing the cue-controlled relaxation in response, only four subjects reported setting aside regular periods of time for relaxation as they had during the training period. Maintenance of the relaxation-related changes in NK cell activity may depend on continued practice; NK cell activity can
change quite rapidly. Significant declines in NK cell lysis have been reported in mice within 24 hours of stressor exposure (Aarstad, Gaudernack, & Seljelid, 1983).

These immunological data have particular relevance for health in the elderly. Significant decrements in immunocompetence are normally associated with aging, and these decrements may increase the risk of infection, as well as the incidence of malignant disease; poorer cellular immunocompetence is associated with higher mortality in individuals over 80 years of age (Roberts-Thomson, Whittingham, Youngchaiyud, & Mackay, 1974). The enhancement of cellular immunocompetence by relaxation may therefore be particularly beneficial in an older population.

Despite numerous anecdotal reports linking stress to the onset and course of infectious and malignant disease, the essential human immunological data needed to clearly establish the link have been sparse. However, there is growing evidence that various stressful events can adversely affect immunocompetence through a number of pathways (Coe et al., in press; Cohen-Cole, Cogen, Stevens, Kirk, Gaitan, Hain, & Freeman, 1981; Jemmott, Borysenko, Borysenko, McClelland, Chapman, Meyer, & Benson, 1983; Laudenslager, Ryan, Drugan, Hyson, & Maier, 1983; Solomon, 1981). The data obtained in this study using geriatric subjects suggest that psychosocial interventions may also significantly enhance immunological functioning.

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REFERENCES