Human Performance

ISSN: 0895-9285 (Print) 1532-7043 (Online) Journal homepage: http://www.tandfonline.com/loi/hhup20

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To cite this article: Dale N. Glaser , B. Charles Tatum , Delbert M. Nebeker , Richard C. Sorenson & John R. Aiello (1999) Workload and social support: Effects on performance and stress, Human Performance, 12:2, 155-176

To link to this article: http://dx.doi.org/10.1080/08959289909539865

HUMAN PERFORMANCE, *12*(2), 155–176

Workload and Social Support: Effects on Performance and Stress

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A work simulation was conducted to test the effects of workload on stress and performance. Social support was also investigated as a moderator variable. Two hypotheses were tested: (a) stress is an intervening variable between workload and performance and (b) social support moderates the workload–stress relation such that workload leads to lower stress when social support is high. For the 1st hypothesis, a path analysis showed an indirect relation between workload and performance with stress as an intervening variable. For the 2nd hypothesis, there was a significant 3-way interaction between workload, social support, and time. The interaction showed that, in the early

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stages of the experiment, high social support led to higher (rather than lower) stress. This "reverse buffering effect" did not occur during later stages of the experiment. Several alternative explanations are offered regarding the reverse buffering finding, including the possibility that stress leads to social-support seeking behavior. One practical implication of this study is that managers may need to take into consideration the employee workloads when developing performance goals.

Occupational stress has generated substantial interest in the research literature as well as the popular press. The financial repercussions of stress have been well documented (Ganster & Schaubroeck, 1991; "Monster Needs," 1992). Medical care expenditures have skyrocketed and health promotion within corporate settings is increasingly popular (DeAngelis, 1993; Murphy, 1984). In their recent review of the literature, Bowers, Weaver, and Morgan (1996) identified many variables that effect stress. Two critical variables were workload and social support. This article presents a model of the effects of workload and social support on stress (and performance), and attempts to test the model using path-analytic techniques. The model is later shown in Figure 1 and elaborated on in the following pages. The essential features of the model are (a) stress intervenes between workload and performance and (b) social support moderates the relation between workload and stress.

WORKLOAD, STRESS, AND PERFORMANCE

It is a common belief that heavy workloads lead to elevated stress and reduced efficiency. Unfortunately, the relation between workload and stress (as well as workload and performance) has received scant attention in the literature. What few studies do exist tend to use nonexperimental, cross-sectional, and correlational methods (e.g., Caplan, Cobb, French, Harrison, & Pinneau, 1975; Kahn, Wolfe, Quinn, Snoek, & Rosenthal, 1964). One influential model is Karasek's (1979) job strain model. Tests of this model using correlational methodology have shown that the combination of low decision latitude and high job demands were associated with mental strain and job dissatisfaction (Karasek, 1979) and cardiovascular disease (Karasek, Baker, Marxer, Ahlbom, & Theorell, 1981). A valuable contribution can be made by demonstrating the relations between workload, stress, and performance under controlled, laboratory conditions that allow for more direct causal inferences. This study attempts to study these variables in a controlled work simulation.

At least two forms of workload can be identified: quantitative and qualitative. Quantitative workload refers to the amount of work required in a given task; qualitative workload refers to the complexity of tasks required for a given quantitative workload (Shaw & Weekley, 1985). Most of the research on workload has concentrated on quantitative rather than qualitative workload (Caplan & Jones, 1975; French & Caplan, 1972). These studies have focused primarily on the work-

load–stress relation. The workload–performance relation, with a few exceptions, has been neglected (Frankenhaeuser & Gardell, 1976; Sales, 1970; Shaw & Weekley, 1985).

Shaw and Weekley (1985) conducted one of the few experiments investigating quantitative and qualitative workload. They found a higher level of stress (what they refer to as strain) in the overload condition, but no performance differences between overload and underload, and no differences between qualitative and quantitative workload. Aside from this study by Shaw and Weekley, few empirical studies have been conducted on qualitative workload. An exception can be seen in the task complexity literature. In general, task complexity is presumed to have a positive effect on performance, except when the employee's resources are taxed beyond capacity (Wood, 1986). Therefore, when task complexity reaches a certain critical level, the expectation is that performance will suffer.

Quantitative and qualitative workload are intimately related to goal setting (Huber, 1985; Locke, Shaw, Saari, & Latham, 1981). Individuals striving to achieve goals for high volumes of work are exposed to a high quantitative workload. By contrast, individuals assigned goals that focus on increased work complexity are operating under high qualitative workloads. The literature on goal setting, however, does not clearly address the complex relations between quantitative and qualitative goals (Gilliland & Landis, 1991). Terborg and Miller (1978) found that goal setting affected both the quality and quantity of performance, and several researchers have shown that difficult goals hamper performance in highly complex tasks (Wood, Bandura, & Bailey, 1990; Wood, Mento, & Locke, 1987), but there is no research to date that manipulates qualitative and quantitative goals simultaneously and examines the effects on performance and stress.

Given the lack of data directly comparing quantitative and qualitative workload, it is difficult to make any clear predictions regarding their differential effects. These manipulations are included in this research for exploratory purposes. We expect, at the very least, that variations in these measures of workload will have direct effects on stress and performance. It may be, however, that these measures of workload do not effect stress or performance differently. If this turns out to be the case, then the present research will at least indicate that the effects of quantitative and qualitative workload, as measured here, are comparable.

SOCIAL SUPPORT AND STRESS

Social support is another variable, in addition to workload, that is presumed to affect stress and performance (House, 1981; Bowers et al., 1996). Caplan et al. (1975) examined the effects of social support on stress. They found evidence that men in high-stress jobs suffered from low social support whereas men in low stress jobs re-

ported high social support. Even though the stress reducing properties of social support have been questioned (Dignam & West, 1988; Kaufmann & Beehr, 1986), the Caplan et al. model is frequently cited and used as a template for occupational stress research. LaRocco, House, and French (1980) also reported beneficial effects of social support on mental and physical health variables.

A dual model reviewed by Cohen and Wills (1985) suggested that social support may have both a direct (main-effect) and a buffering (moderator) effect on stress. In their view, social support may moderate the relation between the environmental stressor (e.g., workload) and the stress response. Thus, the effects of overload should be less taxing as the participant perceives more social support.

Controversy exists, however, about whether social support moderates the relation in the predicted manner. In a review of 22 studies that tested the effects of social support on stress, Kahn and Byosiere (1992) found that: (a) all but two of the studies reported main effects, (b) 10 studies reported a buffering effect in the predicted direction, (c) two studies reported the reverse buffering effect, and (d) one study found neither main effects nor buffering effects. The authors conclude that "social support is a demonstrably potent variable, that with only occasional exceptions it has significant main effects, and that it frequently has buffering effects as well" (p. 623). Although their findings are the exception, it is worthwhile to note that Kaufmann and Beehr (1989) found a reverse buffering effect; more stress was actually found under conditions of high social support than under conditions of low support. Given the complexity associated with ascribing causation to the social support–stress relation, a controlled, longitudinal design may be useful in offering alternative explanations.

Figure 1 provides a model of the predicted relations implied by the aforementioned studies.

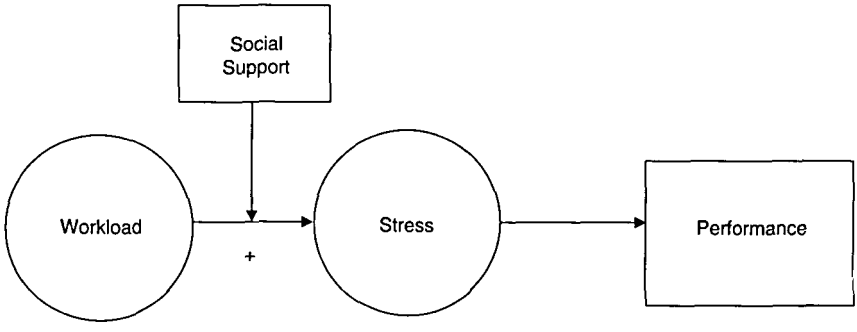

FIGURE 1 Model of the relations between workload, stress, performance, and social support.

HYPOTHESES

Based on the model in Figure 1 and the research literature, the following hypotheses are proposed:

Hypothesis 1: Stress will intervene between workload and performance. Those experiencing high workload conditions will report high stress and reduced performance, but there will not necessarily be a direct relation between workload and performance.

Cox (1978) argued that the most appropriate way to view stress is as a variable that intervenes between the stimulus and the response. Kahn and Byosiere (1992) also pointed out that research has tended to treat stress exclusively as a dependent variable rather than an intervening or independent variable. Stress can be legitimately viewed from many points of view (as an independent, dependent, or intervening variable). Hypothesis 1 views stress as an intervening variable and proposes that there will be significant workload–stress and stress–performance path coefficients, but no direct relation between workload and performance.

Hypothesis 2: There will be an interaction between social support and workload on stress such that social support will moderate the relation between workload and stress.

Based on the research by Cohen and Wills (1985) and the review by Kahn and Byosiere (1992), it is expected that, under high workload, high social support will decrease stress. In the low workload conditions, social support is not expected to influence stress. Given that the preponderance of the research findings show a buffering effect, Hypothesis 2 predicts that such an effect will occur in this study.

METHOD

Overview of Design

Employees were hired to work 10 days (5 days per week for 2 weeks) on a data-entry task in a simulated work environment similar to that described in separate studies by Nebeker and Tatum (1993) and Tatum and Nebeker (1995) using different sets of workers. The primary advantage of this setting is that experimental controls can be maintained in a realistic work environment. The task involved entering information from scientific references into a computerized database. On the first day, the employees were trained and allowed to practice the task. On the second day, the workers were divided into four experimental groups that represented

four combinations of qualitative and quantitative workload. The workers were provided with computerized performance feedback on demand, and the computer recorded the frequency and duration of their feedback requests. Daily performance measures were also recorded by the computer. Each day, employees were administered a computerized survey that obtained self-reports of stress, social support, and feedback use.

Participants

Forty participants were initially recruited through a local temporary employment agency. Thirty-seven participants completed all the required work hours in this study. Employees ranged in age from 19 to 52 with an average age of 28.51. There were 8 men and 29 women in the study. White participants comprised 54.1% of the sample, 21.6% were Black, 10.8% were Hispanic, and 2.7% were Asian. Education level ranged from high school graduate to college postgraduate.

Procedures

Employee orientation and training. The employees' job assignment was defined as a data entry operator in which they were to enter and maintain a computerized database of literature citations. The participants were paid at an hourly rate of $7.25. Criteria for inclusion in the study were capability of typing at 35 words per minute and familiarity with computer keyboards. The applicants were informed that this work assignment was temporary.

Employees were told by the employment agency that there would be a research component to their employment, but in all other respects this was a typical temporary job. Each employee was scheduled to participate for a total of 40 hr (4 hr per day 5 days per week, for 2 weeks). Each employee was told they were allotted 15 min for breaks and 15 min for reviewing reports for each 4 hr in a shift.

For the first 2 hr on the first day of employment (after a general introduction by the supervisor and completion of the informed consent form) the employees were trained on the computer, including proper use of the software, and then were allowed to practice the task. On Day 2, the employees were randomly assigned to their respective workload conditions and instructed on how to obtain performance feedback from the computer. Adjusting to the work demands and learning to use the performance feedback consumed most of Day 2. Consequently, Days 1 and 2 were excluded from the subsequent analyses. Also, Day 10 was excluded from subsequent analyses because a good portion of the last day was used to complete the final questionnaires and debrief the participants.

Computer software. All employees were assigned to their own workstation equipped with an IBM compatible personal computer. Original software was developed in the FOXPRO version of the dBASE programming language to control and monitor the data entry task. Capabilities of the software included: (a) recording of performance (e.g., keystrokes per hour [KPH], time on task, accuracy rate), (b) managing of the data base entry task, (c) aggregating performance data for the purposes of analysis, and (d) providing performance feedback for employees.

Work sessions. The start of a typical work day involved the employees sitting at their designated workstations where the work was already distributed by the supervisor. The work consisted of several batches of literature citations (a batch consisted of 30 photocopies of reference material to be entered into the data base) as well as the final batch from the prior day if it was not completed. The employees generally spent the first few minutes of their shift reviewing their performance summary report. Throughout the day, a supervisor was available to answer questions and supply additional batches of work.

Independent Variables

Half of the employees were assigned to one of two specific qualitative workload conditions (single goal vs. multiple goals). Each of these two qualitative workload groups were again divided in half and employees were randomly assigned to either a low or high goal condition (quantitative workload). Thus, there were four groups, each representing one of the four combinations of qualitative workload (single vs. multiple goal), and quantitative workload (low vs. high goal).

To determine the exact levels for the independent variables (e.g., high vs. low goal conditions) a pilot study was conducted with different employees recruited from the same temporary agency. Twenty participants engaged in the pilot study with 10 participants assigned a single goal (low qualitative workload) and 10 participants assigned multiple goals (high qualitative workload). The performance data from the pilot study was used as a basis to establish performance levels for the high and low goal conditions (quantitative workload). Details about how the quantitative and qualitative workload conditions were established are presented in the following paragraphs.

High quantitative workload (high goal). All employees were required to meet three performance standards. They were required to: (a) work rapidly (KPH), (b) maintain accuracy (correct key entries), and (c) stay on task (spend their time entering documents into the computer). In this condition, employees were required

to attain high levels of performance on all of these goals. A high level was defined as one standard deviation above the baseline performance of the pilot study workers. The KPH goal for this condition was calculated by taking the average keystroke rate for Day 4 during the pilot study (from past studies the fourth day is generally when the participants reach asymptote on keystroke rate) and adding one standard deviation (5381 KPH + 1077 = 6458 KPH).

For performance accuracy (percentage of characters correctly entered into the data base), the average accuracy rate during the pilot study was 96.3%. The high workload condition for accuracy was calculated as 1 standard deviation above this average (.963 + .015 = 97.8%).

Productive time was derived from the following formula: percentage of time entering keystrokes (the amount of time a special form was displayed on the computer screen that allowed workers to enter data) divided by total time on task (all other time minus 15 min for work breaks, 15 min for viewing feedback reports, and time completing questionnaires). During the first week of the pilot study, the average participant attained 89.7% (SD = .038) productive time. Hence, the high workload condition for the productive time standard was set at 1 standard deviation above this average (.897 + .038 = 93.5%). To summarize, the three performance standards in the high quantitative workload condition were defined as follows: (a) a keystroke rate of 6458 KPH, (b) an accuracy rate of 97.8%, and (c) a productive time of 93.5%.

Low quantitative workload (low goal). In this condition, the employee was to maintain a performance rate that was at the average level as established by the pilot study. Average keystroke rate was 5381 KPH, average accuracy rate was 96.3%, and average productive time was 89.7%.

High qualitative workload (multiple goal). In this condition, the employees were instructed to achieve goals set in three separate areas: (a) KPH, (b) accuracy, and (c) productive time. Half the employees were assigned high goals (as defined earlier), and half were assigned low goals. The rationale for this manipulation is that the complexity of the task increases (high qualitative workload) when the workers must attend to multiple pieces of information. In this case, the workers must monitor three different types of feedback (keystrokes, accuracy, and productive time), presented in the form of three separate feedback reports.

Low qualitative workload (single goal). In this condition, the employees were instructed to achieve a single goal during the data entry task. It seems reasonable that this condition represents a level of complexity that is lower than the multiple

goal group because the workers must monitor only a single feedback report. The goal was actually a combination of all three goals as presented in the previously described multiple goal condition, but it was expressed as one distinct goal (i.e., the number of correct KPH on task). This single value was calculated by multiplying the participant's keystroke rate by the proportion of correct keystrokes and by the proportion of time actually spent entering data (KPH × Accuracy Rate × Proportion of Productive Time). As with the multiple goal group, half of the employees were assigned a high goal and half were assigned a low goal.

As an incentive to reach the quantitative and qualitative goals, the participants were told that if they exceeded their assigned goals on 5 of the 10 work days, they would receive a letter of recommendation to the temporary employment agency. Spontaneous comments from many of the workers indicated that the possibility of a letter was a valued incentive.

Dependent Variables and Measures

Stress. This dependent/intervening variable was measured by adapting the Worry–Emotionality Scale developed by Morris, Davis, and Hutchings (1981) to a work environment. This self-report scale, which was administered on a daily basis, consists of 10 items with a 5-point response scale ranging from 1 (*I do not feel that way at all*) to 5 (*I feel that way very strongly*). Sample scale items include "While on the job, I feel tense," "While on the job, my heart beats fast," and "I feel I should have worked harder." This scale is consistent with the definition of stress proposed by Caplan et al. (1975) in that it captures both psychological pressure (e.g., worry, anxiety) and the physiological strain (e.g., heart rate, tension).

The Worry–Emotionality Scale has been previously adapted for prior studies in the laboratory with this scale showing high internal consistency (alpha > .80). Eden (1990) pointed out that most of the research in the field of stress has tended to rely on measurement of chronic or global forms of stress, rather than work-related occurrences or more acute incidents. Thus, an advantage of this scale is that it was geared toward assessing daily, more acute, job-related manifestations of stress.

Performance. Job performance was defined as the level of accomplishment on the computerized data entry task. Performance consisted of the following three variables: (a) KPH, (b) accuracy (assessed as percentage of characters correctly entered), and (c) productive time (the proportion of time spent actually entering documents into the computer). Time spent for breaks, looking at reports, or any other activity that was not related to entering records (e.g., time spent responding to questionnaires) was not counted as productive time. Thirty minutes was allotted for breaks and report review per day (15 min for each activity). Productive time would

be negatively affected if the employee exceeded the allotted time for breaks and report review.

Ability. On 2 separate days (Day 1 and Day 4 of Week 1), the employees were administered a work sample test. The test consisted of 10 standard documents, and the employees were instructed to enter the data from the documents into the computer as quickly as possible while minimizing errors. The second work sample test was used as a measure of ability and served as a covariate in subsequent analyses.

Moderator Variable (Social Support)

For the purposes of this study, social support was measured on a daily basis with a self-report social-support scale developed by Caplan et al. (1975). Each question (e.g., "How easy is it to talk with each of the following people") was segmented into three possible sources of social support: (a) supervisor (three questions); (b) other people at work (three questions); and (c) spouse, friends, and relatives (three questions), for a total of nine questions. The 5-point scale ranged from 0 ("*Don't have any such person*") to 4 ("*Very much*").

Many studies of social support have relied on the social support scale as developed by Caplan et al. (1975), which addresses social support from such sources as the employee's supervisor, coworkers, and family or relatives. The estimate of reliabilities for the subscales ranged from .73 to .83. Ganster, Fusilier, and Mayes (1986) also found reliabilities of .78 to .82 for a scale similar to the social support items of Caplan et al. (1975). In the study of occupational stress, frequently the framing of the questions is tailored according to the specific study or worksite. Kaufmann and Beehr (1986) used the scale generated by Caplan et al. (1975) but also added three instrumental support items that assessed the reduction of workload pressures via social support. These three instrumental support items were included in this study because they specifically address workload issues. A total of 12 items were used from both scales, with redundant items excluded.

Manipulation Check

As noted earlier, the workers were promised a letter of recommendation if they could achieve their performance goals on half of the work days. At the end of each day the workers were asked if the workload made it difficult to obtain the letter. Their perception of the workload was rated on a 5-point scale ranging from 1 (*rarely was the work too difficult*) to 5 (*very often the work was too difficult*).

RESULTS

Combined Workload, Manipulation Check, and Descriptive Statistics

Based on preliminary analyses, no significant differences between quantitative and qualitative workload on any of the dependent variables were found. Moreover, there were no significant interactions between quantitative and qualitative workload on the dependent measures.[1] Because quantitative and qualitative workload did not appear to operate as independent factors in the study, the workload condition was combined into a three-level independent variable (low, moderate, and high). The low workload condition consists of employees in the low qualitative–low quantitative condition. The high workload condition consists of employees in the high qualitative–high quantitative condition. The intermediate conditions made up the moderate workload condition. By constructing a combined workload variable in this way, we hoped to achieve a more powerful manipulation by analyzing a range of workload levels rather than dichotomous levels. As noted later, this strategy was successful in demonstrating workload effects on the manipulation check and stress scale.

Table 1 shows the relation between the combined workload variable and the manipulation check (the interday correlations from Days 3 through 9 for the manipulation check item yielded a Cronbach alpha of .82). As anticipated, higher levels of perceived workload were associated with increases in the experimentally manipulated workload. A significant relation between workload and the manipulation check item can be seen in Table 2, which shows a significant correlation ($r = .39, p < .05$) between the manipulation check and workload. Table 2 also gives the means and standard deviations of other variables in the study (averaged across Days 3 through 9), along with the intercorrelations among these variables.

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[1]Quantitative and qualitative workload were used as independent variables in four repeated measures analyses of variance. Each analysis was performed on a different dependent measure (performance, stress, social support, and the manipulation check) across days of the study. The results follow. (Note: The degrees of freedom for the error terms are different due to incomplete data on some dependent variables.)

Performance: Quantitative Workload, $F(1, 33) < 1.00$; Qualitative Workload, $F(1, 33) = 3.45, p > .05$; Quantitative × Qualitative Interaction, $F(1, 33) < 1.00$.

Stress: Quantitative Workload, $F(1, 32) < 1.00$; Qualitative Workload, $F(1, 32) = 4.01, p > .05$; Quantitative × Qualitative Interaction, $F(1, 32) < 1.00$.

Social Support: Quantitative Workload, $F(1, 32) = 1.09, p > .05$; Qualitative Workload, $F(1, 32) = 1.21, p > .05$; Quantitative × Qualitative Interaction, $F(1, 32) = 3.98, p > .05$.

Manipulation Check: Quantitative Workload, $F(1, 32) = 1.58, p > .05$; Qualitative Workload, $F(1, 32) = 3.43, p > .05$; Quantitative × Qualitative Interaction, $F(1, 32) < 1.00$.

TABLE 1
Descriptive Statistics for the Workload Manipulation Check

	M	*SD*	*N*
Workload Condition			
Low	1.04	.096	10
Medium	1.57	.670	19
High	1.71	.760	7
Total	1.45	.634	36[a]

Note. Ratings were on a 5-point scale ranging from 1 (*rarely*) to 5 (*very often*).
[a]Missing data for one subject on Day 9.

TABLE 2
Means, Standard Deviations, and Correlations Among the Major Variables

Measure	*M*	*SD*	*1*	*2*	*3*	*4*	*5*
Workload	1.95	.71					
Stress	1.31	.35	.25				
Performance	5328.75	1114.63	−.31	−.15			
Ability	6116.11	1183.67	−.37*	−.16	.82**		
Social support	2.60	.79	.05	.10	.06	.04	
Manipulation check	1.45	.63	.39*	.53**	−.09	−.33	.31

*$p < .05$. **$p < .01$.

Reliabilities for Stress and Social Support

For the Worry–Emotionality Scale, when the daily total scores were intercorrelated (Days 3 through 9), the Cronbach alpha was .93. The internal consistency for each day of the Worry–Emotionality Questionnaire ranged from .70 to .93 ($M = .83$). For the social support scale, when the daily total scores were intercorrelated the Cronbach alpha was .97. The internal consistency for this scale on each day ranged from .85 to .90 ($M = .87$).

Reliabilities for Performance Measures

The Cronbach alphas for the three performance measures over days 3 through 9 were .98 for the number of KPH, .16 for accuracy,[2] and .75 for productive time. The

[2]The low reliability for accuracy reflects the fact that maintaining a stable error rate was a difficult task for workers in this study. Nevertheless, the low reliability of the accuracy measure did not have a detrimental effect on the composite metric (alpha = .96) that was used as the performance measure in this study.

Cronbach alpha for the composite performance metric that combined keystrokes, accuracy, and time efficiency (i.e., multiply the three performance measures to obtain correct keystrokes per productive hour) was .96.

Analysis of Hypotheses

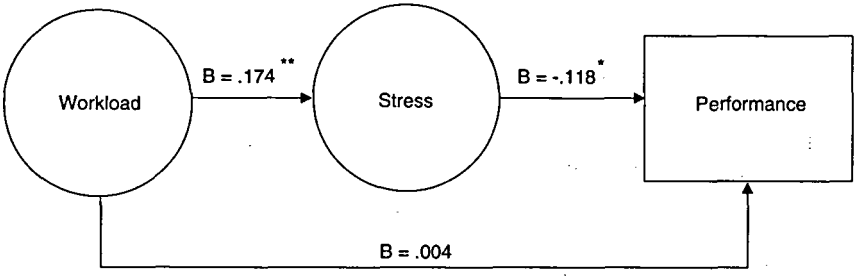
Even though analysis of the performance dependent variable could be segmented in three ways (i.e., keystrokes, accuracy, and productive time), a composite of the three variables was used as the unit of analysis to maintain a common performance measure for all groups. As noted earlier, this was achieved by multiplying Keystrokes × Accuracy × Productive Time, thus resulting in a dependent measure of correct keystrokes per productive hour (i.e., only the correct keystrokes were calculated, and these keystrokes were adjusted by the proportion of each hour the participant spent actually entering data). This measure of performance reflects the achievement of both single and multiple goal groups because in both cases the employees were evaluated on keystrokes, accuracy, and time efficiency.

The first hypothesis predicted that stress would intervene between workload and performance. This was tested with path analytic procedures as outlined in Pedhazur (1997, pp. 769–782). This entailed a two-step procedure: (a) a regression analysis was conduced with stress as the dependent (endogenous) variable and workload entered as the predictor (exogenous) variable and (b) another regression analysis was conducted with performance (correct KPH) as the dependent variable and workload and stress entered in as predictors. For the purposes of the path analysis, subject–day combinations for Day 3 through Day 9 were used as the unit of observation, and ability was used as a covariate to partial out the within-subjects variance.[3] We did not use Days 1, 2, or 10 in the analysis because (a) Day 2 was the first real day of work (Day 1 was spent in training) and was a period of adjustment to the work environment and use of the feedback reports and (b) Day 10 was spent administering the final questionnaires and debriefing the participants. The hypothesized path model is supported statistically if the path coefficients for both the workload–stress relation and stress–performance relation are significant, and the direct effect of workload on performance is not significant.

[3]Using a subject/day unit of observation means that the analysis is based on 259 observations (37 subjects × 7 days). These observations are not independent, however, and so a between-subject blocking factor should be used to reduce the error term. We used ability as the individual difference measure because ability, in fact, accounts for a large portion of the between-subject variance ($r^2 = .67$). The analysis is possibly more conservative using ability rather than subject coding, but the results are potentially more interesting, because it allows for an examination of interactions between ability and other factors (i.e., workload and stress). We did not find any meaningful interactions between ability and these other factors, and so ability was used as a covariate only and does not appear as part of the path model in Figure 2.

Results of the path analysis were consistent with Hypothesis 1. As Figure 2 shows, there is a significant path from workload to stress (beta = .174, $p < .01$) and stress to performance (beta = −.118, $p < .02$). However, the direct effect of workload on performance was not significant (beta = .004, $p > .94$) when both performance and stress were regressed on workload. There were no interactions among any of the variables in the model. The nonsignificant path coefficient between workload and performance, coupled with the two significant path coefficients between workload and stress and stress and performance, suggest that workload has an indirect effect on performance. Another way of viewing these path relations is to say that stress intervenes between workload and performance. After partialling out the effects of ability, workload and stress accounted for 38% of the performance variance.

As shown in Table 3, and supported by the path coefficient in Figure 2, the effect of workload on stress was significant (beta = .174, $p < .01$, when ability is used



* $p < .05$
** $p < .01$

FIGURE 2 Path analysis of the effect of workload on performance as mediated by stress (B = standardized path coefficients).

TABLE 3
Descriptive Statistics for Stress at Each Level of Workload

	M	*SD*	*N*
Workload			
Low	1.18	.250	10
Medium	1.33	.367	19
High	1.44	.436	7
Total	1.31	.356	36[a]

Note. Ratings were on a 5-point scale ranging from 1 (*I do not feel that way at all*) to 5 (*I feel that way very strongly*).

[a]Missing data for one subject on Day 9.

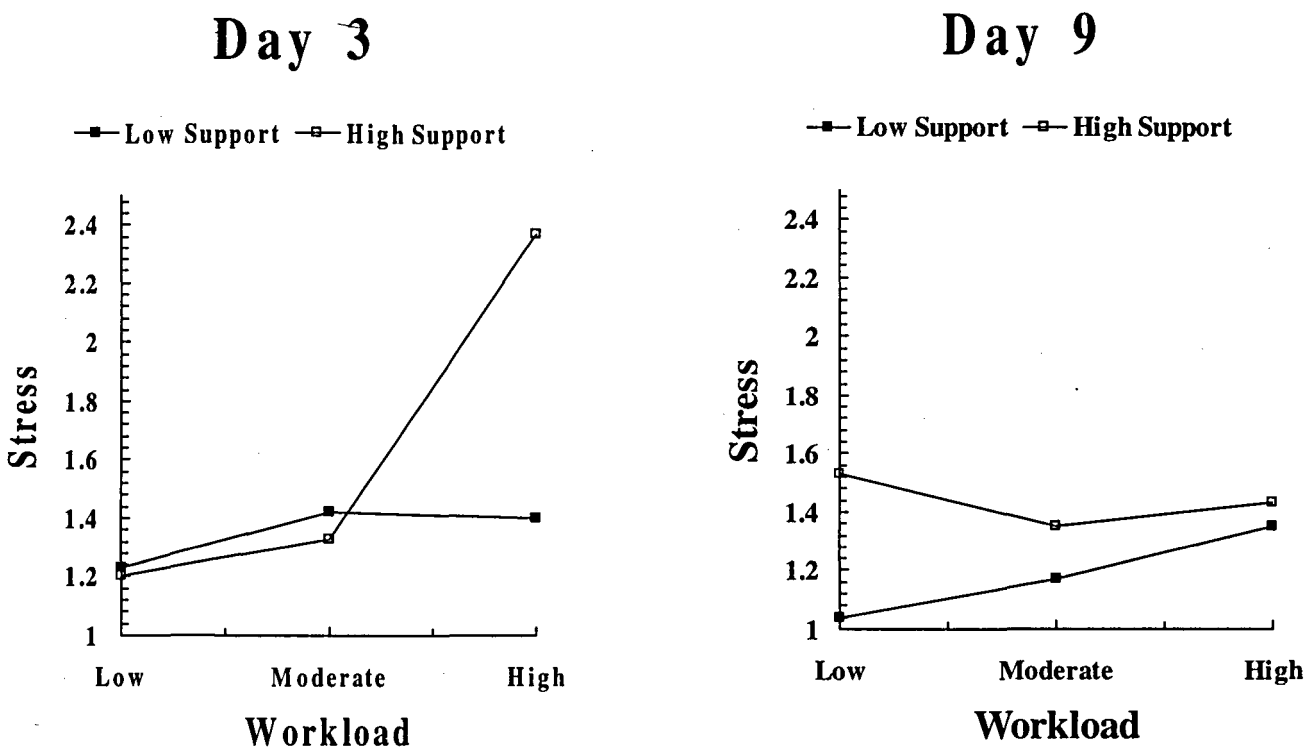


FIGURE 3 The effect of social support and workload on stress for Days 3 and 9.

as a covariate), despite the fact that perceived stress was generally low. The positive relation between workload and stress shown in Table 3 was also confirmed by a positive correlation between perceived workload (manipulation check item) and stress ($r = .53, p < .001$) shown in Table 2.

Further analyses revealed that there were no nonlinear (quadratic) relations between workload and stress or workload and performance. When the quadratic component of workload was entered into regression equations with stress and performance as criterion variables, the standardized regression coefficients for the quadratic component were not significant (Stress: beta = –.22, $p > .50$; Performance: beta = .07, $p > .80$).

The second hypothesis predicted there would be an interaction between workload and social support with stress as the criterion variable. A repeated measures multivariate analysis of variance was conducted with stress measured from Day 3 through Day 9. We did not use Days 1, 2, or 10 in this analysis for the same reasons we excluded these days in the path analyses. Social support was dichotomized into two groups (low vs. high) by dividing the scores at the mean (i.e., the mean for the entire set of social support scores—Day 3 through Day 9—was computed, and then the score for each day was split at this mean value). The result of this analysis revealed a significant three-way interaction of Workload × Social Support × Time; Hotellings $T^2(12, 48) = 4.26, p < .001$. As Figure 3 illustrates, there was evidence for a reverse buffering effect in the initial part of the study (Day 3). The result of a t-test revealed significant differences between the low versus high social support groups when workload was high ($p < .007$). None of the differences on Day 9 were significant.

For Day 3, and consistent with the buffering effect, for the low workload condition there were negligible differences in perceived stress whether social support was low or high. However, for the high workload condition, a higher level of stress was perceived by the group experiencing a higher level of social support. Thus, for Day 3, a reverse buffering effect appears to have occurred; the high social support group had a higher level of perceived stress that dissipated over time. This effect, however, may have an alternative explanation that will be discussed later.

DISCUSSION

The subject of stress is a complex construct with both conflicting and complementary findings. Concerns with respect to the study of stress have been well documented, including the preponderance of cross-sectional studies, lack of moderator variables, and paucity of experimental designs (Burke, 1987; Kahn & Byosiere, 1992). This study attempted to redress some of those deficiencies.

The purpose of this study was twofold: (a) assess the role of stress as an intervening variable between workload and performance (Hypothesis 1) and (b) determine the role of social support as a moderator (buffer) variable (Hypothesis 2).

With workload as the exogenous factor, stress as the endogenous variable, and performance (correct KPH on task) as the criterion variable, the path analysis was consistent with Hypothesis 1. This finding suggests, but does not demand, that there is a causal link between workload, stress, and performance. It may be that workload often has no direct effect on performance, but it may elevate stress levels, which, in turn, causes degradation in performance. Thus, workload indirectly affects performance.

It should be noted that, technically, stress is not a mediator variable in this study (James & Brett, 1984). Formally, for stress to mediate the workload–performance relation, we need to show that stress weakens the association between workload and performance when it is partialled out. Because we have no direct workload–performance relation to begin with, obviously stress cannot mediate this nonexistent effect. What we do have is a significant path model that is consistent with a causal progression from workload to stress to performance (see Pedhazur, 1997).

There are alternative interpretations of these data, of course, but none seem as plausible as the interpretation offered here. For example, it could be argued that workload degrades performance, which in turn causes stress. However, our data fail to show any direct relation between workload and performance, which poses a serious challenge to this alternative. Another possibility is that workload effects performance and stress simultaneously, rather than sequentially. This possibility also seems unlikely because, again, our data reveal no direct effect of workload on performance. Finally, it is possible that workload has no effect on performance, and stress plays no intermediary role at all. This explanation, however, runs contrary to the many studies showing that workload does effect performance (e.g., Frankenhaeuser & Gardell, 1976; Sales, 1970; Shaw & Weekley, 1985; Wood, 1986; Wood, Bandura, & Bailey, 1990, Wood, Mento, & Locke, 1987).

Even though the path coefficient showed a significant relation between workload and stress, the overall stress levels were quite low in this study. These low stress levels are no doubt the result of the ethical constraints we applied to our human research participants. To satisfy the requirements for ethical treatment of human participants, we did not adopt procedures designed to induce high levels of stress. The hope was that the workload manipulations would closely approximated the stress-inducing conditions in a typical data entry task. This hope was realized in that the manipulation was sufficiently powerful to produce significant changes in stress even at relatively low levels.

For the second hypothesis, there was a significant three-way interaction of Workload × Social Support × Time. An examination of Figure 3 illustrates a curious phenomenon: for Day 3 the reverse buffering effect occurred. Employees with perceptions of higher social support actually reported higher levels of stress. This appears to be consistent with the reverse (or negative) buffering effect that involves an increase in negative affect with an increase in social support. Kaufmann and Beehr (1986) reviewed the reasons that may account for this phenomenon: (a)

the support source and the source of stress may not necessarily be independent (increased interaction with the support figure may exacerbate the stress response if they are the actual source of the stress); (b) sources of social support "may sometimes convince us that job conditions are not as bad as they seem, whereas at other times they may help us to see that they are as bad as, or even worse than, we thought" (LaRocco, House, & French, 1980, pp. 213–214); and (c) a cohesive group with extensive communication may either serve in attenuating or exacerbating the level of stress (Beehr, 1976).

It is possible that in the initial part of this study, workers may have provided high levels of social support, especially as they were acclimating themselves to the task at hand (constraints on the amount of interaction that employees could have with fellow workers were not imposed during the course of the study). It is also possible that if, in these discussions, employees complained about the task, then high social support may have actually increased the level of perceived stress. A positive relation between social support and stress has been reported in the literature (Kahn & Byosiere, 1992).

Because, unlike workload, social support was not a manipulated variable, it is more difficult to draw causal inferences. Consequently, there are alternative explanations for the social support–stress relation, especially when investigating this phenomenon across time. Hence, we propose yet another explanation for the reverse buffering effect. Because the data for social support and stress are typically collected concurrently, as here, it is difficult to impute a causal direction. Perhaps people who are experiencing stress from workload demands seek more social support from others than those feeling less stress. Thus, stress may influence social support seeking behavior. If successful, the level of social support would be high. Furthermore, if the social support were beneficial, stress would go down over time.

This is precisely the pattern of results found in these data. On Day 3, those individuals who report higher stress also report higher levels of social support. But as time goes on, both stress and social support behavior decline, perhaps because of the earlier levels of social support provided. Although, this argument may be compelling, our design cannot verify this explanation. The ultimate confirmation or rejection of this or any other explanation must await designs that can manipulate social support across time while observing stress and support seeking behavior. Research in areas such as supervisor support (Seers, McGee, Serey, & Graen, 1983) and the recent interest in computer monitoring (Aiello, 1993; Aiello & Kolb, 1995) may also be crucial determinants in describing the relation of social support and stress.

Despite our efforts to correct some of the design flaws common in stress research, there are still some limitations to this study. One challenge was the difficulty of manipulating the independent variables (qualitative workload and quantitative workload) so that they appeared as two distinct variables. Very few studies have manipulated both of those factors in a single experimental design.

Our operational definitions of these variables did not yield differential effects on any of our dependent measures. It is unclear whether these null effects are due to inadequate operations or, simply, because quantitative and qualitative workloads do not differ with regard to stress and performance.

Other studies that have attempted to manipulate quantitative and qualitative workload have used artificial stress-inducers (e.g., tasks involving anagrams), which brings into question the external validity of those designs. One advantage of this study was the increased external validity and generalizability due to the realistic work environment. No study is completely generalizable, however, and this study is no exception. Clearly, the results are limited by many factors (e.g., workload remains constant over time, the task involves data entry, the workers are temporary, the workers are part time).

Some readers may also question the power of the design given that the total sample size was less than 40. Even though limited work has been expended on power analysis for repeated measures design, Stevens (1992) provided a table that can be used for determining sample sizes needed for a power of .80, given the following information: (a) desired alpha level, (b) number of repeated measures (the table goes up to seven repeated measures), (c) average correlation of the repeated measure variable, and (d) effect size. Assuming a moderate effect size (.56), average repeated measures correlations of .80, an alpha level at .05, and seven repeated measures, then a sample size of 14 would be required to achieve the desired power (i.e., .80). It appears that, given these parameters, the expected power of the present design was sufficient.

The findings generated from this study give an interesting twist to the study of stress and its practical implications. The results from the path analysis suggest a different view of the workload–performance relation. Increased workload may have a detrimental effect on performance indirectly through increased stress. Further research is needed to confirm this view. One implication of this view is that, when organizations and/or managers are in the midst of establishing goals for their employees, they may want to take into consideration the employee workloads. For employees with higher levels of stress, any increase in workload may degrade performance. It may be difficult to individualize employee workloads, but the possible stress-reduction and productivity increase may justify it. Certainly other methods to reduce stress should be evaluated.

The appearance of a possible reverse buffering effect (Kaufmann & Beehr, 1986, 1989) of social support early in the experiment is intriguing. If social support under these conditions increases stress, it may not have a desirable or beneficial impact early on in the job. If, on the other hand, stress increases social support seeking, and when successful the resulting support reduces stress, we have a strong argument for increasing support structures. Clearly, the next stage in this research effort is to manipulate social support independently and examine its effect on stress and support-seeking behavior.

ACKNOWLEDGMENTS

We would like to thank two anonymous reviewers for their helpful comments.

The opinions expressed in this article are those of the authors, are not official, and do not reflect the views of the Department of Defense or the Department of the Navy.

REFERENCES

Aiello, J. R. (1993). Computer-based work monitoring: Electronic surveillance and its effects. *Journal of Applied Social Psychology, 23,* 499–507.

Aiello, J. R., & Kolb, K. J. (1995). Electronic performance monitoring: A risk factor for workplace stress. In S. L. Sauter & L. R, Murphy (Eds.), *Organizational risk factors for job stress* (pp. 163–179). Washington, DC: American Psychological Association.

Beehr, T. A. (1976). Perceived situational moderators of the relationship between subjective role ambiguity and role strain. *Journal of Applied Psychology, 61,* 35–40.

Bowers, C. A., Weaver, J. L., & Morgan, B. B. (1996). Moderating the performance effects of stressors. In J. E. Driskell & E. Salas (Eds.), *Stress and human performance.* Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Burke, R. J. (1987). The present and future status of stress research. In J. M. Ivancevich & D. C. Ganster (Eds.), *Job stress: From theory to suggestion* (pp. 249–267). New York: Haworth.

Caplan, R. D., Cobb, S., French, J. R. P., Harrison, R. V., & Pinneau, S. R. (1975). *Job demands and worker health: Main effects and occupational differences.* Ann Arbor, MI: Institute for Social Research.

Caplan, R. D., & Jones, K. W. (1975). Effects of work load, role ambiguity, and type A personality on anxiety, depression, and heart rate. *Journal of Applied Psychology, 60,* 713–719.

Cohen, J., & Cohen, P. (1983). *Applied multiple regression/correlation analysis for the behavioral sciences* (2nd ed.). Hillsdale, New Jersey: Lawrence Erlbaum Associates, Inc.

Cohen, S., & Wills, T. A. (1985). Stress, social support, and the buffering hypothesis. *Psychological Bulletin, 98,* 310–357.

Cox, T. (1978). *Stress.* Baltimore: University Park Press.

DeAngelis, T. (1993, January). Conferees examine job stress, prepare to cook up solutions. *APA Monitor,* pp. 1, 24.

Dignam, J. T., & West, S. G. (1988). Social support in the workplace: Tests of six theoretical models. *American Journal of Community Psychology, 16,* 701–724.

Eden, D. (1990). Acute and chronic job stress, strain and vacation relief. *Organizational Behavior and Human Performance, 45,* 175–193.

Frankenhaeuser, M., & Gardell, B. (1976). Underload and overload in working life: Outline of a multidisciplinary approach. *Journal of Human Stress, 2,* 35–46.

French, J. R. P., & Caplan, R. D. (1972). Organizational stress and individual strain. In A. J. Morrow (Ed.), *The failure of success* (pp. 30–66). New York: Amacom.

Ganster, D. C., Fusilier, M. R., & Mayes, B. T. (1986). Role of social support in the experiences of stress at work. *Journal of Applied Psychology, 71,* 102–110.

Ganster, D. C., & Schaubroeck, J. (1991). Work stress and employee health. *Journal of Management, 17,* 235–271.

Gilliland, S. W., & Landis, R. S. (1991, April). *Quality and quantity goals in a complex decision task: Strategies and outcomes.* Paper presented at the sixth annual conference of the Society for Industrial and Organizational Psychology, St. Louis, MO.

House, J. S. (1981). *Work stress and social support.* Reading, MA: Addison-Wesley.

Huber, V. L. (1985). Effects of goal setting, and strategy on performance of a heuristic task. *Journal of Applied Psychology, 70,* 492–504.

James, L. R., & Brett, J. M. (1984). Mediators, moderators, and tests for mediation. *Journal of Applied Psychology, 69,* 307–321.

Kahn, R. L., & Byosiere, P. (1992). Stress in organizations. In M. D. Dunnette & L. M. Hough (Eds.), *Handbook of industrial and organizational psychology* (pp. 572–650). Palo Alto, CA: Consulting Psychologists Press.

Kahn, R. L., Wolfe, D. M., Quinn, R. P., Snoek, J. D., & Rosenthal, R. A. (1964). *Organizational stress: Studies in role conflict and ambiguity.* New York: Wiley.

Karasek, R. A. (1979). Job demands, job decision latitude, and mental strain: Implications for job redesign. *Administrative Science Quarterly, 24,* 285–308.

Karasek, R., Baker, D., Marxer, F., Ahlbom, A., & Theorell, T. (1981). Job decision latitude, job demands, and cardiovascular disease: A prospective study of Swedish men. *American Journal of Public Health, 71,* 694–705.

Kaufmann, G. M., & Beehr, T. A. (1986). Interactions between job stressors and social support: Some counterintuitive results. *Journal of Applied Psychology, 71,* 522–526.

Kaufmann, G. M., & Beehr, T. A. (1989). Occupational stressors, individual strains, and social supports among police officers. *Human Relations, 42,* 185–197.

LaRocco, J. M., House, J. S., & French, J. R. P. (1980). Social support, occupational stress, and health. *Journal of Health and Social Behavior, 21,* 202–218.

Locke, E. A., Shaw, K. N., Saari, L. M., & Latham, G. P. (1981). Goal setting and task performance: 1969–1980. *Psychological Bulletin, 90,* 125–152.

Monster that needs to be slain: California has one of worst workers' comp systems in U.S. (1992, April). *Los Angeles Times,* Section B, p. B6.

Morris, L. W., Davis, M. A., & Hutchings, C. H. (1981). Cognitive and emotional components of anxiety: Literature review and a revised worry–emotionality scale. *Journal of Educational Psychology, 73,* 541–555.

Murphy, L. R. (1984). Occupational stress management: A review and appraisal. *Journal of Occupational Psychology, 57,* 1–15.

Nebeker, D. M., & Tatum, B. C. (1993). The effects of computer monitoring, standards, and rewards on work performance, job satisfaction, and stress. *Journal of Applied Social Psychology, 23,* 508–536.

Pedhazur, E. J. (1997). *Multiple regression in behavioral research* (3rd ed.). Fort Worth, TX: Harcourt Brace.

Sales, S. M. (1970). Some effects of role overload and role underload. *Organizational Behavior and Human Performance, 5,* 592–608.

Seers, A., McGee, G. W., Serey, T. T., & Graen, G. B. (1983). The interaction of job stress and social support: A strong inference investigation. *Academy of Management Journal, 26,* 273–284.

Shaw, J. B., & Weekley, J. A. (1985). The effects of objective work-load variations of psychological strain and post-work-load performance. *Journal of Management, 11,* 87–98.

Stevens, J. (1992). *Applied multivariate statistics for the social sciences.* Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Tatum, B. C., & Nebeker, D. M. (1995). Effects of system control and feedback variability on job performance and affective reactions. *Human Performance, 8,* 297–325.

Terborg, J. R., & Miller, H. E. (1978). Motivation, behavior, and performance: A closer examination of goal setting and monetary incentives. *Journal of Applied Psychology, 63,* 29–39.

Wood, R. E. (1986). Task complexity: Definition of the construct. *Organizational Behavior and Human Decision Processes, 37*, 60–82.

Wood, R., Bandura, A., & Bailey, T. (1990). Mechanisms governing organizational performance in complex decision-making environments. *Organizational Behavior and Human Decision Processes, 46*, 181–201.

Wood, R. E., Mento, A. J., & Locke, E. A. (1987). Task complexity as a moderator of goal effects: A meta-analysis. *Journal of Applied Psychology, 72*, 416–425.