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## **System response time and method of pay: cardiovascular stress effects in computer-based tasks\***

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Psychophysiological effects of computer system response time (slow vs. rapid) and method of pay (incentive vs. nonincentive) were assessed in a computer-based data entry task among forty-five professional typists. Cardiovascular responses (i.e., heart rate and blood pressure) were monitored on a regular basis over four consecutive workdays. Heart rate and blood pressure did not vary significantly with slow or rapid response times. Incentive pay, however, significantly increased blood pressure and decreased heart rate variability across the workdays compared to nonincentive pay. Irrespective of response time or method of pay, performance of the data entry task for sustained periods of time was associated with reduced heart rate and increased heart rate variability. This temporal effect was indicative of reduced effort or increased mental fatigue. The results of this study suggest that incentive pay programmes in data entry work may produce stress-related physiological reactivity among healthy workers.

### **1. Introduction**

In the past decade, concern has been raised regarding the stress effects of introducing computer technology into the office workplace (National Research Council 1983, Office of Technology Assessment 1985). Computer-mediated work has altered several job and organizational factors related to health (Amick and Celentano 1991, Smith 1987), including workload, job control, task content, and interpersonal relations. However, a review of the job stress literature shows little evidence of a direct association between computer-mediated work and stress-related illness or disease (Amick and Ostberg 1987, World Health Organization 1987).

Much of the research on the stress effects of computer-mediated work has focused primarily on self-reports of psychological and behavioural disturbances. (See WHO 1987 for a review of this literature.) Only limited attention has been directed to the psychophysiological stress effects of computer-mediated work (e.g., Johansson and Aronsson 1984). If a link between computer-mediated work and health is to be established, it is necessary to identify psychophysiological response effects (e.g., elevated blood pressure) that may intervene between working conditions and stress-related illness or disease. The present laboratory study evaluated the cardiovascular stress effects of computer system response time and method of pay among workers performing a computer-based data entry task.

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## 2. Background

### 2.1. System response time

Several studies support the premise that slow system response time to operator inputs or commands is a common problem and a source of stress and dissatisfaction in the computerized workplace. The Datapro Corporation (1983) reported that, in a survey of mainframe users, only 56% of 1578 respondents were satisfied with response time. Johansson and Aronsson (1984) observed that 63% of VDT users at an insurance company preferred a response delay of not more than 5 s. Only 20% of the VDT users would accept a delay of more than 10 s. Schleifer and Amick (1989) found that slow response time (3–10 s delays) generated higher ratings of 'frustration' and 'impatience' than did rapid response time (350 m delays). Komatsubhara *et al.* (1985) reported that data entry operators using a system characterized by slow response time reported feelings of irritation and fatigue.

Research on the psychophysiological stress effects of slow system response time has been sparse. The study by Johansson and Aronsson (1984) suggests that delayed response time and unscheduled down time can result in elevated blood pressure and increased catecholamine production. In the only other study of the psychophysiological effects of computer response delays (Kuhmann *et al.* 1987), it was found that systolic blood pressure and reports of headache and eye pain were higher under rapid than under slow response time conditions (i.e., 2 s vs. 8 s). Error rates also were higher. These findings, which are inconsistent with the premise that computer delays are a source of stress, can be explained by a confound between rapid response time and increased workload demands.

The psychological characteristics that may make slow system response time a particularly stressful event include unpredictability and lack of control. It is difficult to predict with any degree of accuracy when computer response delays will occur. In addition, there is no instrumental response that can be made to avoid or terminate response delays. Response delays shift the locus of task control from the operator to the machine. The operator can do little more than wait helplessly until the system responds. Several studies suggest that unpredictability and lack of control are associated with a range of stress reactions, including ulcers and weight loss (Weiss 1970), increased catecholamine production (Frankenhauser and Rissler 1970), and elevated cardiovascular risk (Karasek *et al.* 1981).

### 2.2. Method of pay

In our rapidly growing information/service economy, computers are being used increasingly to monitor work performance, establish performance standards, compare actual work output with performance standards, and administer incentive pay regimens based on performance standards. Such computer-based incentive systems are fairly common in repetitive, short-cycle office tasks (Kopelman 1986, OTA 1987), and represent an alternative method of pay to the hourly wage system.

Little research has been conducted on the stress effects of incentive pay regimens in office work, particularly computer-based incentive pay programs. Cakir *et al.* (1979) observed that VDT typists under piece work conditions reported a greater reduction in 'sociability' and a larger increase in 'stress' and 'fatigue' compared with VDT typists under non-piece work conditions. Schleifer and Amick (1989) found that VDT data entry workers experienced more pronounced feelings of 'rush' and 'tension' under incentive than nonincentive pay conditions.

In one of the few psychophysiological studies of incentive pay in an office setting, Levi (1972) reported higher levels of urinary adrenaline and noradrenaline under piece-wage than under salaried work conditions among invoicing clerks. Self-reports of 'rush' and 'fatigue' were also higher. Studies of repetitive, light assembly line work (Cox *et al.* 1982) also have obtained higher levels of urinary adrenaline and noradrenaline under incentive pay conditions compared to nonincentive pay conditions.

The present laboratory study evaluated the stress effects of computer system response time (slow vs. rapid) and method of pay (computer-based incentive pay vs. nonincentive pay). Professional typists performed a computer-based data entry task under simulated office conditions over a four-day period. An earlier report based on this study examined the effects of response time and method of pay factors on mood disturbances and somatic discomfort (Schleifer and Amick 1989). This paper addresses the cardiovascular stress effects of system response time and method of pay using heart rate and blood pressure as criterion measures. Based on the response time studies reviewed above the following hypotheses were tested: that heart rate would be higher under slow response time than under rapid response time; that blood pressure would be higher under slow response time than under rapid response time; and that heart rate variability, as measured by the variance of the cardiac inter-beat interval, would be lower under slow response time than under rapid response time. This last hypothesis is based on the premise that normal variations in heart rate (e.g., respiratory sinus arrhythmia) are suppressed under stressful conditions (see Grossman 1983, Porges 1985).

Similarly, the following method of pay hypotheses were tested: that heart rate would be higher under incentive than under nonincentive pay conditions; that blood pressure would be higher under incentive than under nonincentive pay conditions; and that heart rate variability would be lower under incentive than nonincentive pay conditions.

Another purpose of this study was to characterize the psychophysiological effects of performing a data-entry task for sustained periods of time. Extended performance of light repetitive tasks has been associated with increased urinary adrenaline and noradrenaline (Cox *et al.* 1982), reduced heart rate variability under increased mental loads (Weber *et al.* 1980), and decreased heart rate (Floru *et al.* 1985) and increased heart rate variability associated with mental fatigue (Weber *et al.* 1980, Floru *et al.* 1985). A better understanding of the temporal effects of repetitive computer-based tasks would be helpful in developing remedial measures (e.g., optimal work-rest regimens) that are designed to reduce psychophysiological stress reactions.

### 3. Methods

#### 3.1. Subjects

Forty-five female, professional typists (mean age = 28, range 19–41) with primarily a vocational or business school background were recruited from a clerical-secretarial agency. The subjects received a medical examination and met the following selection criteria: (a) good general health—no heart disease or hypertension; (b) corrected visual acuity of 20:20; (c) no current medication except aspirin; (d) not pregnant; and (e) typing speed of at least 45 words per min with no errors. All of the subjects except one were nonsmokers.

#### 3.2. Data entry task

The subjects performed a data-entry task developed by Dainoff *et al.* (1982), which consisted of entering records from paper copy into a computerized data base via a video

Table 1. A sample data entry record.

Prompt	Sample entry
Record Number	R100
Part Name	5-Sulfamyl
Stock Number	A320251XL3
Manufacturer	Akro-Mils, Inc.
Street Address	212 Railroad Drive
City, State	Atlanta, GA
Zip Code	50321
Phone	654-0871
Bin Number	2156
Price	\$532.20
Location Code	B3R25S227

display terminal. Each record contained eleven fields of alphanumeric information from a chemical stock inventory. Data entries were made in response to a series of prompts displayed on a video screen. A sample record is provided in table 1.

Subjects commenced the task by entering the appropriate information next to the 'Record Number' prompt and then pressing the return or 'field termination' key. Data entries were made in a similar manner until the last field of information for a given record (i.e., 'Location Code') was completed. This task cycle was then repeated for the next record.

All subjects received a base wage of \$5.30 per h for performing the data entry task.

### 3.3. Task conditions

Subjects made their data entries under one of four conditions assigned on a random basis.

3.3.1. *Rapid response time/nonincentive pay (RR/NI)*: A computer response delay of 350 m occurred each time a field of information was entered. During this delay interval, the computer would not accept any data inputs.

3.3.2. *Slow response time/nonincentive pay (SR/NI)*: Response time can be considered 'slow' when it impedes the operator's normal pace for performing a given task. Typically, the time duration of the response delays is not constant; it varies in an unpredictable manner. The frequency at which response delays occur is also unpredictable. Periods of slow and rapid response times alternate on a random basis. In this task condition, variable response delays of 3–10 s in duration were presented. A sample response time schedule designed to maximize uncertainty regarding the frequency and duration of response delays is shown in figure 1. The 'R' (rapid) and 'S' (slow) intervals shown in figure 1 for this condition alternated on a random basis, but no more than three similar intervals were ever presented consecutively.

3.3.3. *Rapid response time/incentive pay (RR/I)*: Data entries were made under the RR condition. In addition to the base wage of \$5.30 per h, subjects were awarded 10 cents for each keystroke/minute above their prestudy baseline, but penalized 5 cents for each error/minute above this baseline.

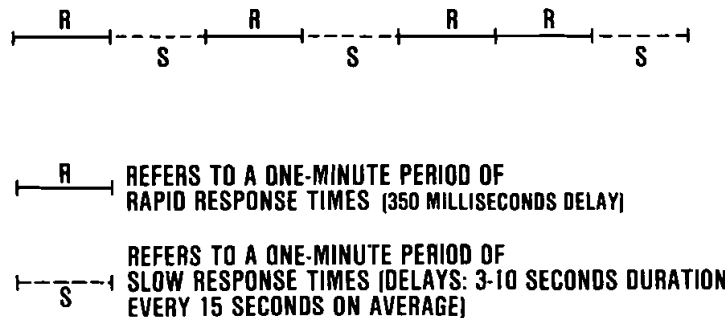


Figure 1. A sample schedule of response delays under the slow response time condition.

3.3.4. *Slow response time/incentive pay (SR/I)*: Data entries were made under the SR condition, with incentive pay provided as described under the RR/I condition above.

#### 3.4. Apparatus

The study was conducted in a simulated VDT workplace at the NIOSH work stress laboratories. Three workstations were equipped with video display terminals (VT-100, Digital Equipment Corporation), ergonomic tables and chairs (IBM Synergetix Furniture), wrist supports, micromesh contrast enhancement filters, and copyholders. Overhead fluorescent lighting fixtures were fitted with diffusing lenses. Ambient illumination levels were set at 500 lux. All ergonomic adjustments were made on an individual basis to maximize physical comfort. A PDP 11/34 computer system (Digital Equipment Corporation) was used to simulate the task conditions, collect physiological responses, and control the VDTs.

Heart rate was monitored continuously using disposable electrodes (Andover Medical). Electrodes were placed at the level of the second intercostal space just to the right of the sternum, and near the six or seventh intercostal space along the left and right midclavicular positions. A Beckman R-611 Dynograph and an R-wave peak detection system (Taylor 1979) were used to obtain a continuous recording of the cardiac inter-beat interval. Diastolic and systolic blood pressure were measured using an automatic blood pressure recorder (Sphygmometrics, Model SR-2).

#### 3.5. Design and procedure

A mixed-factorial, repeated measures design was employed in which the between group factors were response time (RR or SR) and method of pay (NI or I), and the within group factors were day, session and period.

Following informed consent, subjects were assigned on a random basis to one of four task conditions: RR/NI ( $n = 11$ ); SR/NI ( $n = 12$ ); RR/I ( $n = 10$ ); or SR/I ( $n = 12$ ). The study was conducted over four consecutive days (days 1, 2, 3 and 4), with each day consisting of a morning and afternoon session (sessions 1 and 2). Each session was further divided into three, 50-min work periods (periods 1, 2 and 3). There was a 45-min lunch break between the morning and afternoon sessions. A 10-min rest break also was taken at the midpoint of the second period during the morning and afternoon sessions. The mean inter-beat interval (IBI) and variance of the inter-beat interval (VARIBI) were summarized at 1 min intervals on a continuous basis over the course of each workday. At the beginning and end of each work session, three consecutive readings of

diastolic and systolic blood pressure were taken. The first blood pressure reading was discarded, and the average of the last two readings was recorded as the mean blood pressure for a given session.

To minimize the possibility of a confound in cardiovascular activity, subjects were instructed to refrain from drinking caffeinated beverages before coming to work in the morning and during the course of the workday.

The first day was devoted to familiarizing the subjects with the VDT workplace, making appropriate workstation adjustments, and practising the data entry task. During the baseline or second day, all subjects performed the data entry task under the RR/NI conditions. The various response time and method of pay conditions were introduced on the third and fourth days of the study.

Subjects assigned to the RR/I or SR/I conditions received electronic performance feedback (displayed on the VDT) regarding the amount of incentive pay earned at the end of each work period.

## 4. Results

### 4.1. Statistical approach

Planned contrasts (day 2 vs. day 3 and day 2 vs. day 4) were performed using *F*-ratios (SAS Institute 1985) to determine whether or not there were any Response Time  $\times$  Day and Method of Pay  $\times$  Day interactions, since these interactions would demonstrate a differential change across the workdays from baseline measures of heart rate and blood pressure. Additional analyses were performed to characterize changes in the cardiovascular measures as a function of the day, session and period factors.

Since day 1 was devoted to subject orientation and practice, the observations for this day were not included in the data analyses.

### 4.2. Heart rate activity

Due to problems arising from the subject-transducer interface (loose electrode contact or subject movement) and data acquisition equipment malfunction, there was a high number of missing IBI and VARIBI values for 5 of the 45 subjects. These subjects, therefore, were not included in the data analyses of heart rate activity.

The IBI and VARIBI scores for each one-minute interval were reduced to a summary data set by calculating the mean IBI and VARIBI at the period level, the smallest time interval over which the data analyses were performed. In addition, the IBI and VARIBI scores at the period level were transformed by a natural log transformation to better approximate a normal distribution of these measures (i.e., log IBI and log VARIBI).

The mean log IBI and mean log VARIBI for the response time and method of pay conditions on day 2, day 3 and day 4 are presented in table 2 and table 3, respectively.

Preliminary analyses (two-tailed tests) of baseline data collected on day 2 indicated that the RR vs. SR conditions and the I vs. NI conditions were statistically comparable with respect to log IBI and log VARIBI.

4.2.1. *Response Time  $\times$  Day*: There were no response time  $\times$  day effects, indicating that, in comparison to day 2, the log IBI and log VARIBI were the same for RR and SR on day 3 and day 4.

Table 2. Mean log IBI as a function of task condition and day.

Task condition	Day		
	2	3	4
Rapid response time (RR)			
<i>M</i>	6.55	6.54	6.53
<i>SD</i>	0.10	0.12	0.13
Slow response time (SR)			
<i>M</i>	6.58	6.57	6.57
<i>SD</i>	0.09	0.10	0.09
Nonincentive pay (NI)			
<i>M</i>	6.57	6.57	6.57
<i>SD</i>	0.09	0.09	0.11
Incentive pay (I)			
<i>M</i>	6.55	6.55	6.53
<i>SD</i>	0.11	0.12	0.12

Table 3. Mean log VARIBI as a function of task condition and day.

Task condition	Day		
	2	3	4
Rapid response time (RR)			
<i>M</i>	7.67	7.42	7.40
<i>SD</i>	0.68	0.58	0.75
Slow response time (SR)			
<i>M</i>	8.09	7.92	7.91
<i>SD</i>	0.86	0.78	0.74
Nonincentive pay (NI)			
<i>M</i>	7.76	7.72	7.72
<i>SD</i>	0.70	0.70	0.80
Incentive pay (I)			
<i>M</i>	8.03	7.65	7.60
<i>SD</i>	0.89	0.78	0.78

4.2.2. *Method of Pay* × *Day*: Figure 2 shows the change in log VARIBI across the workdays as a function of Method of Pay. Pair-wise constasts (one-tailed tests) indicated that, in comparison to day 2, the log VARIBI was lower for I than NI on day 3 [ $F(1, 36) = 6.47, p < 0.01$ ] and day 4 [ $F(1, 36) = 4.13, p < 0.05$ ].

There were no method of pay × day effects on log IBI, indicating that, in comparison to day 2, the log IBI was the same for I and NI on day 3 and day 4.

4.2.3. *Day*: In comparison to day 2, the log VARIBI was lower on day 3 [ $F(1, 36) = 10.60, p < 0.001$ ] and on day 4 [ $F(1, 36) = 6.02, p < 0.05$ ] (see table 4). The decrease in

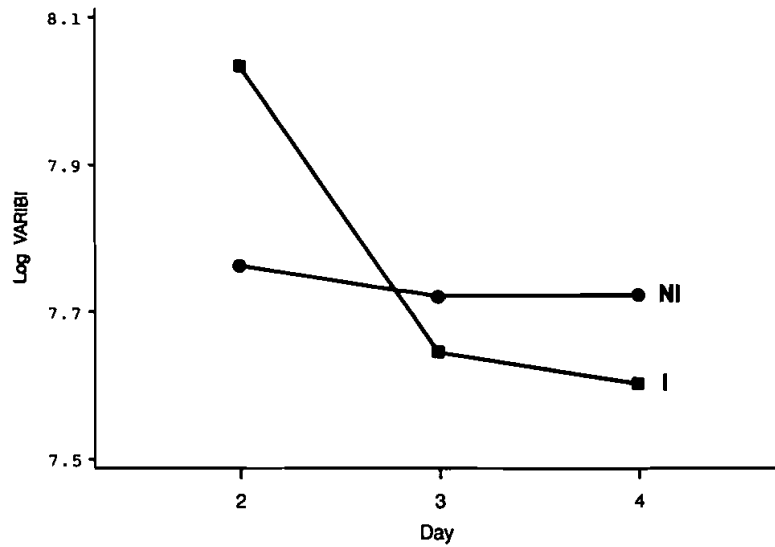


Figure 2. Mean log VARIBI as a function of method of pay and day.

Table 4. Mean log VARIBI and mean systolic pressure as a function of day.

Measure	Day		
	2	3	4
<b>Log VARIBI</b>			
<i>M</i>	7.89	7.69	7.67
<i>SD</i>	0.81	0.74	0.78
<b>Systolic pressure (mmHG)</b>			
<i>M</i>	105.30	106.70	107.80
<i>SD</i>	8.25	9.56	9.64

Table 5. Mean log IBI, mean log VARIBI, and mean systolic pressure as a function of session.

Measure	Session	
	1	2
<b>Log IBI</b>		
<i>M</i>	6.58	6.53
<i>SD</i>	0.11	0.10
<b>Log VARIBI</b>		
<i>M</i>	7.88	7.62
<i>SD</i>	0.85	0.69
<b>Systolic pressure (mmHG)</b>		
<i>M</i>	105.20	108.10
<i>SD</i>	8.90	9.30

log VARIBI across the workdays was due primarily to the influence of method of pay. There was no change across the workdays in log IBI.

4.2.4. *Session*: Irrespective of response time or method of pay, there was a significant session effect for log IBI [ $F(1, 36) = 55.75, p < 0.001$ ] and log VARIBI [ $F(1, 36) = 27.63, p < 0.001$ ]. Inspection of table 5 indicates that log IBI and log VARIBI decreased from the morning to the afternoon work sessions.

4.2.5. *Period*: Inspection of table 6 indicates that, in comparison to period 1, log IBI was higher for period 2 [ $F(1, 36) = 126.30, p < 0.001$ ] and period 3 [ $F(1, 36) = 78.42, p < 0.001$ ]. In addition, in comparison to period 1, log VARIBI was higher for period 2 [ $F(1, 36) = 67.55, p < 0.001$ ] and period 3 [ $F(1, 36) = 71.56, p < 0.001$ ]. The period effects for log IBI and log VARIBI were evident in both the morning and afternoon sessions. In addition, they were the same regardless of response time or method of pay.

#### 4.3. Blood pressure

The mean blood pressure data for the response time and method of pay conditions on day 2, day 3 and day 4 are presented in table 7 and table 8.

Table 6. Mean log IBI and mean log VARIBI as a function of period.

Measure	Period		
	1	2	3
Log IBI			
<i>M</i>	6.53	6.57	6.57
<i>SD</i>	0.10	0.11	0.10
Log VARIBI			
<i>M</i>	7.50	7.83	7.91
<i>SD</i>	0.73	0.76	0.80

Table 7. Mean diastolic pressure (mmHG) as a function of task condition and day.

Task condition	Day		
	2	3	4
Rapid response time (RR)			
<i>M</i>	65.9	67.5	67.9
<i>SD</i>	7.1	6.8	8.0
Slow response time (SR)			
<i>M</i>	62.7	62.9	62.8
<i>SD</i>	8.6	7.9	8.7
Nonincentive pay (NI)			
<i>M</i>	64.4	64.4	64.3
<i>SD</i>	8.8	7.8	9.3
Incentive pay (I)			
<i>M</i>	63.9	65.7	66.1
<i>SD</i>	7.3	7.7	7.9

Table 8. Mean systolic pressure (mmHG) as a function of task condition and day.

Task condition	Day		
	2	3	4
Rapid response time (RR)			
<i>M</i>	105.9	107.0	108.2
<i>SD</i>	7.6	10.1	8.6
Slow response time (SR)			
<i>M</i>	104.8	106.5	107.5
<i>SD</i>	8.8	9.1	10.5
Nonincentive pay (NI)			
<i>M</i>	104.0	104.6	105.5
<i>SD</i>	8.4	9.5	9.1
Incentive pay (I)			
<i>M</i>	106.8	108.9	110.3
<i>SD</i>	7.9	9.1	9.6

Preliminary analyses (two-tailed tests) indicated that the RR vs. SR conditions and the I vs. NI conditions were statistically comparable with respect to diastolic and systolic blood pressure at baseline, day 2.

The pre- and post session readings of blood pressure represented the smallest time interval over which the data analyses were performed for this cardiovascular indicator.

4.3.1. *Response time × day*: There were no response time × day effects, indicating that, in comparison to day 2, diastolic and systolic blood pressure were the same for RR and SR on day 3 and day 4.

4.3.2. *Method of Pay × Day*: Figure 3 and figure 4 show changes in diastolic and systolic blood pressure, respectively, across workdays as a function of method of pay. Pair-wise contrasts (one-tailed tests) indicated that, in comparison to day 2, there was no change in diastolic or systolic blood pressure on day 3. In comparison to day 2, blood pressure was higher for I than NI on day 4 [diastolic,  $F(1, 41) = 3.38$ ,  $p < 0.05$ ; systolic,  $(1, 41) = 3.30$ ,  $p < 0.05$ ].

4.3.3. *Day*: There was no change across workdays in diastolic pressure. In comparison to day 2, however, systolic pressure was higher on day 3 [ $F(1, 41) = 5.25$ ,  $p < 0.05$ ] and day 4 [ $F(1, 41) = 19.39$ ,  $p < 0.001$ ]. Table 4 shows the mean change in systolic pressure across workdays. The increase in systolic blood pressure across workdays was due primarily to the method of pay × day interaction (see Table 8).

4.3.4. *Session*: There was no change in diastolic pressure from the morning to the afternoon work sessions. Inspection of table 5, however, indicates that there was an increase in systolic pressure from the morning to the afternoon work sessions [ $F(1, 41) = 48.04$ ,  $p < 0.001$ ]. This session effect occurred irrespective of system response or method of pay.

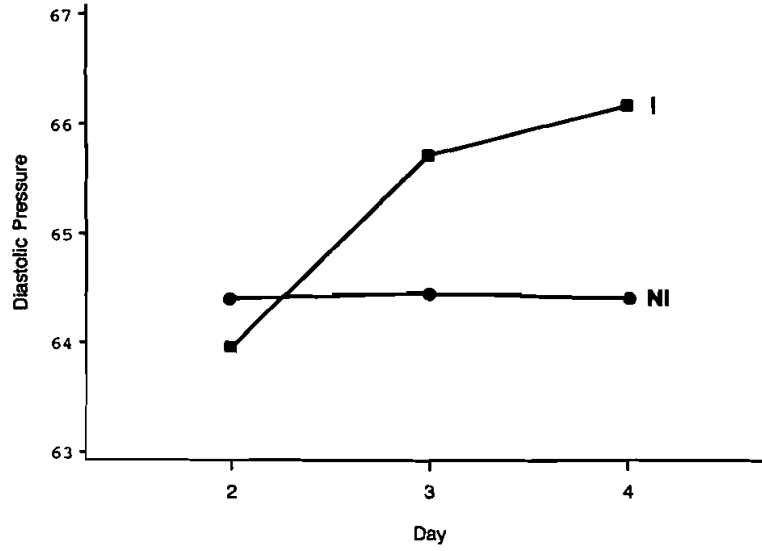


Figure 3. Mean diastolic blood pressure as a function of method of pay and day.

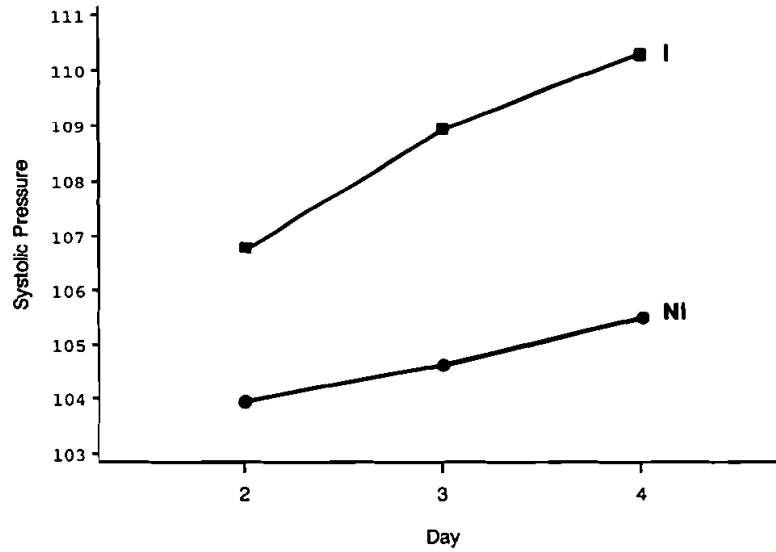


Figure 4. Mean systolic blood pressure as a function of method of pay and day.

Table 9. Mean diastolic pressure as a function of pre-post session.

Measure	Pre-post session	
	1	2
Diastolic pressure (mmHG)		
<i>M</i>	63.5	66.1
<i>SD</i>	7.8	8.4

4.3.5. *Pre-Post Session*: There was no change in systolic pressure from pre- to postsession. Irrespective of response time or method of pay, however, there was an increase from pre- to postsession in diastolic pressure [ $F(1, 41) = 41.41, p < 0.001$ ] (see table 9).

## 5. Discussion

The results of this study indicate that performing a data entry task under computer-administered incentive pay conditions elicits a pattern of stress-related cardiovascular reactivity. Compared to nonincentive pay, incentive pay resulted in a significant reduction in heart rate variability and increased blood pressure across workdays. These findings are similar to those of Levi (1972) who reported increased sympathetic arousal (i.e., elevated adrenaline and noradrenaline levels) among invoice workers under incentive pay conditions.

It is difficult to specify the precise psychophysiological mechanism by which the effects of incentive pay on heart rate variability are mediated. However, one possibility suggested by Ley (1987) and supported by the work of Grossman (1983), Grossman and Svebak (1987), and Porges (1985) is that incentive pay conditions result in stressful or emotional responses which alter normal breathing patterns and, in turn, lead to a reduction in respiratory sinus rhythms (RSA) or a decrease in heart rate variability. Studies are currently underway at NIOSH to explore the relationship between the stress of computer-mediated work and changes in breathing patterns and suppression of RSA.

The findings of this study suggest that under nonincentive pay conditions, slow response time does not alter cardiovascular functioning. However, the lack of a slow response time effect under the more demanding incentive pay conditions was rather surprising and difficult to comprehend. One possible explanation is that the electronic feedback of incentive pay earnings reduced the performance uncertainty or stress associated with system delays and, thereby, minimized any cardiovascular stress effects. Future research should evaluate the physiological effects of slow system response time under conditions in which the performance and pay consequences are more negative than was the case in the present study.

Regarding the psychophysiological effects of performing a repetitive data entry task, it was found that in comparison to period 1, heart rate was lower and heart rate variability was higher during period 2 and 3. These temporal effects occurred irrespective of response time and method of pay, and they are indicative of reduced effort or increased mental fatigue associated with performing the data entry task for sustained periods of time. Psychophysiological studies of the temporal effects of light, repetitive work also have found similar decreases in heart rate and increases in heart rate variability that are consistent with increased mental fatigue (Floru *et al.* 1985, Weber *et al.* 1980).

Another physiological effect associated with performing the data entry task, which occurred irrespective of response time or method of pay, was the increase in heart rate and systolic blood pressure, and decrease in heart rate variability, from the morning to the afternoon work session. This temporal pattern is consistent with a morning to afternoon circadian rhythm effect (Minors and Waterhouse, 1985).

In conclusion, the results of this experiment indicate that incentive pay programmes produce stress-related cardiovascular effects among healthy workers. Future research should increase our understanding of whether these effects, which were obtained over a two-day period, persist over time and result in stress-related disease or illness. Such a

possibility is of particular concern for workers who may be at increased risk for cardiovascular disease (e.g., older workers, Type A workers, and hypertensive workers). Research efforts also should be directed toward the establishment of incentive pay systems that minimize psychophysiological stress effects and facilitate performance.

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#### Disclaimer

Mention of any company name or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

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On a analysé les effets psychophysiologiques du temps de réponse (long vs. court) d'un ordinateur et du mode de rétribution (incitateur vs. non-incitateur). Une tâche de saisie de données a été utilisée avec 45 dactylos. Les réponses cardiovasculaires (fréquence cardiaque et pression artérielle) ont été prises en compte pendant quatre jours de travail consécutifs. On n'a pas observé de variations significatives dans ces variables en fonction des temps de réponse du système informatique. Cependant le mode incitateur a significativement augmenté la pression artérielle et abaissé la variabilité de la fréquence cardiaque au cours des jours, comparé au mode non-incitateur. Quels que fussent le temps de réponse ou le mode de rétribution, les performances à la tâche au cours d'une période de travail soutenu ont entraîné une réduction de la fréquence cardiaque et une augmentation de sa variabilité. Cet effet temporel indiquerait ou une réduction de l'effort ou une fatigue mentale accrue. Ces résultats suggèrent que le mode de rétribution d'une activité de type saisie de données peut entraîner une réactivité physiologique indicatrice de stress chez des travailleurs bien-portants.

Psychophysiologische Effekte bedingt durch Antwortzeiten (lang vs. kurz) und Entlohnungsart (leistungsbezogene vs. nicht leistungsbezogene) wurden anhand von 45 Typisten, die mit einer Eingabeaufgabe am Computer betraut waren, untersucht. Kardiovaskuläre Reaktionen (d.h., Herzschlagfrequenz und Blutdruck) wurden über vier gewöhnliche aufeinanderfolgende Arbeitstage beobachtet. Dabei zeigte sich, daß sich die Herzschlagfrequenz und der Blutdruck in Abhängigkeit von langen oder kurzen Wartezeiten nicht signifikant veränderten. An Tagen jedoch, an denen ein leistungsbezogener Lohn gezahlt wurde, stieg der Blutdruck im Vergleich zu Tagen ohne leistungsbezogene Bezahlung signifikant an, und die Herzschlagarrhythmie nahm signifikant ab. Unabhängig von der Antwortzeit und der Art der Bezahlung war die Leistung bei anhaltender Dateneingabe verbunden mit einer reduzierten Herzschlagfrequenz

und einer steigenden Herzschlagarrhythmie. Dieser zeitliche Effekt war indikativ für eine nachlassende Anstrengung bzw. für eine höhere mentale Ermüdung. Die Ergebnisse der Studie lassen darauf schließen, daß eine leistungsbezogene Entlohnung für eine Dateneingabetätigkeit bei gesunden Arbeitspersonen eine physiologische Reaktion durch Stress auslösen könnte.

計算機システム反応時間（低速対高速）と給与支払い方法（奨励対非奨励）の精神生理学的影響を計算機ベース・データ入力作業で45名の職業タイピストを用いて評価した。心臓血管反応（心拍数、血圧）は4連続作業日にわたって定期的に監視した。心拍数と血圧は低速、高速反応時間でもあまり変化しなかった。奨励的給与の場合、しかしながら、非奨励的給与と比較して連続作業日にわたって血圧が大幅に上がり、心拍数のばらつきが大幅に減った。反応時間と支払い方法に関係なく、持続期間にわたるデータ入力作業の成績は心拍数の低下と心拍数ばらつきの増大に関連していた。この時間的影響は努力の減少または精神的疲労の増大を示していた。本研究の結果はデータ入力作業での奨励給与制度は健康な作業者のにストレス関連生理的反応を引き起こすと示唆される。