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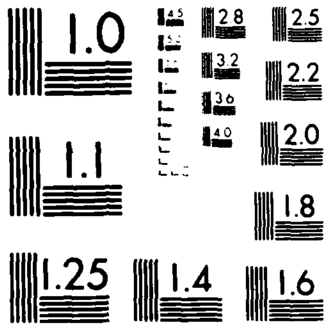

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SUMMARY

Response times to the items in a series of computer administered questionnaires were measured in two continuous sustained operation studies. These studies involved subjects performing repeated exercise at 30% of maximum aerobic power as well as subjects doing no exercise. Two start times (noon and midnight) were also used. Thirty subjects were tested for 33 one hour continuous work sessions over two days with a three hour nap allowed between the days. The questionnaire scales selected for analysis included the Vigor and Fatigue scales of the Profile of Mood States (POMS), the Kogi Symptom Checklist, the School of Aerospace Medicine (SAM) Fatigue scale, and the Naval Health Research Center Mood Questionnaire (NHRC MQ) Negative and Positive Mood scales. These scales were selected to reflect the major experimental conditions (sleep loss and exercise fatigue) and they included the three different response scaling types (Likert, Dichotomous, and Guttman).

Response times to the scales were not significantly related to reading test speed or grade level. The response times to almost all scales were significantly faster on the second workday. The symptom, negative mood, and fatigue scale values increased, and the Vigor and positive scale scores decreased between the first and second days. Reaction times on a simple psychomotor task were significantly slower during the second workday and did not correlate with the questionnaire response times. This finding suggested that response times to questionnaire items are not based on the same mechanism as psychomotor reaction times.

Response times for those subjects using straight lining were significantly faster than for those using variable response patterns. Although the incidence of this straight-lining increased significantly over the two workdays, it did not occur often enough to explain the shorter response times during the second workday. The decrease remained significant even after those who were straight lining were omitted from the analyses.

There were significant positive correlations between scale values and scale response times on the first day for the POMS Fatigue, Kogi Symptom, and NHRC Negative scales; subjects with longer response times had higher scale scores. In contrast, the NHRC Positive scale value and the response time to

that scale were negatively related the first day. Thus, scale content influences the direction of the relationship of scale value and response time. Positive mood response times appear to reflect the intensity of feeling (the higher the scale value, the faster the response), whereas negative affect responses may be moderated by denial or deliberation in response level selection. Only the POMS Fatigue scale showed significant ($p<.001$) value-response time correlation the second day. This scale was particularly valid because it closely reflected the experimental conditions (fatigue and sleep loss). Thus the scale value-response time relationship may be a measure of scale validity in particular experimental situations.

The Guttman scaled items had the longest response times, and the Kogi Symptom dichotomous scaled items the shortest response times, indicating that the more complex the scale type, the longer the response times. When the average response times were compared between scales having the same format but different contents, the NHRC Positive scale took longer to respond to, per item, than the Negative scale, and the POMS Vigor took longer than POMS Fatigue scale both days. This supports Bower's theory (1981) that subjects respond more quickly to questions that reflect moods congruent with their present state (i.e., increased fatigue in these studies).

Response times to questionnaire scales were shown to be important measures in indicating intensity, denial and congruence with the scale contents, as well as showing the influence of straight-lining and reflecting the experimental conditions and scale difficulty and validity. Response times were not found to be due to reaction time, reading speed, or ability.

COMPUTER RESPONSE TIME MEASUREMENT OF MOOD, FATIGUE AND SYMPTOM SCALE ITEMS: IMPLICATIONS FOR SCALE RESPONSE TIME USES

David H. Ryman, Paul Naitoh, Carl E. Englund and S. G. Genser

Reaction times have long been used by psychologists to measure vigilance/attention, cognitive processing, and skill levels. Shorter reaction times have been found to indicate greater vigilance and attention as well as higher skill levels. More complex cognitive processing has been found to cause longer reaction times.

Although computer administered questionnaires have been in use for over twenty years and computer administered reaction time measures have been available equally long, there is scant literature on the measurement or use of response times[1] to questionnaire scales. Depressives have been shown to have longer response latencies to psychomotor reaction time measures (Ban, 1964), but the relationships between response times and questionnaire scale values with depression or other psychological states or behaviors are not well defined.

Bower (1981) proposed the theory that emotional states would influence activation of memory for words congruent with the mood state and inhibit opposing mood state words. In such a theory, response times to mood scales items reflecting the prevailing moods would be expected to be faster, and response time to opposite moods slower. Response time to mood scale items might therefore reflect the intensity, denial or other dimensions of affective states. For example, extremely fast response time for the items of a particular mood may indicate that a subject felt that mood strongly; it clearly applied to his present feelings or that the subject was sensitive to the mood and denied it.

Footnote: 1. In this report, the term "response time" refers to the time between the presentation of a questionnaire item on a CRT and the key press reflecting the questionnaire response scale by a subject. The term "reaction time" is used for the psychomotor task time between stimuli presentation on the screen and the subjects' keyboard reaction to the stimuli.

However, fast response times may also occur when subjects want to quickly complete the questionnaire. This is called "straight lining." Extremely slow response times to items of a particular mood could also be interpreted in several ways. A subject may have had a difficult time deciding on a response to an item because it was complex or had unfamiliar words, or the subject had difficulty deciding between which response scale level to choose.

Gilbert (1967) had previously reported findings which supported Bower's theory using a mechanical presentation and timing method for the Taylor Manifest Anxiety Scale. He developed "latency weighted" scoring using a combination of response time and strength of agreement or disagreement to test items. These "latency weighted" scores showed correlations from .76 to .86 with regular non-weighted scores which did not incorporate response times. However, low anxiety subjects had significantly higher regular scores, whereas high anxiety subjects had higher "latency weighted" scores.

Dunn, Lushene and O'Neil (1972) reported on relationships of MMPI item response latencies and item characteristics (length, social deviant content) using computer presentation and timing of the MMPI. They found that the length of the items (number of letters and words) accounted for 48-58% of the response time variability, and the social desirability of the items accounted for only a slight but significant amount (4-7%). They did not report the relationships between response latencies to the standard scales, but "deviant" responses to a subset of 38 items were found to have greater response times than "non-deviant" responses.

The Specific purposes for the inclusion of scale item response time measurement in present research were to:

1) Determine if response times to items reflect intensity (i.e., greater scale value) in acceptance or denial of the mood, fatigue, or symptom state expressed by the item content.
2) Investigate whether response times are related to scale content indicating congruence of the scale content and the subject's state.

3) Determine if extremely short response times indicate hasty, "straight-lining" response patterns.

4) Determine if scale response times reflect changes in experimental conditions such as the effects of sleep loss, exercise-induced fatigue, circadian phase, and start-time of work shift.

5) Determine whether response times to questionnaire items were related to the reaction times in psychomotor tasks or with reading speed or grade level.

Response times and the scale values were collected in two studies involving sleep loss, exercise, and shifts in workday start times. The computer administered and timed questionnaires used in these studies included two Likert scaled mood questionnaires, a dichotomously scaled symptom checklist, and a Guttman scaled fatigue questionnaire. Reaction times on a simple psychomotor task were also collected via computer immediately after the questionnaire administration.

METHOD

Subjects

There were 15 pairs (N=30) of informed, volunteer U.S. Marine Corps enlisted personnel who completed a week long laboratory study. Their mean age was 21.2 yrs (SD=1.2), and they had an average of 11.1 yrs (SD=1.3) of education with an average reading grade level of 10.9 (SD=2.5) on the Nelson-Denny Reading Test (Brown, 1966).

Procedures

One subject of each pair was randomly chosen as the exercise subject. This subject exercised by walking on a treadmill carrying a 22.7 kg (50-lb) pack for the first 1/2 hour of each of the 33 one hour task sessions over the two continuous workdays. This exercise subject walked at a rate and grade that required 30% of his maximum aerobic capacity. The other (control) subject did the same tasks while seated at a computer terminal throughout the sessions.

The first study had seven pairs of subjects who started the two continuous workdays of the study at midnight (2400 hr), whereas the second study involved eight pairs of subjects who started the continuous workdays at 1300 hr. Subjects in both studies spent the first day performing 8 to 12 one hour sessions to familiarize them with the tasks and schedule. There were eight hours of sleep allowed between this training day and the first continuous workday. A 3hr nap was also given between the two continuous workdays.

Questionnaire Description

A series of mood, symptom, and fatigue questionnaires were administered and timed by a MINC 11 computer (Digital Equipment Corporation Modular Instrumentation Computer) with a programmable clock (MNCKW) and two CRT terminals (for more details on the task battery and computer system, see Ryman, Naitoh and Englund, 1984).

The first questionnaire presented was the Profile of Mood States (POMS; McNair, Lorr and Droppleman, 1971). The 65 items appeared, one at a time, after the instructions on use of the 5 point Likert type scale. The subjects were to press the number key corresponding to how each adjective described "your present state now", then hit the enter or return key. The response time to each item was the time from the moment the adjective appeared on the screen to the subject's typing of the number key. If a value was mistakenly entered or the subject changed his mind, the delete key could be hit and the timing was restarted for that item. Only after the subject pressed the return key was the response time and the item scale value stored in the computer, and then the next item presented.

The second questionnaire presented was the 10-item School of Aerospace Medicine Subjective Fatigue Checklist (SAM Fatigue; Pearson and Byars, 1956) which has a Guttman-type scale. This questionnaire was presented in the same manner as the POMS. The next questionnaire was the Naval Health Research Mood Questionnaire (NHRC MQ; Moses, Lubin, Naitoh and Johnson, 1974). The NHRC MQ has a four point Likert response scale with the same wording as the POMS scale, except there is no mid-point value. The last questionnaire presented was the

Kogi Symptom Checklist (Kogi, Saito, and Mitsuhashi, 1970) which is a set of 30 symptoms found to increase with work fatigue.

If the subject gave an invalid (out of range) response to an item on any of these four questionnaires, the response was rejected, the item reappeared on the screen, and timing was restarted. Timing was done with a programmable clock board with the time to respond stored in milliseconds in the higher bits (4-16) and the scale value response in the lower bits (0-3).

Scaling Methods

Guttman scales are developed by administering a large number of items reflecting a given measure to a population of raters. These raters sort and rate items as to what level of a measure (fatigue in the SAM questionnaire) they represent. Items on which most raters agreed are then used to construct a scale range of approximately equidistant levels. Subjects are given a dichotomous or, in this case, trichotomous (0 = better than, 1 = same as, and 2 = worse than) response choice on each item.

A Lickert-type scale has three or more equally appearing response alternatives. Lickert scales are usually developed by the factor analysis of the responses to a pool of such items, grouping the highly correlated items into scales. The NHRC MQ scales were generated from the principal components solution (Moses, Lubin, Naitoh and Johnson, 1974) whereas the POMS scales were derived by varimax (orthogonal) rotation (McNair, Lorr and Droppleman, 1971).

Scoring Methods

Scoring programs computed the response times on the scales and the total scale scores for the six POMS scales, the total SAM Fatigue scale, the negative and positive scales of the NHRC MQ, and the total number of symptoms on the KOGI. The data from these questionnaires were stored on floppy disk media. The scale scores and times were output to another floppy and transferred to a larger VAX computer system where further analysis was done. Since the first item in a questionnaire appeared with the instructions, the response time to the first item in a questionnaire was not included in its scale total response time. This was done because the reading of questionnaire instructions and adjustment from one questionnaire response scale to the next would affect those scales having the first questionnaire item.

Psychomotor Reaction Time Task

The Simple Reaction Time task (Lisper and Kjellberg, 1972), modified for visual stimuli, was administered by computer immediately after the series of Mood, Fatigue and Symptom questionnaires were finished. There are 60 trials at random intervals with a mean between trial interval of 6 seconds. Subjects respond as quickly as possible to a stimulus consisting of the presentation on a CRT screen of clock ticks in 100ths of a second increasing from 000 to 250 (2.5 secs) or until the subject presses any key on the terminal keyboard. The subject's reaction time, or 250 for an omission, remained on the CRT screen for .5 seconds after each trial. The most sleep loss sensitive measure for this task has been found to be the mean reaction time of the slowest 10% of the responses. This measure was related to the scale response times to estimate the psychomotor reaction time component of scale response times.

ANALYSIS

Skewness and kurtosis of scale value and response time distributions were similar and almost all were in the range of -1 to +1. Hence, these response times were not log-transformed before statistical comparisons as is usually done for reaction time measures prior to analysis.

Effects of Experimental Conditions

Multivariate analyses of variance (MANOVA) of Continuous Work Start-Times by exercise group over the repeated day and session periods (Norusis, 1985) were done on the response times for the six selected scales to determine if response times differed between the experimental conditions or changed with accumulating fatigue and sleep loss.

In order to produce more stable measures, data for each subject from the two continuous work days were condensed into the means of eight time periods as follows:

Time Period 1: sessions 1-4 of continuous work day 1.
Time Period 2: sessions 5-8 of continuous work day 1.
Time Period 3: sessions 9-12 of continuous work day 1.
Time Period 4: sessions 13-17 of continuous work day 1.
Time Period 5: sessions 1-4 of continuous work day 2.
Time Period 6: sessions 5-8 of continuous work day 2.
Time Period 7: sessions 9-12 of continuous work day 2.
Time Period 8: sessions 13-16 of continuous work day 2.

Interrelationships of Scale Values and Response Times:

Correlations between the means of daily scale scores and the means of daily response times were calculated for each scale. Pearson Product-Moment Correlation Coefficients (r_p) were obtained to test for any linear relationships between response times and scale values. The Spearman Rank Order Correlation (r_s) was also calculated to confirm Pearson correlations because the Spearman is not influenced by extreme values (high or low outliers) as is the Pearson and, therefore, is more robust for small samples. The interrelationships of scale values and response times were accepted only when both correlation coefficients were significant.

Effects of Reaction Time

Correlations of the daily mean response times for the scales and the mean reaction time for the slowest 10% trials on the Simple Reaction Time (SRT) task were computed. This determined if reaction time was a significant component of mood, fatigue, or symptom scale item response times.

Effects of Reading Ability

Correlations with the Nelson-Denny Reading Test number-of-items-attempted and grade level score were correlated with the daily mean response times to the six scales, to determine if reading speed or ability was related to the scale item response times.

T-Tests of Extreme Response Style on Time and Scale Values:

The use of only one response alternative to respond to all the items for all the scales of the questionnaire was defined as straight-lining that questionnaire. If the questionnaire only had one scale (Kogi and SAM), shifting from a variable response pattern to the use of only one response alternative was also considered straight-lining. The frequency of straight-lining was analyzed at each session for each questionnaire. The scale values and response times of straight-liners were compared by t-test with all other scale response times. Other analyses which showed significant results were verified by repeating the analyses with straight-lining subjects excluded.

Comparisons of Mean Item Response Times of Scales:

The mean item response times for each scale for each day were computed by dividing the number of items in a scale into the mean response time for the scale. This allowed comparisons between the response times across the various scaling types (four and five point Likert, Guttman, Dichotomy) and between the various scale contents.

RESULTS

Scale Characteristics, Values and Response Time Differences

Items in the four scales using the Likert response scaling method were comparable in number and length of words. The Guttman scaled SAM Fatigue and dichotomously scaled KOGI symptom checklist were also similar in this regard (Table 1).

The Kogi symptom, NHRC Negative mood and SAM and POMS fatigue scales scores showed significant increases over the two continuous workdays, whereas the POMS Vigor and NHRC Positive scores decreased. The reaction times to all scales, however, showed significant decreases between these days despite the

TABLE 1
MOOD, FATIGUE AND SYMPTOM SCALE CHARACTERISTICS

QUESTIONNAIRE	POMS		SAM	KOGI	NHRC MQ	
SCALE	VIGOR	FATIGUE	FATIGUE	SYMPTOMS	NEGATIVE	POSITIVE
NO. OF ITEMS	9	7	10	30	10	19
MEAN NO. WORDS	1.3	1.1	2.2	2.7	1.0	1.6
MEAN NO. LETTERS	7.4	7.3	12.7	16.3	6.2	9.5
SCALE RESPONSE TYPE	LIKERT 5[a]		GUTTMAN[b]	DICHOTOMY[c]	LIKERT 4[d]	

[a]0 = Not at all; 1 = A little; 2 = Moderately; 3 = Quite a bit; and 4 = Extremely
[b]0 = Better than; 1 = Same as; and 2 = Worse than
[c]Y = Yes; and N = No
[d]0 = Not at all; 1 = A little; 2 = Quite a bit; and 3 = Extremely

sleep loss and exercise fatigue experienced. The correlation between mean response times day 1 and day 2 for a given scale were very similar to the correlation between the scale scores on the two days (see Table 2).

Differences in Scale Response Time Across Experimental Factors:

The most significant factor seen from the MANOVA analysis of these scale response times was the Day effect. Response times were faster during continuous work day 2 (CW2) than during continuous work day 1 (CW1). Table 2 shows means and standard deviations for scale scores and response times.

TABLE 2
SCALE VALUE AND RESPONSE TIME* MEANS AND STANDARD DEVIATIONS FOR THE TWO CONTINUOUS WORKDAYS WITH T-TESTS AND CORRELATIONS BETWEEN THE DAYS

		DAY	CW1		CW2					
QUESTIONNAIRE	SCALE	MEASURE	MEAN	SD	MEAN	SD	t	p	r	p
POMS	Vigor	Value	14.1	7.5	9.9	6.2	4.61	<.001	.753	<.001
POMS	Vigor	RT	2.0	.5	1.6	.6	4.35	<.001	.635	<.001
POMS	Fatigue	Value	3.8	3.9	5.5	4.5	−2.13	.04	.451	.01
POMS	Fatigue	RT	1.5	.5	1.3	.5	1.82	–	.589	<.001
SAM	Fatigue	Value	8.3	3.3	10.3	3.9	−3.47	.002	.647	<.001
SAM	Fatigue	RT	2.4	.9	2.1	1.0	2.93	.007	.828	<.001
KOGI	Symptoms	Value	2.4	2.0	6.3	7.1	−3.09	.004	.186	–
KOGI	Symptoms	RT	.9	.5	.8	.4	2.17	.039	.760	<.001
NHRC	Negative	Value	5.2	4.9	6.8	5.0	1.98	–	.598	<.001
NHRC	Negative	RT	1.4	.5	1.3	.4	2.73	.011	.572	<.001
NHRC	Positive	Value	33.9	13.6	25.7	13.3	5.19	<.001	.791	<.001
NHRC	Positive	RT	1.7	.06	1.5	.5	3.35	.002	.800	<.001
SRT	Slowest	10% rt⁺	.69	.43	1.01	.56	−5.19	<.001	.808	<.001
							df = 29		df = 28	

*RT = Response Time per questionnaire item in seconds
rt⁺ = Reaction Time to SRT psychomotor task in seconds
– = not significant ($p > .05$, two-tailed)
SRT = Simple Reaction Time Task (mean of the slowest 10% responses)

The effect of workday start-time was seen in the significant interaction of Day with Start Time. The noon start time group showed much longer response times on continuous workday 1, as compared to workday 2 for POMS Fatigue and Vigor and NHRC Negative and Kogi Symptom scales, than the midnight group did (Table 3). This indicated that the Day effect previously discussed occurred primarily in the noon group for these four scales.

Session (see Analysis Section) differences were seen for the Kogi and both NHRC scales with the last sessions taking longer. Longer response times to the POMS fatigue for the noon start time group over the last four sessions were also shown by the significant Start Time by Days by Sessions interaction.

TABLE 3
SELECTED MANOVA RESULTS FOR RESPONSE TIMES TO SIZE SCALES

QUESTIONNAIRE	POMS				SAM		KOGI		NHRC MQ			
SCALE	VIGOR		FATIGUE		FATIGUE		SYMPTOMS		NEGATIVE		POSITIVE	
FACTORS	F	p	F	p	F	p	F	p	F	p	F	p
Days*	25.62	<.001	4.22	.05	10.03	.004	5.05	.03	11.43	.002	15.15	.001
Days × ST+	6.01	.021	4.21	.05	.64	--	6.53	.02	8.67	.007	3.69	--
Sessions	1.41	--	2.80	--	.99	--	4.96	.008	4.47	.012	3.47	.032

*Response times faster CW2 than CW1 (see Table 2 for means, SDs) df = 1,26

+ = Start time of CW (Midnight vs Noon groups); df = 1, 26

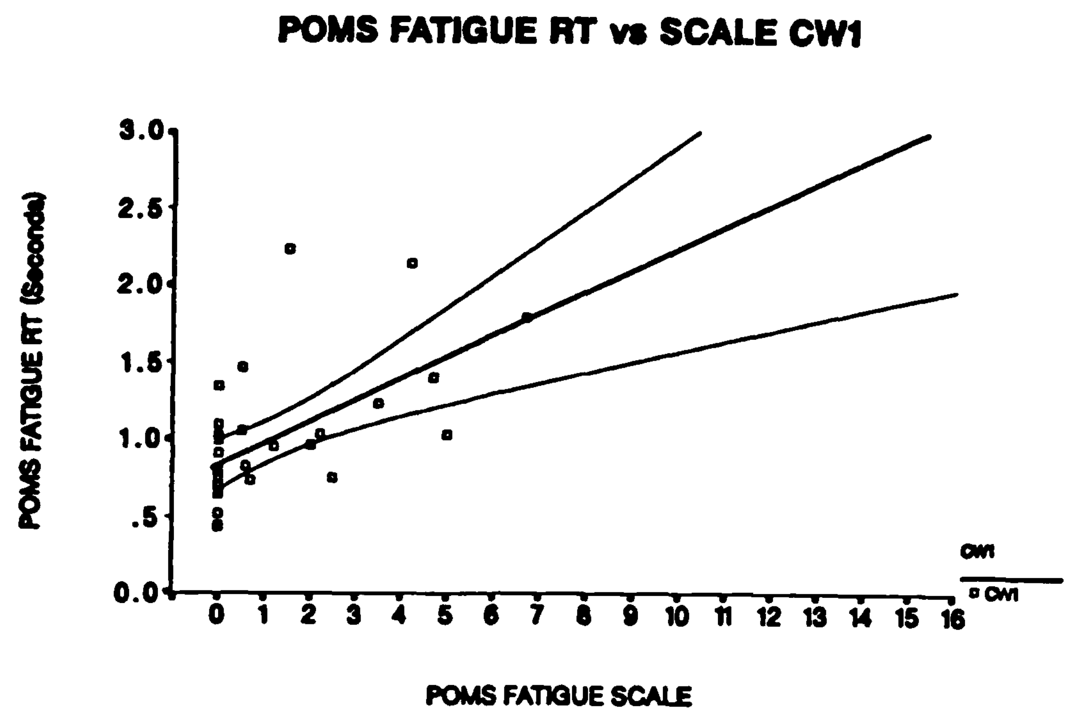
-- = not significant (p > .05)

Sessions df = 1, 24

Relationships Between Scale Response Times To Reading Scores and Scale Values:

There was a significant linear relationship between the response times and scale values each day for the POMS Fatigue scale (see Figure 1). Even when the Dunn-Bonferoni correction for multiple testing (Harris, 1975) was applied to the significance levels (.05/12 or p>.004), this relationship remained significant for both the Pearson and Spearman correlations. Figure 1 shows that correlations result from subjects with higher fatigue having consistently slower response times, and those denying fatigue (zero fatigue scale) responding very quickly.

The Kogi symptom scale scores had a significant positive correlation with the response times only during CW1 (Pearson $r_p = .49$, $p = .006$; Spearman $r_s = .65$, $p < .001$). The NHRC Negative scale response times also showed a positive correlation with scale values only during CW1 ($r_p = .36$, $p = .05$; $r_s = -.46$, $p = .005$). There was a significant negative correlation (see Figure 2) between the NHRC Positive scale response times and scale values ($r_p = -.40$, $p = .03$; $r_s = -.53$, $p = .001$) during the first continuous workday. During CW1 higher NHRC Positive scale values were associated with faster responses, while higher scale values on the NHRC Negative and Kogi Symptom scale RTs were associated with slower (longer) response times. All correlations between the scales' Response Times and Values for both days can be seen in Table 4.



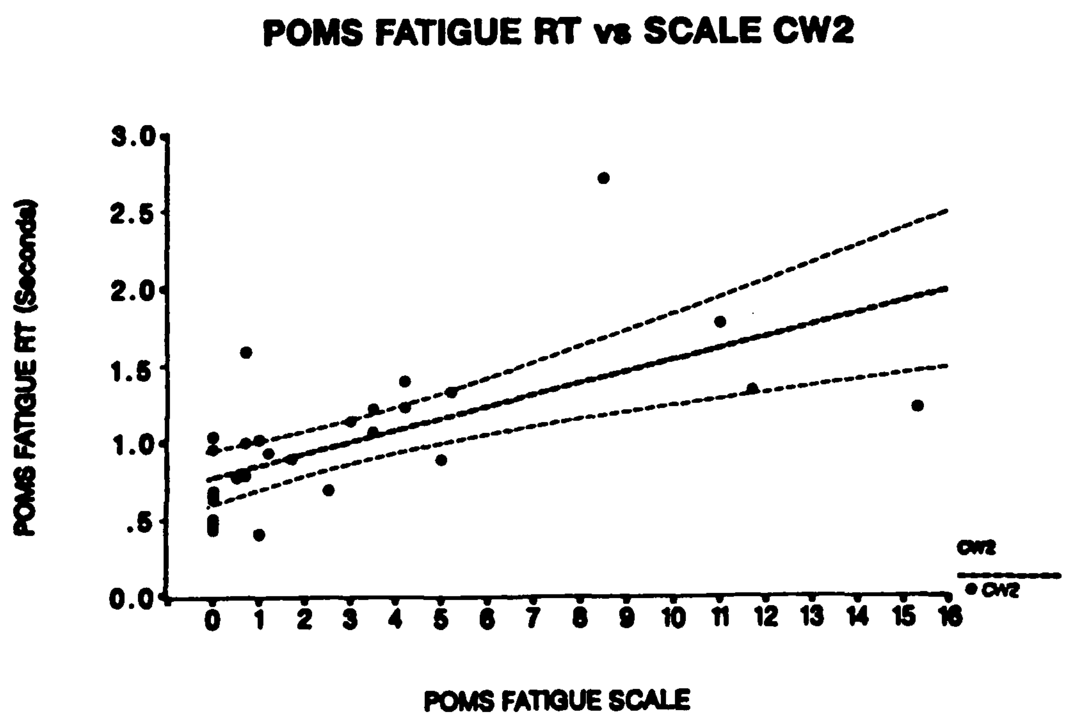
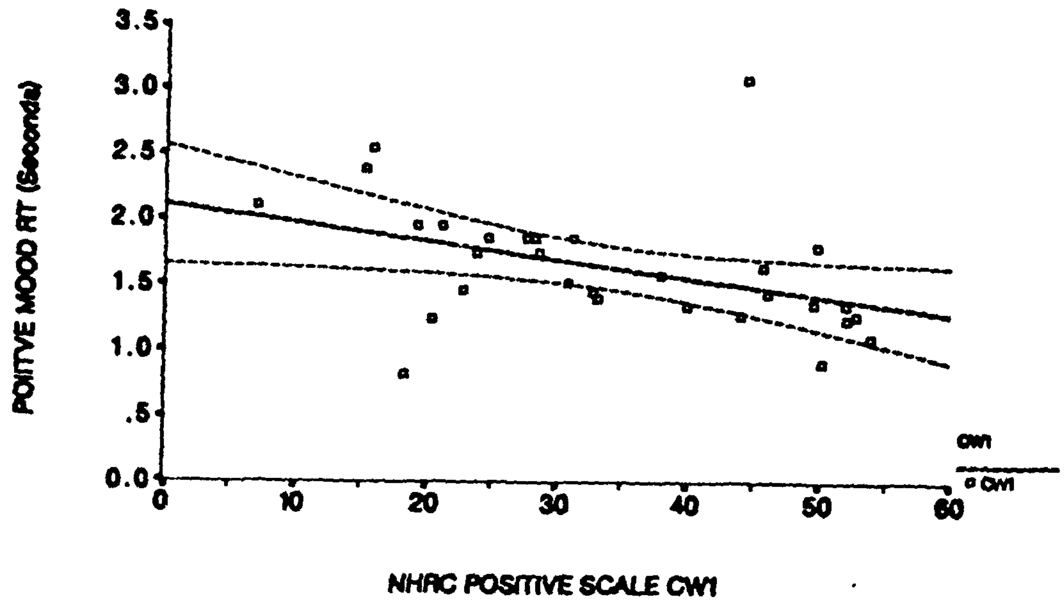


Figure 1. Regression Line with 95% Confidence Intervals and Data Points for Correlations Between Mean POMS Fatigue Response Time and Scale Value at CW1 (upper graph) and CW2 (lower graph).



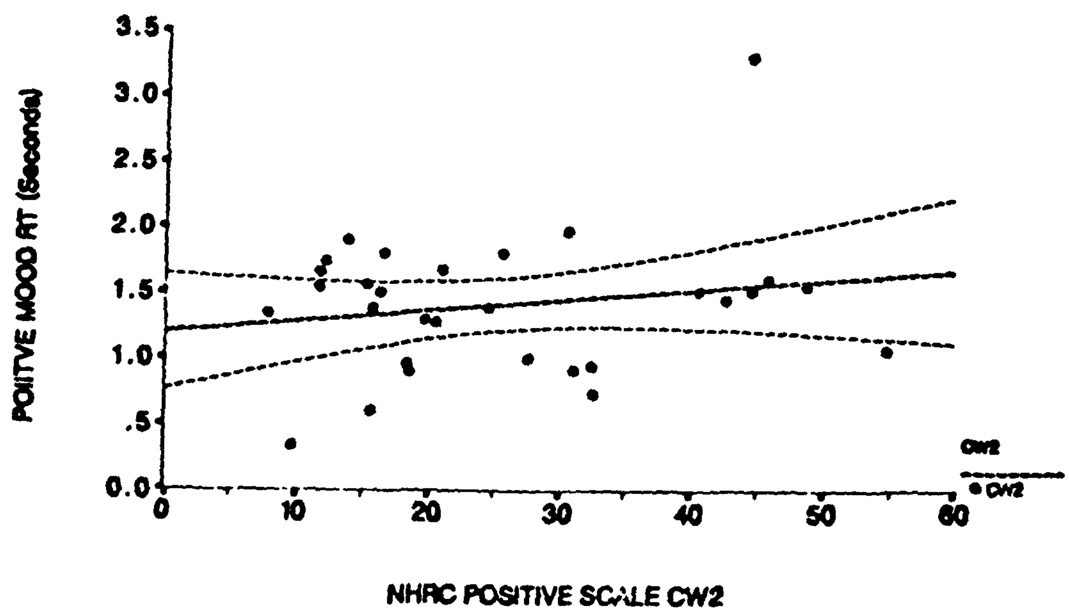


Figure 2. Regression Line with 95% Confidence Intervals and Data Points for Correlations Between Mean NHRC Positive Mood Response and Scale Values at CW1 (upper graph) and CW2 (lower graph).

TABLE 4
CORRELATIONS BETWEEN THE DAY MEAN SCALE VALUES AND RESPONSE TIMES

QUESTIONNAIRE	POMS				SAM		KOGI		NHRC MQ			
SCALE	VIGOR		FATIGUE		FATIGUE		SYMPTOMS		NEGATIVE		POSITIVE	
DAY	r_p	r_s	r_p	r_s	r_p	r_s	r_p	r_s	r_p	r_s	r_p	r_s
CW1	−.23	−.28	.66	.82	.30	.42	.49	.65	.36	.46	−.40	−.53
p	–	–	<.001	<.001	–	.01	.005	<.001	.05	.006	.03	.001
CW2	.08	.02	.56	.61	−.09	−.12	−.21	−.03	−.15	−.07	.20	.03
p	–	–	<.001	<.001	–	–	–	–	–	–	–	–

r_p = Pearson
r_s = Spearman
– = not significant ($p > .05$, two-tailed)
df = 28

Scale Response Time Relationships With Psychomotor Reaction Times and Reading

The mean of the slowest 10% reaction times on the Simple Reaction Time task for CW2 was negatively correlated with the POMS Vigor scale response time. Those subjects with faster Vigor scale responses had slower SRT reaction times (r_p = −.43, p=.02 and r_s=−.45, p=.01). There were no other significant relationships between the psychomotor reaction times and the scale response times. None of the scale response times were significantly correlated with the Nelson-Denny reading test grade level (ability) or number of answers attempted (speed).

Comparisons of Constant Scale Value Responders Versus Others:

Straight-lining occurred in less than 2% of sessions on the first continuous workday. However, during the second workday 12 to 16% of all sessions showed such response patterns (Table 5). Four subjects (13.3%) were found to use straight-lining in responding to most scales (five subjects for the Kogi) for a majority of the sessions on continuous workday 2.

TABLE 5
CW2 SCALE VALUE AND RESPONSE TIME MEANS AND STANDARD DEVIATIONS AND T-TESTS BETWEEN 'STRAIGHT-LINING' AND 'OTHERS'

QUESTIONNAIRE	SCALE	MEASURE	OTHERS		STRAIGHT-LINING			
			MEAN	SD	MEAN	SD	t	p
POMS	Vigor	Scale	10.5	6.3	6.3	4.8	1.28	.21
POMS	Vigor	RT	12.9	3.9	4.6	2.7	4.05	.001
POMS	Fatigue	Scale	5.9	4.5	2.9	3.4	1.23	.23
POMS	Fatigue	RT	9.7	3.0	4.9	2.8	3.02	.005
SAM	Fatigue	Scale	10.9	3.6	6.5	4.3	2.24	.03
SAM	Fatigue	RT	19.8	8.1	10.6	8.8	2.08	.05
NHRC	Negative	Scale	6.9	5.2	6.2	3.3	.23	.82
NHRC	Negative	RT	13.0	3.4	6.9	2.5	3.45	.002
NHRC	Positive	Scale	27.2	13.6	15.5	4.1	1.69	.10
NHRC	Positive	RT	27.2	8.5	12.8	5.3	3.26	.003
			n = 26		n = 4		df = 28	
KOGI	Symptoms	Scale	6.1	7.4	7.4	5.7	−.40	.70
KOGI	Symptoms	RT	23.0	11.4	15.7	6.9	1.37	.18
			n = 25		n = 5		df = 28	

*Use of constant response alternative throughout all questionnaire scales for questionnaires having more than one scale, or the sudden switching to one response alternative for all items for questionnaires having one scale.

The straight-liner's response times were significantly faster (p<.001) than the response times of those using more than one response alternative. When the subjects using straight-lining were excluded from the analyses, the significant results did not change (slower response times on continuous workday 2 and the significant correlations between response times and scale values remained).

Comparisons of Response Time Between Scale Contents and Scaling Types:

The Postive NHRC MQ scale took significantly longer than the Negative scale on both days (CW1, t=2.66, p=.003; CW2, t=2.18, p=.037), and the POMS Vigor scale took longer to complete than the POMS Fatigue scale each day (CW1, t=4.72, p<.001; CW2, t=2.18, p<.037). The complex Guttman scaled SAM fatigue items had a longer response times than the Likert scaled POMS Fatigue items (CW1, t=6.08, p<.001; CW2, t=4.07, p<.001). There was no significant difference in the response time per item between the NHRC Negative and POMS Fatigue scales, but the Five Point Likert scale POMS Vigor scale took longer per item than the NHRC Positive (CW1, t= 5.58, p< .001; CW2, t= 2.08, p= .047). The response times to the dichotomous scaled symptom items were, as expected, significantly faster (p<.001) than with all other scale types.

DISCUSSION

The primary purpose of this paper was to investigate how measurement of response time items could be useful in such areas as: 1) the investigations of intensity, denial, or congruence of mood states, 2) the occurrence of straight lining, 3) experimental effects like sleep loss or exercise, and 4) its relationships with reaction time and reading measures. Although the present studies had small sample sizes, the number of questionnaires were limited, and there were many statistical tests run on this one set of studies, nevertheless, the results from these analyses suggest many research applications for scale response time as a significant and useful measure.

It appears that the scale content moderated the value-response time correlations on day 1. The negative correlation between the NHRC positive mood scale and the response time to that scale may have indicated greater intensity, higher scale value having faster responses on the NHRC Positive mood; whereas the negative correlations of the POMS Fatigue, Kogi symptom and NHRC Negative scale-response times might have been due to denial or deliberation. Perhaps subjects tended to respond quickly to sensitive items that they wanted to deny (give a low score) or, conversely, there may have been increased deliberation between higher scale values on negative items that they were willing to apply to themselves. The results of previous studies also indicate that scale content may influence the relationship with response time. Gerrig and Bower (1982) did not find any differences in speed or correct selection of words with experimental manipulation of happiness or anger. However, Ladavas, Nicoletti, Umilta and Rizzolatti (1984) in the study of visual field differences on a reaction time task found a slowing of reaction time post self-induced sadness as opposed to initial testing and post recall of every day events. They attributed this finding to "an activation of the right hemisphere during sadness", (pg. 484).

The relationship of response time to scale value on the POMS Fatigue scale was particularly strong ($p<.001$) on both workdays. Fatigue was a major factor in our experimental protocol. This particular correlation suggests that response time may be a useful indicator of scale validity. This was the one scale response time that did not significantly decrease between the days. Response times of all other scales were faster during CW2 than during CW1. The correlations, however, between response times and scores for these other scales were not significant during CW2. Thus, for the other scales, sleep loss and exercise fatigue appear to affect the relationships between scale values and scale response times differently than the POMS Fatigue scale. Figure 1 shows that fast response time with denial (zero scale value) of fatigue as well as slow responses due to deliberation with higher fatigue responses contribute to the significant relationship.

Significant slowing of psychomotor reaction time in continuous workday 2 as compared to 1 was found in the present study, as in a similar earlier study (Englund, Naitoh, Ryman and Hodgdon, 1983). This was an expected result of sleep loss and exercise fatigue. In contrast, faster scale response times for most scales were seen on CW2 as compared with CW1. Apparently, questionnaire response times are affected differently by sleep loss and exercise fatigue than psychomotor reaction times. Possible explanations include: increased familiarity with the questionnaires and scales, or less inhibition of the subjects to admitting poor mood, greater fatigue and greatly increased number of symptoms making the questionnaires more pertinent. Response times to the scales used in present studies were also not related to reading speed or ability.

The differences in scale structure played a major role in response speed. The Guttman-scaled SAM Fatigue questionnaire showed longer response times than the five point Likert POMS Fatigue scale. This finding probably reflects the comparative nature of Guttman scaling. The SAM Fatigue items contain longer descriptive phrases rather than the one word adjectives found in the other mood questionnaires (see Table 1). Length alone, however, does not appear to cause longer response times. The dichotomously scaled Kogi items had the most words and letters per scale item but were, by far, the quickest to complete. Dunn, et al., (1972) found that response time among the dichotomously scaled MMPI items varied most with item length. The present findings comparing different response scales indicate that scale length and complexity contribute to longer response times.

In this and a previous similar study (Englund, et al., 1983) symptoms and the fatigue and negative scale values increased progressively, while Vigor and Positive scales showed decreased scores. The response times to the scales with negative content (fatigue, negative mood scales) were faster than those with positive content (vigor, positive mood scales). The POMS Fatigue items were more quickly answered than POMS Vigor items during both first and second workdays. The response times of NHRC Negative items were also shorter than those for NHRC positive items. This provides some support for Bower's theory (1981) of moods and memory. According to his theory, faster responses should be found for moods congruent with the subject's current state. From this theory the increasing negative scores seen in this study would be expected to be accompanied by decreasing response times. This is congruent with the subjects' increasing fatigue and lowered vigor as sleep loss and exercise-induced fatigue accumulate.

As expected, most of the extremely short response times were the result of subjects' straight-lining responses (Table 5). Straight-lining responders showed significantly faster response times than those with other response patterns. Surprisingly, however, the scale value of the straight-lining responses was not consistently different from other response patterns. This suggests that the loss of correlation between response times and scale scores during the second workday cannot be totally explained by the increased incidence of straight-lining responses.

The noon start group showed slower mood and fatigue response times during the first workday (a significant Day x Start Time interaction) as compared with those starting at midnight. This could be due to a circadian rhythm effect. The noon start group ended the first continuous workday near the period of the circadian trough for human performance (0300-0600), whereas the midnight group had been up 4 hours before they entered this period of circadian low. The noon group had significantly faster responses to these scales during the second work day than they had during the first workday. For the midnight group this difference was not significant. This suggests that sleep loss interacted with the circadian effect on scale response time. The response times were longer during the last periods of each day for both Kogi symptom and NHRC scales. This may be due to the effect of being awake for 20 hours or a loss of concentration.

SUMMARY

These results demonstrate how response times to questionnaire scales indicate reaction to scale content (congruence, intensity and denial), as well as showing scale difficulty and validity. Questionnaire response times were unlike psychomotor reaction times under these experimental conditions involving fatigue and sleep loss. These results indicate that response times to questionnaire scales could be a useful additional measure in many areas of research. With the increased use of computers in the administration of questionnaires, accurate response timing can easily be incorporated into a variety of research protocols.

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Response times (RT) in a series of computer-administered questionnaires were collected in two continuous operation time-shifted studies to evaluate how useful these measures might be in various research areas. These studies involved exercising and non-exercising subjects at two start-of-day times (noon, midnight). Thirty subjects were tested over two continuous workdays (CW1 and CW2) of 20 hrs each with a three hr nap allowed between days. The scales analyzed were the Vigor and Fatigue Scales of the Profile of Mood States (POMS), the Kogi Symptom Checklist, the School of Aerospace Medicine (SAM) Fitigue Scale, and the Naval Health Research Center Mood Questionnaire (NHRC MQ) Negative and Positive Mood Scales.

The RT to most scales were faster on CW2, whereas the symptoms, negative moods and fatigue scale values increased and the Vigor and positive scale scores decreased on CW2. There was also no relationship between the scales' RT and level of exercise. Reaction time on a simple psychomotor task was significantly slower CW2 and there was no correlations between this psychomotor RT and the Scale RT either day, suggesting a different response mechanism. In addition, there were no significant correlations between reading speed or grade level (over)

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19. ABSTRACT (continued)

with scale RTs. The significant negative correlation between the POMS Vigor scale value value and RT scale RT CW1 indicated some support to RT as a measure of intensity of mood (faster RT with higher Vigor scores). The NHRC Positive Scale showed longer RT than the Negative Scale and the POMS Vigor took longer than the POMS Fatigue scale on both days, consistent with the theory that moods congruent with the present state are more prominent in memory, causing faster RT. The items using the most complex (Guttman) scale had the longest RT while the most simply (dichotomous) scaled items had the shortest RT. The results demonstrate the RT measurement of questionnaire scales can be used as a measure of intensity and congruence of mood, as well as indicating scale validity. RT alone was not useful for indicating hasty responders (straight liners), but subjects using a constant scale response value were significantly faster (lower RT). The POMS Fatigue scale and RT were significanly correlated on both days indicating the usefulness of RT in showing scale validity (the more fatigue, the slower the response).

Scale item RT was demonstrated to be useful in showing congruence, intensity and denial to various scale content. RT also reflected the experimental conditions and indicated scale difficulty and validity, but was not found to be related to reaction time speed or reading measures.

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