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The reliability and stability of various individual difference and tolerance to shiftwork measures

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The aim of the study was to evaluate the reliability and temporal stability of various individual difference and tolerance to shiftwork measures which were used in an extensive study on relationships between shiftworkers' features and tolerance to shiftwork. The study was conducted in a Croatian oil refinery where 604 male shiftworkers, working in a 2:2:3 continuous three-shift system were examined by means of various questionnaires. A subsample of 61 shiftworkers were re-examined using the same questionnaires and the same administration procedure nine years later. The questionnaires were: Jenkins Activity Survey, Eysenck Personality Inventory, Morningness–Eveningness Questionnaire, Behavioural Arousal Questionnaire, Circadian Type Questionnaire and Inventory, Way of Life Questionnaire, Health Information Questionnaire, Sleep Quality Scale. The questionnaires were scored for 14 individual difference measures and eight tolerance to shiftwork measures. In addition to these scores sleep durations on night, morning, afternoon shifts, and on days off were used as tolerance to shiftwork measures. The reliability of each measure was determined by means of Cronbach alpha coefficients computed on a total of 604 shiftworkers and temporal stability by means of correlation coefficients between the scores obtained on two occasions on the subsample of 61 shiftworkers. The internal consistency coefficients for most of the measures ranged between moderate to high, and were considered to be satisfactory. The correlations between the scores obtained twice over a period of nine years proved both the individual difference and tolerance to shiftwork measures to be temporally stable. The only measure that had insignificant correlation was the sleep duration on days off.

1. Introduction

A number of studies have examined the relationships between the individual difference measures and tolerance to shiftwork (Monk and Folkard 1985). In recent years various questionnaires, scales, and indexes have been developed to gather data on both the individual differences (personality dimensions, life habits, circadian rhythm characteristics) and the degree of tolerance to shiftwork (sleep, health, mood etc.). However, except for the widely-used scales of extroversion, neuroticism (Eysenck and Eysenck 1964), and some scales of morningness–eveningness (Torsvall and Akerstedt 1980, Šverko *et al.* 1979, Šverko and Fabulić 1985), very little is known about the reliability and stability over time of the measures used (Heider *et al.* 1981, Nachreiner 1990).

In an extensive on-going study on relationships between shiftworkers' features and tolerance to shiftwork, the concurrent and predictive validities for various individual difference and tolerance to shiftwork measures are being evaluated

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(Vidaček *et al.* 1987a, 1987b, 1989, 1990a, 1990b). In this paper, the reliability of the instruments used, as well as the temporal stability of the individual difference and tolerance to shiftwork measures are examined.

2. Procedure

The subjects were 604 male oil-refinery shiftworkers. Their mean age was 32·1 years (range 19–61), and shiftwork experience 9·6 years (range 0·5–38). They worked in a 2:2:3 continuous three-shift system with the morning shift working hours from 06·00 to 14·00, the afternoon shift from 14·00 to 22·00, and the night shift from 22·00 to 06·00. The shifts rotated in the order of mornings–afternoons–nights followed by days off.

The subjects were administered a battery of various individual difference and tolerance to shiftwork questionnaires. The individual difference questionnaires comprised: (*a*) Jenkins Activity Survey—JAS (Jenkins *et al.* 1967) scored for Hard-driving and Competitiveness, and Speed and Impatience; (*b*) the Eysenck Personality Inventory—EPI (Eysenck and Eysenck 1964) scored for Extroversion, Neuroticism, and Lie Scale; (*c*) the Morningness–Eveningness Questionnaire—ME (Vidaček *et al.* 1977) scored for Eveningness; (*d*) the Behavioural Arousal Questionnaire—BAQ (Vidaček *et al.* 1980) scored for Relaxedness, Efficiency, and Flexibility of Behaviour; (*e*) the Circadian Type Questionnaire—CTQ (Folkard *et al.* 1978) scored for Rigidity of Sleeping Habits and Vigorousness; (*f*) the Circadian Type Inventory—CTI (Folkard *et al.* 1982) scored for Languidness, Inveterateness, and Flexibility of Habits. Tolerance to shiftwork was assessed by means of: (*a*) the Way of Life Questionnaire—WLQ (Vidaček *et al.* 1980) scored for Night Shift Tolerance and Morning Shift Tolerance; (*b*) the Health Information Part of the General Health and Adjustment Questionnaire—HIQ (Tasto *et al.* 1978) scored for Generally Poor Health, Musculo-Skeletal Complaints, Respiratory Complaints, Psychosomatic-Digestive Complaints and Digestive Problems; and (*c*) the Sleep Quality Scale (Vidaček *et al.* 1987). In addition to these scales the duration of sleep when working in different shifts and on days off was assessed by means of selected questions from the Way of Life Questionnaire.

The scoring of each questionnaire, except for the Eysenck Personality Inventory, was determined by the results of principal component analysis performed. The questionnaires and the results of factor analyses are presented elsewhere (Vidaček *et al.* 1989, 1990a, 1990b, Kaliterna *et al.* 1990).

The questionnaires were administered in a guided collective application way which was found to be the most appropriate for large investigations in industrial workers (Petz and Bujas 1961). The subjects were placed in groups of up to 20. Each subject was given a questionnaire, the examiner (psychologist) read question by question, and the subject put down his answer. All subjects were examined by the same testing procedure during their working hours in the morning shift.

A subsample of 61 shiftworkers was re-examined using the same questionnaires and the same procedure after nine years. These shiftworkers were selected for the purpose of another study as the 'extremely' tolerant or intolerant to shiftwork; 29 of them were found to be tolerant and 32 intolerant to shiftwork on the basis of their results on the Sleep Quality and Psychosomatic–Digestive Complains scales.

The mean age of this subsample when they were first examined was 30·7 years (range 21–43) and shiftwork experience 8·8 years (range 1–19). When they were re-examined their mean age was 39·9 years (range 30–53) and shiftwork experience 17·9 years (range 10–28).

3. Results

Table 1 displays the means and standard deviations of the results on the various individual difference and tolerance to shiftwork measures obtained in the overall sample of 604 shiftworkers and in a subsample of 61 who were examined on two occasions. The number of items and theoretical range of scores on each scale are also presented in that table.

Table 1. Descriptive statistics of individual difference and tolerance to shiftwork measures.

		No. items	Theoret. range	Overall sample $n=604$ M	Overall sample $n=604$ SD	Subsample $n=61$ I. M	Subsample $n=61$ I. SD	Subsample $n=61$ II. M	Subsample $n=61$ II. SD
JAS	Hard-Driving and Competitiveness	13	13–48	32·7	4·1	32·2	4·6	31·7	4·0
JAS	Speed and Impatience	13	13–49	27·3	3·5	27·1	3·9	24·2	3·7
ME	Eveningness	11	11–34	20·0	4·0	19·5	3·6	20·1	4·1
BAQ	Relaxedness	10	10–31	19·3	3·4	19·5	4·2	21·1	3·2
BAQ	Efficiency	9	9–27	18·8	3·3	18·8	3·1	20·7	2·9
BAQ	Flexibility of Behaviour	4	4–12	8·2	1·7	8·0	1·5	9·1	1·8
CTQ	Rigidity of Sleeping Habits	8	8–80	39·7	12·9	38·0	14·7	39·0	12·8
CTQ	Vigorousness	8	8–80	42·7	11·8	44·3	12·3	50·6	10·2
CTI	Languidness	15	15–90	60·5	11·6	58·2	12·3	54·8	11·3
CTI	Inveterateness	15	15–90	57·0	11·3	58·0	10·5	58·7	9·5
CTI	Flexibility of Habits	15	15–90	50·3	12·0	52·0	13·0	56·1	12·2
EPI	Neuroticism	24	0–24	12·0	4·9	11·7	4·9	10·1	5·3
EPI	Extroversion	24	0–24	14·2	2·8	13·8	2·8	14·1	3·1
EPI	Lie Scale	9	0–9	2·8	1·7	2·7	1·5	2·4	1·4
WLQ	Night Shift Tolerance	14	14–40	24·2	4·1	24·8	4·1	27·7	4·4
WLQ	Morning Sh. Tolerance	9	9–30	19·8	3·5	19·5	3·0	19·9	2·7
HIQ	Generally Poor Health	20	20–84	28·1	5·8	27·3	5·3	27·2	5·8
HIQ	Musculo-Skeletal Com.	8	8–32	12·1	3·6	11·2	3·3	12·0	3·5
HIQ	Respiratory Complaints	7	7–30	11·1	3·8	10·6	3·9	10·0	3·2
HIQ	Psychosomatic-Digestive Complaints	15	15–60	25·3	7·0	24·0	7·0	24·5	5·7
HIQ	Digestive Problems	4	4–20	5·9	3·5	5·6	2·8	5·9	3·5
	Sleep Quality Scale	7	7–23	16·5	3·4	16·2	4·6	18·8	3·0
	Sleep Durations:								
	Night Shift			5·3	1·7	5·4	1·4	5·4	1·7
	Morning Shift			6·6	0·9	6·6	0·9	6·6	1·2
	Afternoon Shift			9·0	1·4	8·9	1·4	8·6	1·2
	Days Off			9·5	1·4	9·7	1·7	8·7	1·2

The reliability of each individual difference and tolerance to shiftwork measure was determined by means of Cronbach alpha coefficients computed on a total of 604 shiftworkers. Temporal stability was determined by correlating the scores obtained on the subsample of 61 shiftworkers who were re-examined after a nine year period.

The coefficients of internal consistency for the majority of scales were moderate to high, running between 0·58 and 0·82. Taking into account that the scales vary a good deal in their length, item content, and scoring system, these coefficients could be considered satisfactory. The lower coefficients were obtained for the EPI-Extroversion (0·47), EPI-Lie Scale (0·44), HIQ-Digestive Problems (0·19) and the

Table 2. Coefficients of internal consistency and nine-year retest correlations for individual difference and tolerance to shiftwork measures.

		Cronbach alpha	*r*
JAS	Hard-Driving and Competitiveness	0·64	0·58**
JAS	Speed and Impatience	0·66	0·39**
ME	Eveningness	0·74	0·53**
BAQ	Relaxedness	0·61	0·53**
BAQ	Efficiency	0·60	0.59**
BAQ	FLexibility of Behaviour	0·37	0·31*
CTQ	Rigidity of Sleeping Habits	0·62	0·54**
CTQ	Vigorousness	0·59	0·36**
CTI	Languidness	0·64	0·35**
CTI	Inveterateness	0·72	0·57**
CTI	Flexibility of Habits	0·78	0·51**
EPI	Neuroticism	0·82	0·67**
EPI	Extroversion	0·47	0·62**
EPI	Lie Scale	0·44	0·52**
WLQ	Night Shift Tolerance	0·66	0·60**
WLQ	Morning Shift Tolerance	0·58	0·73**
HIQ	Generally Poor Health	0·84	0·65**
HIQ	Musculo-Skeletal Com.	0·82	0·60**
HIQ	Respiratory Complaints	0·74	0·38**
HIQ	Psychosomatic–Digestive Complaints	0·83	0·52**
HIQ	Digestive Problems	0·19	0·44**
	Sleep Quality Scale	0·72	0·61**
	Sleep Durations:		
	Night Shift		0·36**
	Morning Shift		0·58**
	Afternoon Shift		0·33**
	Days Off		0·19

*$p<0·05$.
**$p<0·01$.

BAQ-Flexibility of Behaviour (0·39) scales. Since the Cronbach alpha calculation is directly related to the test size, relatively poor coefficients of internal consistency for the two four-items scales (Digestive Problems and the Flexibility of Behaviour) were expected. As for the two EPI scales, the results of the principal component analysis showed that these two scales are not unidimensional (Vidaček *et al.* 1989). However, since the Eysenck Personality Inventory is widely used, it was decided to score it as originally proposed in order to be comparable with other studies' results.

The test–retest correlations were quite high, taking into account that the period between two administrations was nine years. For individual difference measures they ranged between 0·31 (Flexibility of Behaviour) and 0·67 (Neuroticism), and for tolerance to shiftwork measures between 0·38 (Respiratory Complaints) and 0·73 (Morning Shift Tolerance). The correlations for the sleep durations, except for the morning shift ($r=0·58$; $p<0·01$), were not so high as for the other tolerance to shiftwork measures and for the sleep duration on days off the correlation was not significant.

4. Discussion

Psychometrically, the instruments used in this study, with few exceptions, had quite satisfactory internal consistency. The correlations between the scores obtained in two occasions, which reflect the stability over time of the measures used, were quite high, taking into account the long period which elapsed between two administrations.

Besides assumed temporal stability of the measures used it should be pointed out the way of questionnaire administration as partly 'responsible' for relatively high correlations over a nine-year period. The guided collective application (a group of subjects are lead by the examiner from question to question) has certain advantages in comparison to some other techniques of gathering data (by mail, phone, free collective applicaton, interview). It was found to yield fewer unanswered questions than the free collective application (a group of subjects fill in a questionnaire by themselves), and fewer 'favourable' answers than interview (Petz and Bujas 1961). The guided collective application is thought to be quite reliable in terms of the subjects' frankness because it is controlled for the speed of answering, i.e., requires an immediate answer to every item. Since there is no time for evaluating and interpreting the purpose of the questions this procedure may prevent the faking or social desirability response set. The guided collective application enables the examiner to maintain uniform conditions by controlling the environment, instruments, time limits, and other factors which may increase error variance and make the scores less reliable. The fact that the questionnaires were administered under the same conditions on both occasions is also important for quite high correlations obtained, considering the long interval between two administrations.

Between the various individual difference measures the less stable one seems to be the dimension of vigorousness–languidness. Measured by two different (but similar) instruments, that dimension showed relatively low correlations between two administrations ($r=0{\cdot}36$ for the CTQ 8-item scale and $r=0{\cdot}35$ for the CTI 15-item scale). Except for that dimension, the JAS- Speed and Impatience ($r=0{\cdot}39$) and BAQ- Flexibility of Behaviour ($r=0{\cdot}31$), all other individual difference measures proved to be temporally rather stable (correlation coefficients above 0·50).

Of special interest for our further research is the fact that tolerance to shiftwork measures proved to be temporally rather stable also. With the exception of Respiratory Complaints ($r=0{\cdot}38$) and Digestive Problems ($r=0{\cdot}44$) scales, all other correlation coefficients were quite high (0·52–0·73). It is interesting to note that the mean absolute scores on various scales (see table 1) for both the individual difference and tolerance to shiftwork measures, changed very little between two administrations, which also speaks in favour of the stability over time of these measures. Such results might be partly influenced by choosing the subjects between those who were 'tolerant' and/or 'intolerant' to shiftwork. It is possible to conclude that, once established, relatively extreme level of (in)tolerance to shiftwork is quite stable over time.

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