

PSYCHOPHYSIOLOGICAL REACTIONS TO THE TASK DIFFICULTY AND PACING IN SUBJECTS WITH A DIFFERENT ANXIETY LEVEL

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A series of experiments were performed with the aim of looking into possible differences of the effects of task difficulty and pacing on some psychophysiological variables in subjects with a low and high level of anxiety. Two equivalent groups of nine subjects (except in anxiety level) performed computer generated numerical and perceptual tasks, where the numerical task had five different difficulty levels, while the perceptual tasks had three. Each of these were performed by every subject under self-paced (unpaced) and paced working conditions. The levels of pacing were equal to the subject's unpaced working level, and 15% higher. The experimental situations were rotated according to the Latin Square principles.

During the work on these (primary) tasks, the subject had to perform tapping as the secondary task. Their R-R intervals (sinus arrhythmia) were recorded continuously, together with the tapping intervals. After the completion of the task, the subjects were asked to estimate the task difficulty on Borg's scale, and to assess it by squeezing a hand dynamometer without looking at its scale.

The results showed some differences in the magnitude of certain psychophysiological parameters within the groups, which could be attributed to the effects of task difficulty and pacing.

The work-load assessment parameters indicated, that the high anxiety group experienced the tasks and pacing as more strainous, than the low anxiety group. This is especially true when estimations with a higher mental involvement had to be made. Secondary tasks parameters, however, indicated a smaller residual mental capacity in the group with high anxiety subjects which could represent an explanation of the results on the workload assessment.

Introduction:

Anxiety, as a personality variable, has been used in many investigations concerning theoretical or practical aspects of human behaviour or efficiency. According to a number of authors, anxiety accompanies experienced stress or stressful events. Lazarus (1966) in his model of stress said that reactions to perceived threat were anxiety and anger, whose persistence, according to Spielberger (1987) may result in psychosomatic problems, such as coronary diseases, elevated blood pressure or even cancer.

Spielberger (1987) talked about anxiety as two dimensional variable anxiety as a state and anxiety as a trait. State anxiety would be induced by an immediate effect of stress, while trait anxiety is a more stable personality trait, which influences human behaviour in a more permanent way.

Although there are different views and definitions of anxiety, there are several aspects where authors agree. One of them is that anxiety is an emotional reaction accompanied by a feeling of tension, uncertainty and threat, with a marked increase in the autonomic nervous system activity. Furthermore, increased anxiety may affect cognition and behaviour, as well as the affective side of personality. Finally, due to increased autonomic activity, some stereotype physiological reactions take place, such as an increase in cardiac and respiratory output, blood pressure, muscular tension etc. Although it is common knowledge that different states, such as fear, emotional tensions, fatigue, illness etc., may markedly affect general mental capacity, the state of anxiety, therefore, could also have effects on certain mental processes, especially on some aspects of information processing. This could result in an inadequate perception and assessment of environmental stress, which would be followed by higher psychophysiological reactions. This would mean that the same level of stress could cause higher psychophysiological reactions and could result in a higher estimation of stress in high anxiety subjects, while their efficiency may be expected to be poorer.

The aim of this study was to find out whether this hypothesis of different effects of stress on subjects with different level of anxiety can hold. Apart from standard sources of stress (different levels of task difficulty), it was thought that pacing stress could be appropriate for this purpose, since it has been confirmed earlier that it affects subjects in a different way than the workload of the same magnitude under self-paced (unpaced) conditions (Manenica, 1978; Charnock & Manenica, 1979; Manenica & Krosnjak, 1990 etc.). When combined with a varied workload (task difficulty), pacing stress could be differently experienced by low and high anxiety subjects. This also might differently affect their mental processing, which could be assessed via the difference in the residual mental capacity, by the use of a secondary task. The same effects might be reflected in different kinds of stress assessment, depending on the complexity of the assessment. In a study of mental load assessment by Manenica

(1987), a standard Borg's scale was used together with a hand dynamometer for estimation of mental load, where apart from assessing it on the scale, the subjects were asked to repeat the assessment by squeezing the hand dynamometer, correspondingly to the experienced load, without looking at its scale. The author argued that assessment on the dynamometer involved more complex mental processing (matching), than an assessment on a semi-descriptive scale, such as Borg's. The estimations on the dynamometer involved several stages of "cross-modality" matching, while estimation on the scale included fewer, more or less straight-forward attributions to the experienced task-load. Furthermore, one may argue that estimations on the dynamometer have some psychometric advantages. One of them would be the sensitivity and the continuity of the dynamometer scale, as opposed to the implicit category type scaling. The other advantage is the possibility of expressing the individual results in relative terms, i.e. related to the individual maximal hand-grip strength, giving, thus the results with a common point of reference for different subjects.

Due to the differences in the processes underlying the two kinds of assessment, some differences in estimations of the task related stress could be expected between low and high anxiety subjects.

Although there is a paucity of evidence *pro* or *contra* these arguments, this investigation was undertaken with the aim of trying to obtain some answers to these tentative hypotheses.

Method:

An anxiety questionnaire (16 PF), which consisted of 60 items, was administered to a group of 63 subjects, 20-25 years of age. For the purpose of this investigation, a group of nine extreme low-score subjects, and a group of nine extreme high-score subjects were selected. Their mean scores differed significantly ($t=12.52$, $df=16$, $p < 0.001$). Apart from the anxiety scores, the group did not differ in anything else what was thought that could be relevant for this investigation.

The two groups of subjects were trained to perform computer generated numerical and perceptual tasks. The numerical tasks, which involved addition and subtraction, had five levels of difficulty. The tasks consisted of one, two or three digit numbers which appeared in pairs with an addition or a subtraction sign (indicating the operation) and the result. By pressing one of the two buttons on the keyboard (Y/N), the subject had to decide whether the result was correct or not. The perceptual task included identification of the position of three different characters (o, * and +), which appeared on the screen arranged in two squares. The arrangement could be in 3 x 3, 4 x 4 and 5 x 5 squares, which represented three different levels of task difficulty. The subject's task was to identify whether the positions of the characters in the two squares (which appeared at the same time) were identical or not. His response consisted of pressing one of the two buttons on the keyboard (Y/N).

The time, from the moment when the squares appeared on the screen to the

response, was registred together with the errors for each trial separately.

The subjects worked under self-paced (unpaced) working condition, where their instruction was "to work as fast as they could", and paced working condition where they were given a limited time to complete the task. There were two pacing levels, where in one, the subject was paced at his individual self-pacing rate (mean unpaced time) while the other was set-up at 15% higher pacing rate. The experimental situations were arranged according to the Latin Square principles. Every experimental session lasted five minutes, followed by three minutes resting pause.

Apart from these tasks, the subject was given a secondary task, i.e. ordinary tapping, to perform together with primary tasks. He was asked to do tapping on a microswitch, connected with the computer, as regulary as possible. The time intervals between successive touches of the microswitch were recorded in milliseconds. At the same time, by the use of three electrodes and a poligraph the subject was connected to the computer, where his R-R cardiac intervals (sinus arrhythmia) were continuously recorded.

After the completion of the task, the subjects were asked to estimate the difficulty of just completed task on Borg's 21 point scale (Borg, 1973), and by squeezing a hand dynamometer without looking at its scale.

After the completion of the experiments, the whole procedure was repeated by the same subjects in the reverse order.

Results and Discussion:

The obtained results were processed through the standard statistical procedures, where the means for each variable were worked out,, for the two groups in every experimental situation separately (Tables 1. and 2.). The results obtained on Borg's scale were transformed into equivalents of task difficulty in bits, according to the model proposed by Manenica and Krosnjar (1990). The model implies a linear transformation of the estimates, expessed on a standard scale with the mean 10 and $sd = 2$, directly into equivalents of bits ($y = 5.32 + 1.33x$), with thw advantage of comparisons of the results obtained in different situations.

The individual results of task load assessment on the dynamometar were divided by the subject's maximal handgrip strength and multiplied by 100, which meant the possibility of their direct comparasion regardless of the differences strength amongst the subjects.

The analysis of variance showed significant differences amongst the task parameters in different experimental situations, and pacing conditions (Table 3.). No difference was found, however, between the low and high anxiety groups regarding the task parameters.

Mean of R-R intervals reflected the task situations in high anxiety group in numeric and perceptional tasks, while it did not show any effects in low anxiety group. The sd parameter showed the effects of task difficulty in high anxiety group for

perceptual tasks. No differences in the cardiac parameters were found between the two groups of subjects, indicating that these physiological variables were similarly affected by the task in both groups.

Tapping task parameters (mean and sd) reflected the task difficulty in both groups of subjects during numeric task, while the mean only changed significantly during perceptual task in high anxiety group. Both parameters, however, differed significantly between the two groups, showing much longer and more variable tapping intervals in high anxiety group during numeric and perceptual tasks. Considering that the main task parameters did not differ significantly between the groups, the difference in tapping parameters could be attributed to the difference in the residual mental capacity between the high and low anxiety groups while doing the same task. The assessment of the task difficulty on the dynamometer seem to point in the same direction. The results showed that the high anxiety group overestimated the difficulty of both tasks in comparison with the low anxiety group, although there were no significant effects within the groups.

Pacing, as could be expected, affected the time on the task, where the shortest time was achieved at the fastest pacing rate, and the longest at self-paced working rate.

Significant pacing effects were found on R-R intervals, but these were not ready interpretable. The most consistent effects of pacing were shown on the sd parameter of tapping intervals, where their irregularity followed the pacing rate in both groups of subjects and on both tasks, suggesting thus decrement in the residual mental capacity as the pace rate increased. Pacing also affected assessment on the dynamometer in all situations, apart from high anxiety group on numeric task.

The results of this investigation did not completely support the initial tentative hypothesis of possible differences in efficiency and some psychophysiological reactions between high and low anxiety groups of subjects. First of all these results did not give any consistent indication of differences in task efficiency between the two groups. Secondly, the level of psychophysiological indices (mean and sd of R-R intervals) were more or less the same in both groups through the experiment.

The significant differences between the groups, however, were found in the secondary task parameters suggesting a smaller residual mental capacity in high anxiety group of subjects. This could mean that anxiety induces some kind of "noise" in the information processing system, which could not be detected in the changes of other variables, but in the level of mental engagement on the task. This was also supported by the differences in the task difficulty assessment on the dynamometer where the difficulty was assessed as significantly higher by the high anxiety group.

If these results were verified by some future investigations, it could be said that anxiety affects higher mental functions connected with information processing, rather than the level of changes in some bodily variables such as the cardiac output. This could, nevertheless, mean impairment in some aspects of efficiency in tasks involving information processing.

Table 1. The variables parameters in high (HAG) and low (LAG) anxiety groups during numeric task

Working condit.	Estim.task difficulty (bits)		Time on the task (s)		Percentage of errors & misses		R-R intervals (ms)				Tapping int.(ms)				Dynamo.(relative)	
							Mean		sd		Mean		sd		HAG	LAG
	HAG	LAG	HAG	LAG	HAG	LAG	HAG	LAG	HAG	LAG	HAG	LAG	HAG	LAG	HAG	LAG
SP	2.7	1.6	1.0	1.0	3.7	2.6	756	762	77	80	501	392	95	85	60.9	35.5
	2.9	2.7	1.3	1.5	5.2	3.6	763	761	77	76	502	385	91	81	59.6	37.0
	3.9	3.9	1.8	1.9	7.4	7.0	754	756	76	75	508	378	89	80	65.0	42.7
	3.7	4.0	1.8	2.1	4.7	3.4	751	758	77	77	510	380	88	82	61.3	43.8
	4.4	5.2	2.1	2.5	6.7	7.1	761	755	76	77	512	379	87	74	68.1	42.6
PM	2.7	2.5	0.8	0.8	5.1	5.9	771	772	76	78	469	378	94	94	57.9	44.2
	2.8	3.4	1.0	1.0	6.0	8.6	782	768	76	78	480	378	95	90	58.4	45.7
	3.8	3.5	1.4	1.4	6.6	7.0	783	773	80	78	487	372	89	77	63.8	45.0
	3.9	3.9	1.3	1.4	5.3	7.0	777	770	78	79	483	371	88	82	67.8	48.6
	4.2	4.2	1.5	1.7	5.8	8.0	779	775	77	79	485	374	86	79	68.1	48.5
P15	2.4	2.6	0.8	0.8	8.2	7.6	743	760	73	78	482	386	101	95	61.0	46.6
	3.4	3.1	0.9	0.9	8.0	10.9	751	773	73	79	481	385	97	92	61.3	51.1
	3.7	3.7	1.3	1.3	8.4	11.2	750	776	72	78	486	387	98	87	66.1	52.7
	3.4	3.9	1.3	1.4	8.0	10.0	748	779	72	80	492	381	97	87	67.0	52.6
	4.0	4.1	1.5	1.5	8.3	10.5	751	770	73	77	510	382	98	87	68.8	55.6

N.B. SP = self - paced work
 PM = paced at self - paced rate
 P15 = paced at 15 % higher rate

Table 2. The Variables' parameters in high (HAG) and low (LAG) anxiety groups during perceptual task

Work. cond.	Estim.task difficulty (bits)		Time on the task (s)		Percentage of errors & misses		R-R intervals (ms)				Tapping int.(ms)				Dynamo.(relative)	
							Mean		sd		Mean		sd		HAG	LAG
	HAG	LAG	HAG	LAG	HAG	LAG	HAG	LAG	HAG	LAG	HAG	LAG	HAG	LAG	HAG	LAG
SP	2.5	2.4	2.2	2.2	5.0	7.3	786	811	90	85	481	352	69	62	56.2	39.6
	3.6	3.4	3.0	3.3	10.8	7.8	778	803	87	84	480	353	66	62	58.0	42.2
	4.4	4.7	4.4	5.0	13.1	11.7	783	808	90	88	492	348	69	56	61.8	42.6
PM	3.1	2.5	1.8	1.8	11.5	7.7	783	788	83	85	480	356	76	70	62.8	41.4
	3.3	3.4	2.7	2.8	11.1	9.1	772	784	84	86	487	351	74	66	63.3	44.2
	4.0	4.4	4.0	4.1	9.4	12.0	779	786	85	86	496	354	73	64	65.4	49.8
P15	3.0	2.6	1.7	1.7	16.2	14.8	789	781	88	80	463	354	71	70	61.5	42.3
	3.4	3.4	2.5	2.6	14.5	14.7	784	788	90	81	468	350	70	71	67.0	47.3
	3.9	4.2	3.4	3.6	16.0	16.3	783	782	85	84	475	356	71	72	64.7	48.5

N.B SP = self - paced work
 PM = paced at self - paced rate
 P15 = paced at 15 % higher than self - paced rate

Table 3. Effects of experimental variables:

Variable	Effects	within the groups						between the groups			
		NUMERIC TASK			PERCEPTUAL TASK			NUM.	PERC.		
		F - test			F - test			F - test	F - test		
		df	HAG	LAG	df	HAG	LAG	Effects	df		
Estim. task difficulty (bits)	TS	4/8	22.12**	10.79**	2/4	11.83*	85.66**	P	2/2	1.16	18.99*
	P	2/8	0.47	0.03	2/4	0.09	0.03	A	1/2	0.43	0.03
Time on the task (s)	TS	4/8	39.89**	14.70**	2/4	62.75**	73.26**	P	2/2	37.72*	37.74*
	P	2/8	31.18**	20.24**	2/4	12.49*	10.53*	A	1/2	2.93	4.57
Percentage of errors & misses	TS	4/8	2.88	3.98*	2/4	0.35	12.85*	P	2/2	7.70	300.39**
	P	2/8	19.85**	27.17**	2/4	3.61	47.28**	A	1/2	1.07	9.68
R-R intervals (Mean)	TS	4/8	3.84*	0.27	2/4	10.07*	0.14	P	2/2	1.48	4.90
	P	2/8	17.46**	9.44**	2/4	8.53*	31.56**	A	1/2	0.44	9.36
R-R intervals (sd)	TS	4/8	1.93	0.89	2/4	0.02	4.75	P	2/2	0.66	0.59
	P	2/8	11.17**	1.85	2/4	3.93	12.00*	A	1/2	1.97	1.29
Tapp. intervals (Mean)	TS	4/8	4.59*	3.87*	2/4	26.37**	0.61	P	2/2	2.78	1.83
	P	2/8	26.12**	15.43**	2/4	60.41**	0.73	A	1/2	360.3**	646.7**
Tapp. intervals (sd)	TS	4/8	5.40*	7.28**	2/4	2.25	1.29	P	2/2	23.70*	14.23
	P	2/8	28.24**	11.84**	2/4	22.75**	13.59*	A	1/2	56.53*	26.17*
Dynamo. (relative)	TS	4/8	11.80**	8.42**	2/4	3.54	9.21*	P	2/2	0.80	50.05*
	P	2/8	1.46	57.88**	2/4	9.38*	6.97*	A	1/2	105.1**	582.4**

N.B. TS = task situation
 P = pacing
 A = anxiety

* $p < 0.05$
 ** $p < 0.01$

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Ilija Manenica : PSIHOLOGIJSKE REAKCIJE ISPITANIKA S RAZLIČITIM STUPNJEM ANKSIOZNOSTI NA TEŽINU ZADATKA I RADNI RITAM

S u m m a r y

Serijom eksperimenata se htjelo provjeriti da li se opterećenja numeričkim i perceptualnim zadacima, te različitim ritmom rada, različito odražavaju na neke psihofiziološke reakcije ispitanika visokog, odnosno, niskog stupnja anksioznosti. Dvije ekvivalentne skupine ispitanika (osim po stupnju anksioznosti) radile su kompjuterski generirane numeričke i perceptualne zadatke, gdje su prvi zadatci imali pet različitih razina opterećenja, a drugi tri. Sve ove zadatke radili su ispitanici u uvjetima slobodnog i u uvjetima nametnutog radnog ritma. Nametnuti ritam bio je jednak ili 15% viši od prosječnog individualnog ritma rada u uvjetima slobodnog ritma. Eksperimentalne situacije rotirane su po principu latinskog kvadrata.

Za vrijeme rada na ovim (primarnim) zadacima, ispitanici su izvodili jednostavni tapping kao sekundarni zadatak. Njihovi R-R intervali (sinus aritmija) i tapping intervali kontinuirano su registrirani na kompjutoru, zajedno s vremenom rada i pogreškama u primarnom zadatku. Po završetku svakog zadatka, ispitanici su procjenjivali njegovu težinu na Borgovoj skali i stiskom ruke na ručnom dinamometru bez gledanja u skalu dinamometra.

Analiza rezultata je pokazala razlike u veličini nekih psihofizičkih parametara unutar dviju skupina ispitanika, koje se mogu pripisati efektima težine zadataka i radnog ritma. Analiza procjene težine zadataka pokazuje da visoko anksiozna skupina procjenjuje zadatke i radni ritam značajno napornijim, nego skupina s nižim stupnjem anksioznosti. Ovo je naročito evidentno kad se radi o procjenama koje zahtjevaju veće mentalno angažiranje (procjene na dinamometru). Parametri sekundarnog zadatka ukazuju, međutim, da je kod ispitanika s visokom anksioznošću značajno manji rezidualni mentalni kapacitet, nego kod nisko anksioznih ispitanika za vrijeme obavljanja istih zadataka. Ovo donekle objašnjava i razlike u procjeni težine zadataka i radnog ritma među dvjema skupinama.