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Full Papers

Psychophysiological reactivity in Type A and B women during a rapid information processing task

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Summary. Type A and Type B women assessed by a newly developed German questionnaire 'need for control' (NC) were compared with respect to time-pressured information processing performance and to simultaneously recorded psychophysiological reactivity. The task was computer controlled, monetarily reinforced and subject paced. The physiological measurements included the cardiovascular parameters, ECG and finger plethysmographic amplitudes and the noncardiovascular parameters, EMG (frontal muscle), skin conductance reactivity, and respiration. NC-Type A and Type B women did not differ in performance, but the Type As showed stronger vasoconstrictive responses to the task than did the Type Bs. Other physiological intergroup differences were not seen. In addition, the Type As scored significantly higher in nervousness and irritability and marginally higher in depression, reactive aggressivity and neuroticism than did the Type Bs. This particular pattern of NC-Type A/B differences is discussed with regard to relevant differences observed by other studies between SI and JAS Type As and Bs.
Key words. Type A; Type A questionnaire; 'need for control' (NC); rapid information processing; performance; psychophysiological reactivity; personality.

A variety of measurements and procedures have been used to assess patterns of the coronary prone Type A behavior (TABP), which is mostly characterized by aggressivity, achievement striving, time urgency and impatience.

Although different types of TABP measurements appear to be intrinsically reliable and reproducible, they assess different behavioral aspects of the TABP syndrome[24]. Particularly the profile of TABP as defined by the Rosenman Structured Interview differs from that defined by the JAS questionnaire. The JAS has been directed mainly at assessing the competitive striving of Type A persons. So it is not surprising that JAS-A individuals usually report higher educational levels and also that they mostly attain a higher occupational status than JAS-B individuals.

Furthermore, several studies examining laboratory performance on different tests reported higher performance levels in JAS-As than in JAS-Bs, and this was particularly when the tests were difficult or called for persistence and endurance[6]. In contrast to performance, psychophysiological reactivity does not seem to differ between JAS-Type As and JAS-Type Bs.

Rather opposite results were reported with the SI assessment: SI-Type As mostly showed a stronger psychophysiological reactivity than SI-Type Bs, whereas most studies failed to reveal differences in performance[24].

Recently, a new questionnaire[10] for assessing TABP has been developed in German. In contrast to the JAS, it is based mainly on the dimension 'need for control'[14]. Its reliability and validity for the CHD risk have so far been verified in retrospective studies (Prof. Siegrist, Marburg). The present study made use of this new German questionnaire 'need for control' (NC). The question to be studied was whether NC-Type As would perform more like JAS-Type As or more like SI-Type As with respect to performance and psychophysiological reactivity. Performance and psychophysiological reactivity were assessed simultaneously while the subject performed a challenging rapid information processing task (RIP). The task was computer controlled and monetarily reinforced, and its difficulty was continuously adapted to the subject's actual performance. Thus it involved situations of loss of control, time pressure, and fatigue, all of which are rather generally considered as important factors in TABP[14,24]. In addition to the conventionally used cardiovascular parameters blood pressure and heart rate, the psychophysiological measurements included finger plethysmogram amplitude, EMG of the frontal muscle, respiration, and skin conductance reactivity.

A large pool of female subjects was available[25] for the present study. From this pool two groups were selected representing extremes on the 'need for control' scale. Although most studies on TABP carried out so far involved male subjects, there is also a series of reports on this behavioral phenomenon in females[12,19,20,26], suggesting it to be more frequent in employed women than in housewives[33].

Method

1) Subjects. 20 female paid volunteers (between 28 and 57 years old) participated in the experiment. They were selected as low ($x = 8.20$, $SD = 2.13$) or high extremes ($x = 29.1$, $SD = 2.97$) according to the 'need for control' questionnaire in a previous survey study.

Educational level was slightly higher in the Type B subjects: 3 Type Bs had an education beyond secondary school (none among the Type As), 2 a university education (one among the Type As).

Each subject was paid 20.– Sfr. with an additional premium for performance in the rapid information task. All subjects reported themselves to be in good health.

2) Performance task. The present test constitutes a modification of the rapid information processing task (RIP) described by Wesnes and Warburton[35]. Single digits (8×12 cm in size) in yellow on a blue background were presented on a screen in a pseudorandom sequence. The subjects were seated in a comfortable chair at a distance of 2.5 m in front of the screen and were required to press a button whenever the last three digits were either even or odd.

Frequency of digit presentation was initially set to 100 digits/min and was subsequently adapted to the subject's performance by decreasing the interstimulus interval after each correct response and by increasing it after each error of commission or omission in steps of 40 msec. The continuously recorded frequency of digit presentation was used as the measure of RIP performance.

3) Physiological recordings. Continuous polygraphic registration of the physiological signals and of performance level were done as described earlier[4,5,31]. Beckman Ag-AgCl electrodes were attached to obtain the bioelectrical signals for ECG (bipolar electrode setting V5-V6), EMG (musculus frontalis), and skin conductance (inner side of the left foot). Miniature infrared sensors (STRT-850) were attached at the tip of the middle finger of the non-dominant hand[23,30] for recording subcutaneous vascular activity.

Respiration was registrated with the strain gauge method. All physiological signals and performance, as represented by the intervals of digit presentation, were displayed polygraphically with an eight channel Beckman Dynograph Recorder (Type RM, 8 standard) in an adjacent monitoring room and stored in digital form on magnetic tape with a precision tape recorder (SP7, Stellavox) by using a pulse code modulation system (PCM, 8K10 Johne & Reilhofer Ltd).

4) Testing procedure. All experimental sessions started between 13.00 and 17.00 h and were carried out according to the following experimental protocol:

After attaching the electrodes and the strain gauge, the subjects were instructed how to perform the RIP task.

This was followed by a 10-min familiarizing and training period. Then the experiment started with a 10-min relaxation period used to obtain baseline values for the psychophysiological recordings. This was followed by the first 30-min RIP trial, a subsequent second 10-min relaxation period and the second 30-min RIP trial. The experiment ended with a last 10-min relaxation period. Throughout the experimental sessions the subjects were left alone in the sound-dampened room except for the initial instruction phase.

After the experiment the subjects were presented with a German version of the Bortner scale[3] and with a German version of the Eysenck personality inventory (FPI)[11].

5) Data processing and statistical analysis. The continuously recorded physiological and performance data were transformed by a laboratory computer (PDP11/34) so as to obtain means and standard deviations for successive 30-sec blocks. This reduced data set was then transferred to a large scale CDC-computer and statistically analyzed by using SPSS and BMDP software systems. The analysis was based on repeated measure ANOVAs of covariance by including the variables age and the personality dimensions which differed significantly by t-test criteria between the two groups (Type A/B) as covariables. For the measurements with absolute values (pulse rate, frequency of spontaneous skin conductance fluctuations, and respiratory movements), the baseline values served as an additional covariable. This ANCOVA included additionally a trial factor in order to compare between the two RIP trials, a subtrial factor for analyzing developments within the two RIP trials, and a grouping factor to compare Type A and Type B subjects.

Results

The average personality scores as obtained by the FPI questionnaire for the two groups are shown in table 1. Significantly higher scores for nervousness and irritability in Type As than in Bs were paralleled by marginally significant differences for neuroticism, reactive aggressivity, and depression. Based on the Bortner scores the NC-Type A subjects reached an average of 202.4 (±32.5), the NC-Type B subjects an average of 153.7 (±38.3). The Kendall correlation coefficient between the two classifications reached $r = 0.42$ ($p < 0.05$).
The group averages for performance and all physiological variables are shown graphically in their development across the successive 3-min subtrial blocks for the entire experiment in the figure.

Table 1. Average personality scores for the two groups

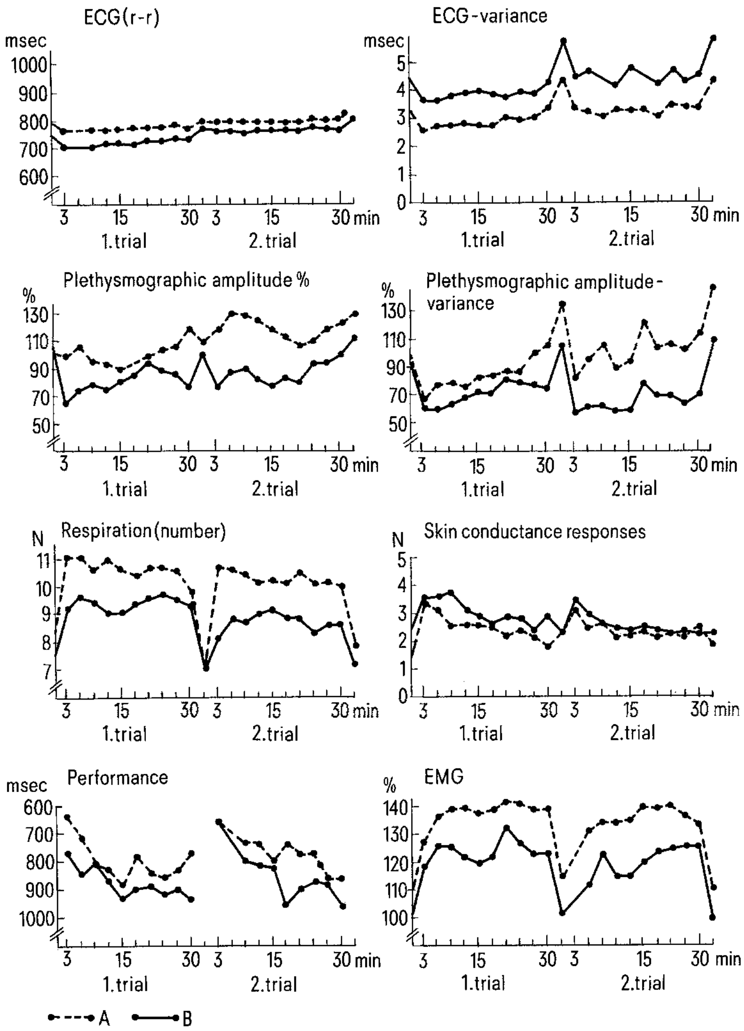
Dimension	A scores	B scores	t	p
Nervousness	4.8	2.8	2.65	0.02
Spontaneous aggressivity	6.1	5.0	1.22	n.s.
Depression	5.3	3.6	1.89	0.10
Irritability	5.4	3.4	2.11	0.05
Sociability	5.2	4.9	0.32	n.s.
Self-confidence	4.9	4.1	0.93	n.s.
Reactive aggressivity	5.9	4.3	1.80	0.10
Restraint	4.4	4.8	−0.41	n.s.
Openness	4.5	5.5	−1.48	0.20
Extraversion	5.5	4.6	0.68	n.s.
Neuroticism	5.2	3.7	1.87	0.10
Masculinity	5.4	6.6	−1.44	0.20

The results of the ANOVAs done separately for each variable are shown in table 2.
With heart rate, the gradual increases seen in the figure across the experiment reached significance for the trial and subtrial factor, but not for the differences between the two groups. For heart rate variance the result was the same, except that for this variable the trial × subtrial interaction also reached significance. In addition, for this variable the initial baseline values also reached significance as cofactor.
Both the photoplethysmographic pulse amplitudes and their variance differred significantly between the two groups, substantiating thus the observation in the figure that the Type As did not recover from the initial vasoconstriction, whereas a gradual vasodilatation developed in the Type Bs. The variance of the pulse amplitudes was further significantly affected by the subtrial factor and with marginal significance by the FPI dimensions depression and neuroticism as cofactors.
Respiration and skin conductance reactivity (number of fluctuations) were both significantly affected by the trial factor underlying the development of habituation as is evident in the figure. In addition to this main result skin conductance reactivity was further significantly affected by the subtrial factor and respiratory frequency by the initial baseline value as cofactor.
The EMG potentials increased within both trials rather rapidly from the initial values to relatively stable levels and this amounted to significance for the subtrial factor. The greater increase, as suggested by the figure, for the type Bs than for the Type As, however, reached significance only marginally.
Performance, finally, showed both the expected trial to trial improvement and within trial decreases which produced significance both for the trial and subtrial factors

Table 2. Analysis of covariances. F-values

Factors	Physiological parameter Performance	Heart rate	Heart rate variance	Photoplethys-mographic finger	Photoplethys-mographic finger variance	EMG	No. Skin conductance reaction	No. Respiration
Group	F(1, 14) = 2.43	F(1, 16) = 1.1	F(1, 16) = 0	F(1, 17) = 4.6*	F(1, 15) = 13.9**	F(1, 16) = 3.9*	F(1, 16) = 1.1	F(1, 16) = 0.7
Trial	F(1, 14) = 15.4**	F(1, 17) = 3.60***	F(1, 16) = 12.8**	F(1, 17) = 2.4	F(1, 17) = 0.5	F(1, 17) = 1.9	F(1, 17) = 7.8*	F(1, 17) = 13.4**
Subtrial	F(9, 126) = 10.3***	F(9, 153) = 3.6***	F(9, 153) = 1.8*	F(9, 153) = 1.7	F(9, 153) = 4.4***	F(9, 153) = 3.5***	F(9, 153) = 16.4***	F(9, 153) = 0.9
Group × trial	F(1, 14) = 0.2	F(1, 17) = 3.3(*)	F(1, 17) = 0.6	F(1, 17) = 0.6	F(1, 17) = 1.8	F(1, 17) = 0.1	F(1, 16) = 3.8(*)	F(1, 17) = 1.4
Group × subtrial	F(1, 153) = 1.1	F(9, 153) = 0.4	F(9, 153) = 0.7	F(9, 153) = 1.4	F(9, 153) = 0.7	F(9, 153) = 0.3	F(9, 153) = 0.8	F(9, 153) = 1.2
Trial × subtrial	F(9, 126) = 2.87**	F(9, 153) = 1.0	F(9, 153) = 1.98	F(9, 153) = 1.2	F(9, 153) = 1.3	F(9, 153) = 0.7	F(9, 153) = 1.9(*)	F(9, 153) = 0.8
Group × trial × subtrial	F(9, 126) = 1.2	F(9, 153) = 1.1	F(9, 153) = 0.4	F(9, 153) = 1.3	F(9, 153) = 0.3	F(9, 153) = 0.5	F(9, 153) = 2.0*	F(9, 153) = 1.0
Significant covariables			Baseline F(1, 16) = 215.7*** r = 0.95		Depression F(1, 15) = 3.7 r = 0.12(*) Neuroticism F(1, 15) = 3.1 r = 0.12(*)	Reactive aggression F(1, 16) = 4.0 r = −0.04(*)	Baseline	F(1, 16) = 19.0*** r = 0.83

(*) = p < 0.1, * = p < 0.05, ** = p < 0.01, *** = p < 0.001.



Group averages for the physiological variables and the performance across successive 3-min subtrial blocks across the whole experiment.

and for their interaction. No group differences, however, appeared.

Discussion

The question to be studied was to see whether NC-type As would behave more like JAS-Type As or more like SI-Type As with respect to performance and psychophysiological reactivity. The 20 female subjects were thereby selected as extreme As or Bs by the newly developed questionnaire 'need for control' (NC). The present experiment reveals no group differences for performance, but a significant performance decrease within the trials and a significant improvement from one trial to the other.

On the other hand, for the physiological parameters significant group differences were obtained for the two closely related cardiovascular parameters, the finger pulse amplitudes and their variance. No significant group differences could be shown for the other physiological parameters. On the other hand, significant trial effects, indicating intertrial habituation of stress reactivity, were observed for heart rate, heart rate variance, skin conductance responses, and respiration, while significant subtrial effects, indicating intratrial habituation of stress reactivity, were seen for the same variables with the exception of respiration, but additionally with EMG and finger pulse amplitude variance.

The FPI personality scores irritability, nervousness, depression, neuroticism, and reactive aggressivity were higher for the NC-Type A than for the NC-Type B females.

Performance level failed to differ between NC-As and NC-Bs. As reported by Matthews[24], studies done with SI-defined subjects failed mostly to reveal A/B differences in performance, while with JAS-defined subjects A/B differences are often reported. In this aspect, therefore, the NC-As are more comparable to SI- than to JAS-defined Type A subjects.

An interesting result is the finding of a higher vasoconstrictive reactivity in NC-A than in NC-B women. Since A/B differences in cardiovascular reactivity were reported more frequently for SI- than JAS-defined subjects, NC-defined Type As might at first be compared with SI-defined Type As.

However, since most other studies were limited to measurements of heart rate, blood pressure[15,17,22], catecholamines, and cortisol[12,13], and since significant A/B differences for SI-defined subjects were reported for systolic blood pressure, heart rate, and occasionally for the catecholamines, our result is not a priori comparable. So far, there are only a few Type A/B studies which assessed microcirculation by measuring pulse amplitudes[1,8,9,16,28,34], but the results are rather ambiguous: Scherwitz et al.[28] found A/B differences in finger vasoconstriction for SI-defined subjects, with greater vasoconstriction for Bs than for As, but failed to see any relation of this phenomenon to the JAS scores of the same subjects. Baker et al.[1] and Diamond and Carver[9] also found no A/B differences in finger vasoconstriction with JAS subjects. On the other hand, for SI-subjects, no A/B differences were seen in the studies of Dembroski et al.[8], Jennings and Choi[16], and Ward et al.[34].

Quite another cardiovascular parameter, forearm vascular resistance, was used by Williams et al.[37] in combination with a mental arithmetic task. He found this parameter to differentiate best Type A and B males, defined by both extreme JAS and SI scores. But it is important to note that the same experiment done with JAS/SI-defined women failed to reveal group differences. This particular result underlines the as yet unresolved problem of sex differences. Although the clinical relationship between Type A and CHD has been demonstrated in females[2,36] as well as in males, several studies suggest that the Type A behavior pattern may be expressed differently in the two sexes depending on the type of challenge[12,21]. Additionally, all studies done so far with females were carried out with college-aged women with the exception of that of Lawler et al.[18,19], who compared within the same experiment college-aged[19] and 25-55-year-old[18] women. In these studies physiological (JAS) A/B differences were observed in the older, but not in the college-aged women. The higher scores for NC-As than for NC-Bs in irritability, nervousness, depression, neuroticism, and reactive aggressivity are consistent both with personal observations[27] and with several studies: Chesney et al.[7] found correlations of Framingham Type A scores with anxiety, neuroticism, and depression in middle-class, employed men. Lundberg[20] could show with JAS-Type A women higher scores in anxiety, aggression, and neuroticism.

In the present study, variance of finger pulse amplitudes was marginally correlated with depression and neuroticism. Interestingly, finger pulse volume is also reported as an important measure of certain personality factors other than the Type A behavior pattern, such as anxiety in response to social threat[29], nervousness, irritability, and neuroticism[32]. These relationships could be an explication for the rather confusing results reported with this parameter in the literature. They suggest that A/B differences in cutaneous vasoconstriction might be the indirect result of a task-personality interaction rather than a direct result of the personality dimensions per se. In this sense, the German NC-personality dimension seems worthy of study in future experiments.

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Short Communications

Adaptive heart and breathing frequencies in 4 ecologically differentiating chromosomal species of mole rats in Israel

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Summary. Breathing (f_R) and heart (f_H) frequencies decreases as aridity increases in 4 chromosomal species of the *Spalax ehrenbergi* that inhabits humid to arid habitats in Israel in the order 2n = 52, 58, 54, 60. Breathing frequencies were 50.0, 46.9, 45.9, and 43.4% of the expected values, and f_H were 37.6, 32.7, 27.8, and 25.8% for 2n = 52, 58, 54, and 60, respectively. The decrease of f_R and f_H has a genetic basis and correlates with the metabolism of the mole rat.
Key words. Physiological adaptation; speciation; subterranean mole rat.

The actively speciating superspecies *Spalax ehrenbergi* has recently radiated into 4 chromosomal species while colonizing increasingly arid zones. The species 2n = 52 inhabits the humid northern region of Israel, and the 2n = 58 is situated in a less humid region south of the 2n = 52. To the northeast lies the range of the 2n = 54 in the drier Golan Heights[1,2], and the species 2n = 60 lives in the southern, most arid part of its distribution range. Radiation into new ecological niches should be concomitant with physiologic adjustments[3,4]. Adaptation to fossorial life in the underground atmosphere (hypoxia and hypercapnia) greatly affects almost every mechanism along the gas transport system of the mole rat[5–8]; therefore, one would expect to find differences between the 4 chromosomal species in their gas exchange physiology, which is under selective environmental pressure[9]. In the present study we compared resting breathing frequency (f_R) and resting heart frequency (f_H) of the 4 chromosomal species. Frequency of both heart and respiration in the mole rat is very low compared to that found in similar-sized mammals, which is typical of adaptation to an underground atmosphere[6,7]. Therefore, 2 opposing trends may be suggested for the mole rat: (1) If a hypoxic-hypercapnic environment selects for low f_H and f_R, then in the north, where precipitation clogs the air pores in the heavy soil (2n = 52), low f_R and f_H are expected compared to the aerated lighter, dry soil of 2n = 60. (2) The metabolic rate of mole rats decreases as aridity increases[3,4]. A reduced 0_2 demand from 2n = 52 to 2n = 60 is expected to correlate with reduced convection of both air and blood, and therefore f_H and f_R are expected to decrease from the humid (2n = 52) to the arid (2n = 60) habitats.

Materials and methods. Thirty-seven mole rats were used in the experiment. The f_H and f_R were not measured in every animal; thus, f_R was measured in 30 mole rats, and f_H was monitored in