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Effects of extraversion and neuroticism on performance in Fitts Tapping tasks

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The aim of this study was to examine the differences in performance between extraverts and introverts, as well as between neurotic and stable subjects, in Fitts' Tapping Task (FTT). Forty subjects classified into the four personality categories according to the EPI questionnaire (10 in each), performed twelve original FTT, with the task difficulty ranging from one to six bits. The results showed the difference in performance between introverts and extraverts, but no differences were found between neurotic and stable subjects. Introverts achieved higher scores in easier tasks, while extraverts were better in more difficult tasks. The differences were attributed to summative effects of natural and task induced arousal, which resulted in an optimal level of cortical arousal in extraverts and hyper arousal in introverts at more demanding tasks. It was also found that stable introverts had the highest, and stable extraverts the lowest estimates of task difficulty assessment. Neuroticism, however, had no effects on the task difficulty.

Keywords: extraversion, neuroticism, psychomotor task, task difficulty, arousal, difficulty assessment

Efficiency in various tasks depends, *inter alia*, on specific personality traits of individuals, as well as on the nature and complexity of the tasks themselves.

Apart from the abilities, the most explored personality traits in research on efficiency are, undoubtedly the bipolar dimensions of extraversion-introversion and neuroticism-emotional stability, proposed by Eysenck and Eysenck (1985). The biological basis of introversion-extraversion is associated with the activity of the reticular activating system (RAS), which is stimulated by oncoming sensory impulses, and in turn, sends a non-specific neural stimulation to the cortex, altering thus its states of facilitation and inhibition. An optimal stimulation of this kind facilitates information processing by the brain. According to Eysenck and Eysenck (1985), arousal is generally higher in introverts than in extraverts, which may be reflected on their performance.

The neuroticism-stability dimension, however, is associated with the limbic system activity, where neurotic subjects are characterized by a higher degree of this activation, in comparison with emotionally stable persons. This means that neurotic persons are emotionally more reactive, i.e. they have lower thresholds of emotional excitement than stable persons. Reticular activating system and hypothalamus, however, are not fully functionally independent, meaning that arousal and activation may interact with each other, which, *via* cortex, may have adverse effects on performance. This is especially the case in strong emotional excitements, when hypothalamic activation prevails. Some of these effects have been shown in various studies, where negative correlations were obtained, e.g. between level of neuroticism and choice reaction time (Socan & Bucik, 1998), as well as between neuroticism and the performance in signal detection tasks (Wallace, 1998).

The results of a number of studies supported Eysenck's explanation of the differences in arousal between extraverts and introverts, indicating generally higher level of arousal in introverts. Stelmack (1997), for example, reported about higher sensitivity of introverts to physical stimulation, which was attributed to a higher level of arousal. Standing, Lynn, and Moxness (1990) found a higher physiological activation in introverts when exposed to 'white noise', and a fall in performance in reading comprehension task. This was not the case with extraverts, whose performance in reading comprehension task was not impaired by 'white noise'.

Furnham and Strbac (2002) found poorer efficiency of introverts in reading comprehension tasks in conditions of background music, or noise, while at the same time, their

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efficiency did not differ from the efficiency of extraverts in silent conditions. This meant that introverts were hyperaroused in the first situation, while in the second situation (silence), their naturally higher arousal did not have an influence on the performance.

Studies of psychomotor tasks showed more or less similar results. Schaphin and Gusev (2001) found that introverts had a shorter reaction time in simple reaction tasks than extraverts. The results of Doucet and Stelmack (1997), however, were somewhat different. They obtained a shorter movement time, but not decision-making time, in extraverts, during simple reaction time tasks of different movement amplitudes. In choice reaction tasks, the movement time of extraverts in various situations (congruency - non congruency, and compatibility - noncompatibility of stimulus-reaction) was shorter than movement time of introverts. The decision-making time, however, was not a reliable parameter for a differentiation between the two personality groups. The authors claimed that the differences between extraverts and introverts were due to the differences in fundamental motor mechanisms, which were mediated by the processes in the peripheral nervous system, rather than differences in arousal. In the situation of a congruent stimulus array, but without the compatibility between the stimulus and reaction, extraverts had a shorter decision-making time than introverts.

The results of various studies may look somewhat contradictory from the point of view of Eysenck's explanation of the differences between extraverts and introverts. If they are viewed through the theoretical framework of Yerkes-Dodson Law, however, it could be said that tasks of higher complexities induce additional arousal, which may summatively, together with the basic arousal, reach the optimal level, or it may result in hyperarousal. This could explain apparently unexpected differences in performance in complex tasks between introverts and extraverts, where extraverts proved to be more successful.

Anderson (1994) demonstrated summative effects of arousal by giving various doses of caffeine to impulsive (neurotic extraverts) and non-impulsive (stable introverts) subjects. He changed levels of arousal of his subjects using five different doses of caffeine in drinks, before the subjects started doing tasks of different complexities. The results obtained on a letter crossing and complex verbal tasks showed an increase of efficiency in the lighter task, as the caffeine dose increased. Efficiency in more difficult tasks, however, increased when smaller doses of caffeine were given and decreased with higher doses. Impulsive subjects had an increase in efficiency in more difficult tasks, while non-impulsive subjects had also an increase at the beginning, and a drop in the efficiency with higher doses of caffeine. The analyses of individual efficiency confirmed summative effects of arousal as well as an inverted U-shape relationship between arousal and efficiency.

There were some studies, however, the results of which did not fit in the same paradigm. Terry, Fore, and Haase (1994), for example, used three different difficulty levels of paired association-learning tasks and found that extraverts were more efficient in easier and more difficult tasks than introverts, but there was no difference in medium difficulty tasks. Furthermore, Bastone and Wood (1997) did not find any differences between extraverts and introverts in facial expression decoding tasks.

The differences in results obtained in various studies may be due to the nature and complexity of the tasks, as well as the way of performance assessment in the tasks used. To avoid some shortcomings of previous studies, this investigation was aimed at examining the differences in performance between introverts and extraverts, as well as neurotic and stable subjects, using the same task with different levels of difficulty. Fitts' Tapping Task (FTT) seemed well suited to this purpose, since its six difficulty levels were easy to quantify.

If the hypothesis of summative effects of arousal and its inverted U-shape relationship with performance holds, extraverts should be more efficient in more difficult tasks, and introverts in easier tasks. Similarly, stable persons should, generally, be more efficient than neurotic (unstable) subjects, since higher hypothalamic activation of the later, may act as a 'neural noise', affecting thus the information processing. The differences in reactivity amongst different personality categories could be reflected in the task difficulty estimates, i.e. introverts and neurotics could be expected to give generally higher estimates, than extraverts and stable subjects.

If these expectancies proved correct, the results would throw more light on Eysenck's personality theory, as well as its relevance in explanation of some aspects of behaviour, such as performance and difficulty perception in tasks of different demands. Furthermore, the results would also emphasise the role of personality traits, as intervening variables in research of this kind.

METHODS

For the purpose of this study, 40 female subjects, 18 to 22 years of age, were selected from a sample of 290 students on the basis of their individual scores on introversion and neuroticism scales of the EPI-questionnaire. Four categories of 10 subjects each (stable extraverts, stable introverts, neurotic extraverts, neurotic introverts), were formed out of the sample of subjects who scored outside the range of $M \pm 2SD$ on extraversion and on neuroticism scales. They performed 12 Fitts' Tapping tasks, which consisted of alternatively hitting two identical targets, 25 times each, as quickly as possible. The target widths (W), and movement amplitudes (A) between them varied. Target widths were 0.5, 1.0, 2.0 and 4.0 cm, while the movement amplitudes were 4.0, 8.0 and 16 cm, which in combinations formed a series of 12 tasks. The task difficulties, ranging from one to six bits, were calculated by the formula ID = $\log_2$ (2A/W) proposed by Fitts and Posner (1973), where ID = index of difficulty (bits), A = movement amplitude (cm), W = target width (cm).

An electronic version of FTT was used, where target hits and misses were automatically recorded. If the targets were missed three or more times during the cycle of 50, the subject had to repeat the whole cycle again.

The task completion time was recorded after each task, when subjects were also asked to estimate the task difficulty on Borg's scale from zero to twenty (Borg, 1973). Zero meant '*not difficult at all*', and twenty meant '*extremely difficult*'.

RESULTS AND DISCUSSION

The data were analysed for each of the personality categories separately. Their means and standard deviations are shown in Table 1 and Table 2. As could be expected, regardless of the personality categories, the task time as well as the estimates of task difficulty changed with the task difficulty. This was reflected in correlations amongst the three variables ranging from 0.44 to 0.91 ($p<0.01$; Table 3). Similar correlations were obtained in a study by Slavić and Manenica (2002), where the subjective estimates of the task difficulty proved to be very reliable parameters.

Figure 1 shows the changes in the task completion time of extraverts and introverts, with a clear crossover of the curves between three and four bits of task difficulty. Introverts had significantly shorter time below ($F(1,38)=11.49$, $p<.01$), and extraverts above the crossover point ($F(1,38)=10.77$, $p<.01$). These results support the initial hypothesis of summative effects of natural arousal and the task-induced arousal on subject's efficiency, since introverts had a better performance in easier tasks, due to a higher natural arousal, and a comparatively poorer efficiency in more difficult tasks due to summative hyperarousal. On the other hand, the task-induced arousal in naturally hypoaroused extraverts, seemed to have resulted in an optimal level of arousal, which was reflected in a better performance in more difficult tasks. These results are in agreement with results of some other studies, where similar kinds of psychomotor tasks were used (e.g., Schaphin & Gusev, 2001). The results of Doucet and Stelmack (1997) showed extraverts to have shorter movement time than introverts in complex psychomotor tasks, while the decision-making time was the same. Although the authors attributed these differences to the differences in fundamental motor mechanisms, mediated by processes in the peripheral nervous system, it seems logical to consider these processes to be affected by the arousal level. Since in the present study movement and decision-making times of Fitts Tapping Tasks were not viewed separately, it would be wrong to assume that they were not affected by the differences in the peripheral motor mechanisms caused by the task complexity, as well as the arousal level.

Blake (1971) found differences in performance of a letter-cancelling task between introverts and extraverts, which he associated with the differences in body temperature during the morning hours. Colquhoun and Folkard (1978) reanalysed Blake's original data, and found no differences when neurotic subjects were taken out of the sample. On the contrary, results of this study showed that the difference between extraverts and introverts remains even without neurotic subjects (Figure 3), confirming thus Blake's

Table 1

Mean task completion time and standard deviations for all categories of subjects

Subjects	I		E		S		N		SI		SE		NI		NE		All	
ID (bits)	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	10.1	1.5	13.7	1.9	11.5	2.0	12.2	2.9	10.0	1.6	13.1	0.9	10.1	1.6	14.4	2.3	11.9	2.5
2	10.4	3.1	12.9	4.4	11.2	2.4	12.2	5.0	10.8	3.2	11.6	1.5	10.0	3.1	14.3	5.8	11.7	3.9
3	12.7	3.4	14.8	3.5	13.6	2.7	13.9	4.4	13.4	3.6	13.9	1.4	11.9	3.2	15.8	4.7	13.8	3.6
4	20.1	3.6	16.1	3.6	18.5	4.4	17.8	3.8	21.4	4.2	15.6	2.2	18.8	2.5	16.7	4.7	18.1	4.1
5	24.1	4.1	19.9	4.3	22.6	5.5	21.5	3.7	25.9	4.6	19.3	4.1	22.2	2.7	20.7	4.5	22.0	4.6
6	29.8	4.9	23.6	8.1	29.2	6.1	24.3	7.7	32.3	5.3	26.0	5.4	27.3	3.1	21.2	9.8	26.7	7.3

Note. I – Introverts; E – Extraverts; S – Stable; N – Neurotic; SI – Stable introverts; SE – Stable extraverts; NI –Neurotic introverts; NE – Neurotic extraverts

Table 2

Mean estimates and standard deviations of task difficulties

Subjects	I		E		S		N		SI		SE		NI		NE		All	
ID (bits)	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
1	1.2	2.6	0.9	1.7	0.6	1.1	1.5	2.8	0.7	1.2	0.5	1.1	1.7	3.5	1.2	2.1	1.0	2.1
2	2.7	3.4	1.3	1.8	1.5	1.8	2.5	3.5	2.2	1.9	0.9	1.5	3.1	4.5	1.8	2.0	1.9	2.8
3	5.1	4.2	3.1	2.5	3.9	3.4	4.2	3.9	5.4	3.3	2.6	2.9	4.9	5.1	3.6	2.1	4.1	3.6
4	7.9	4.3	6.6	3.3	6.9	3.5	7.5	4.2	8.2	3.3	5.8	3.6	7.5	5.3	7.4	2.9	7.2	3.8
5	9.9	3.8	9.2	3.7	9.3	3.6	9.9	3.9	10.5	2.9	8.1	3.9	9.4	4.6	10.4	3.3	9.6	3.7
6	13.8	5.9	11.9	5.0	12.3	5.7	13.5	5.4	14.0	4.9	10.5	6.0	13.6	7.1	13.4	3.5	12.9	5.5

Note. I – Introverts; E – Extraverts; S – Stable; N – Neurotic; SI – Stable introverts; SE – Stable extraverts; NI – Neurotic introverts; NE – Neurotic extraverts

Table 3

Correlation coefficients among task difficulty, task completion time, and difficulty estimation for different categories of subjects

	Categories of subjects								
Variables	I	E	S	N	SI	SE	NI	NE	All
TD-TT	0.88	0.59	0.81	0.68	0.86	0.75	0.91	0.46	0.75
TD-DE	0.72	0.78	0.77	0.72	0.84	0.69	0.65	0.84	0.74
TT-DE	0.62	0.49	0.66	0.49	0.72	0.49	0.60	0.44	0.57

Note. Subjects: I – Introverts; E – Extraverts; S – Stable; N – Neurotic; SI – Stable introverts; SE – Stable extraverts; NI – Neurotic introverts; NE – Neurotic extraverts; Variables: TD – Task difficulty (bits); TT – Task time (s); DE – Difficulty estimation (Borg's scale).
All coefficients are significant at $p<.01$.

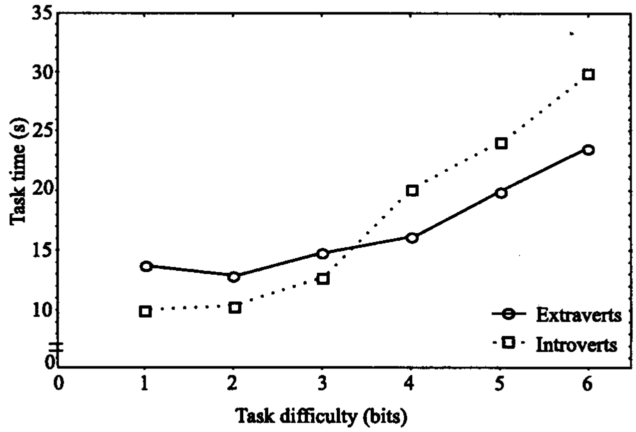

Figure 1. Task completion time of extraverts and introverts

findings. Even a poorer performance of introverts was found in the tasks above three bits of difficulty, when compared with the analysis that included neurotic subjects ($F(1,18)=11.16, p<.01$).

There was no difference in performance, however, between neurotic and stable subjects except for the task of six bits of difficulty (Figure 2), where neurotic subjects performed better ($t(38)=2.22$, $p<.05$). These results do not support the initial hypothesis of possible poorer performance of neurotic subjects. On the contrary, the results at the most demanding task gave support to the results of Socan and Bucik (1998), and Wallace (1998), who found a shorter choice reaction time and a better performance in signal detection tasks, respectively, in neurotic subjects. Since their tasks were rather complex, the results of this study fit in the findings of these authors. Nevertheless, it is difficult to explain the differences between neurotic and stable subjects under the assumption of the same arousal levels. Judging by a better performance in more complex tasks, neurotics should have a lower natural arousal level than stable subjects. This assumption cannot be proved or rejected here, however, because the four personality categories consist of subjects with rather extreme results on extraversion and neuroticism scales. A further comparison of neurotic introverts and neurotic extraverts (Figure 3) showed a difference, which could be attributed to extraversion-introversion dimension ($F(1,18)=7.65, p<.05$). The difference was more obvious for less demanding tasks. A comparison of neurotic and stable introverts on the one hand, and neurotic and stable extraverts on the other, showed no differences in efficiency, indicating thus a smaller importance of neuroticism, as an independent variable, in studies of this kind (Figure 3).

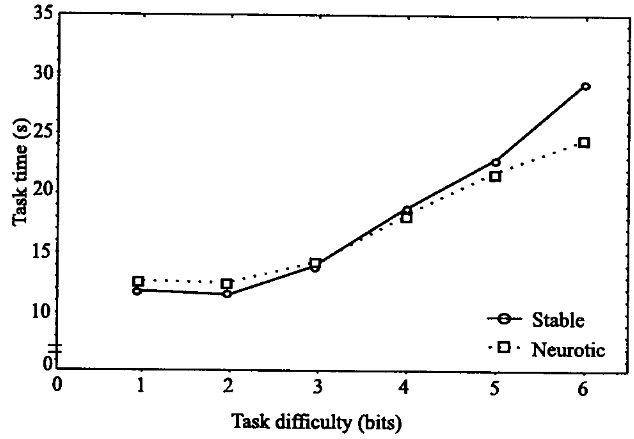

Figure 2. Task completion time of stable and neurotic subjects

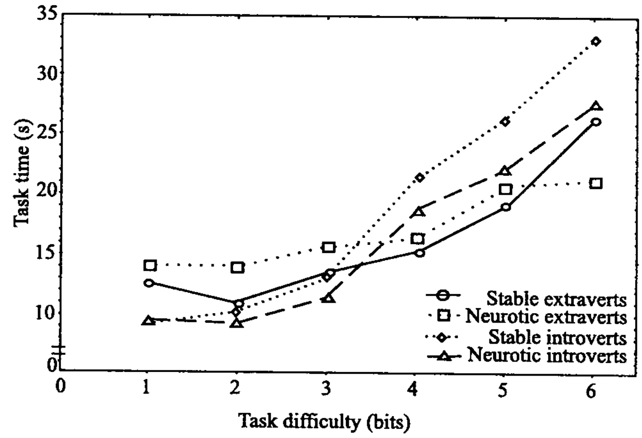

Figure 3. Task completion time of the four personality categories

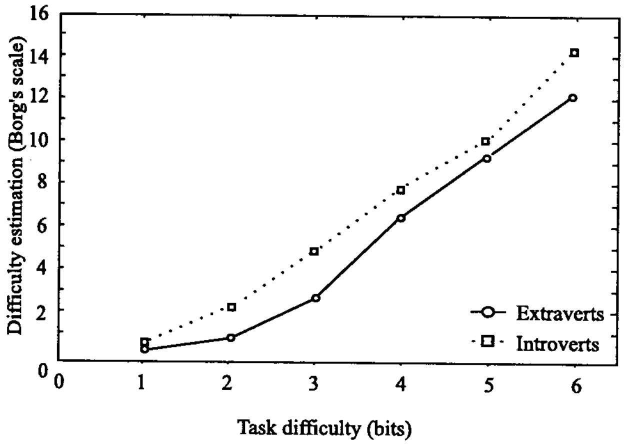

Figure 4. Estimations of the task difficulty of extraverts and introverts

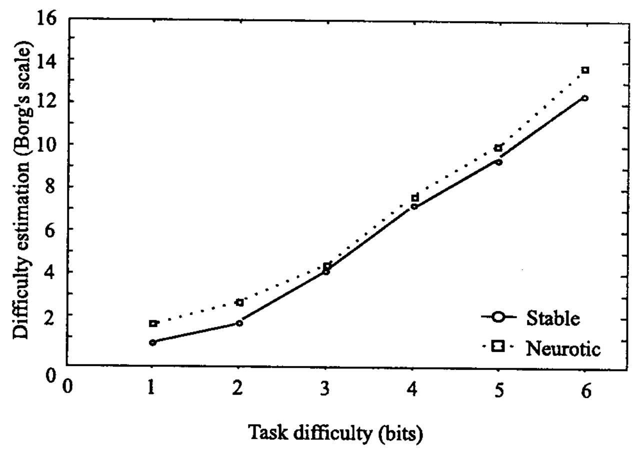

Figure 5. Estimations of the task difficulty of stable and neurotic subjects

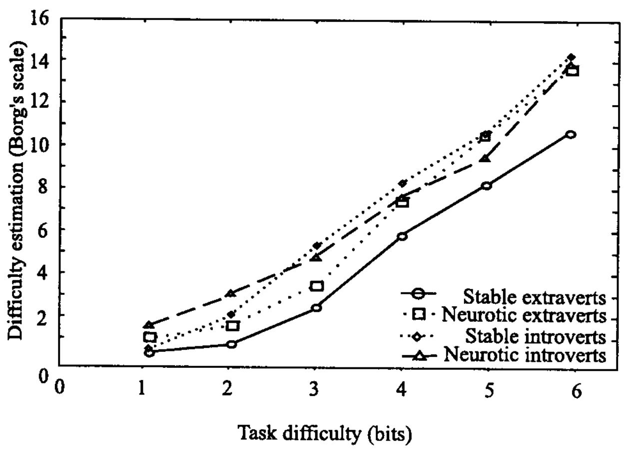

Figure 6. Estimations of the task difficulty for the four personality categories

The results of this study did not generally show the differences in performance between stable and neurotic subjects, while the differences were found between introverts and extraverts. This seems to suggest that neuroticism is not so important variable as introversion-extraversion for the performance in tasks of this kind. It is also interesting that the best performance at the easiest task and the worst performance at the most difficult task was achieved by stable introverts, which supports the hypothesis of arousal summation, but not the idea of activation acting as 'neural noise'. The idea of arousal summation seems to bring together Eysenck's explanation of arousal and Yerkes-Dodson Law as complementary mechanisms which form the relationship between arousal and human performance.

The obtained results did not generally confirm the expectation that introverts and neurotic subjects would be more sensitive to the task difficulties (Figures 4 and 5), as some earlier studies indicated (Stelmack, 1997, for example). If, however, the four personality categories are viewed separately (Figure 6), it appears that stable extraverts had the lowest, and stable introverts the highest task difficulty estimates ($F(1,16)=5.86, p<.05$). Neuroticism seems to have no significant effects on the estimates, which may be due to the fact that the subjects were a rather coherent sample regarding age, which is a relevant variable for neuroticism.

Finally, it could be said that results of this study supported the hypothesis of arousal summation, which seems to improve the efficiency of extraverts in more difficult tasks by bringing their arousal to an optimal level, and to impair performance of introverts in the same tasks by resulting in hyperarousal. Apart from having a naturally higher level of arousal than extraverts, stable introverts seem to be more sensitive (reactive) to the task load in their estimates, which, again, makes the level of arousal an important factor in perception of the task difficulty. A further study should be carried out with the aim of examining the importance of neuroticism in efficiency, by using subjects of a wider age range.

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