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Relationship of gender, dimensions of temperament, and bimanual coordination

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Abstract

Introduction. Bimanual coordination is used in everyday life activities and is a part of work-related skills, sports, and leisure time activities. Dynamics of experiencing is characterized by the dimensions of extraversion and neuroticism, which are believed to be brain correlates. Aim of Study. The objective of this study is to determine whether temperament characteristics and gender have any effects on performance in a test of bimanual coordination. Material and Methods. The research sample consisted of 193 participant, 86 of them were women (45%) and 107 were men (55%). All the participants were university students with an average age of 21.6 years ± 1.76. The Eysenck's Personality Inventory (EPI) was used to determine extroversion and neuroticism levels, while the Supportive Drawing Test (SDT) was employed to assess a level of bimanual coordination. Results. In the SDT, the men demonstrated significantly better performance than the women. These differences were also validated by the level of substantive significance. The analysis of variance did not show any differences in the SDT performance in the extraversion dimension. However, in the dimension of neuroticism, significant intergroup differences have been observed. Labile participants performed more poorly on the SDT than neuropsychiatrically stable and ambivalent ones. The women showed a higher median of neuroticism (Mdn_W = 11) than the men (Mdn_M = 9). Among the female participants, 25.6% exhibited neuropsychiatric lability, while only 14.9% of the men belonged to the labile group. Conclusions. The results of the SDT showed no difference between the groups of labile men and labile women.

KEYWORDS: females, neuroticism, males, support drawing test.

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Introduction

Personality of a person differs significantly on an interindividual level, but intraindividually it is a relatively stable set of qualities [26]. Every person experiences an entirely individual pattern of thoughts, feelings, and behaviors that influences dynamics of experience known here as temperament [28]. Brain correlates of extraversion and neuroticism may contribute to an individual's predisposition to social and emotional states [5, 10]. Differences in these temperament dimensions have an impact on emotional and cognitive processing of a current situation [7]. Extraversion is characterised by openness and need for external stimuli, whereas close-mindedness and overexcitement or even nervousness are typical for introversion. The former is also associated with a tendency to experience positive emotions and social involvement. In contrast, neuroticism, characterised by emotional instability or lability, is related to increased susceptibility to negative emotions and associated processes as a response to perceived threats [29]. Highly neurotic individuals often have greater difficulties controlling their emotions [20]. Many studies have focused on describing gender differences in general patterns of personality traits. Women consistently demonstrate higher levels in

terms of the neuroticism dimension [9], which has been confirmed in 37 nations [18]. This difference decreases with age [25]. Gender has also been proven to affect performing bimanual movements [23, 24]. In the context of this article, gender is conceptualized as a biological dichotomous variable with female or male values. Movements based on bimanual coordination are utilised in work activities (surgeon, dentist, carpenter, hairdresser, dressmaker, computer keyboard typist, etc.) or leisure activities, such as doing sports or playing musical instruments. In everyday activities, bimanual movements occur twice as often as unimanual ones [22].
Movements that require coordination of both hands can be divided into three groups. The first two groups of bimanual movements involve symmetrical movements of hands that are either mirrored equally by both hands (e.g., rowing) or alternate rhythmically at regular intervals (e.g., front crawl swimming, kayak paddling). Nevertheless, most bimanual movements require more complicated synergy based on asymmetric movements of both hands or arms [21, 27]. Coordination of both hands and fingers depends on communication of the cerebral hemispheres via the corpus callosum, whose influence on bimanual coordination is well-proven [11]. Many studies examining the process of bimanual coordination have focused on individuals with specific neurological disorders [6]. Bimanual movements' tasks are often a part of posttrauma or poststroke rehabilitation of impaired cross-hemispheric communication. Based on this fact, it has been assumed that bimanual tasks aimed at both gross and fine motor skills can help develop coordination that is applicable in everyday life, e.g. when driving a car, and in daily self-care activities.

Aim of Study

This study aims to determine whether temperament characteristics can affect performance in a test of bimanual coordination in men and women.

Material and Methods

The research sample consisted of 193 participants (n = 193), 86 of them were women (n_w = 86) and 107 were men (n_m = 107). All the participants were students of the Faculty of Education of the University of West Bohemia, Pilsen, Czech Republic. Their average age was 21.6 years ± 2.76. The study subjects provided informed consent prior to participation. The local ethics committee approved the study protocol before commencement.
The participants were selected based on availability and willingness [15], which means that individuals whose predominant behavior is avoidance of performance and confrontation with others were unlikely to participate in this research. All the subjects identified with their biological identity. Other gender and sociocultural characteristics beyond the binary framework were not included in the research.
A degree of extraversion and neuroticism was determined using a revised version of the Eysenck's Personality Inventory (EPI) test, which assesses a degree of neuropsychic stability and extraversion [10]. EPI scores can range 0-24 for both extraversion and neuroticism.
Bimanual coordination was examined using the Supportive Drawing Test (SDT) [4]. A writing device was set in motion by asymmetrical rotation of two cranks. One hand with the crank moved the writing device along the horizontal axis, while the other moved it along the vertical axis. The participants were asked to move a recording device with the help of the cranks so that the writing device moved in a defined intermediate circle. The objective of this test was to encircle an entire circle without leaving the writing device in the defined intermediate circle. The test time was recorded. The test was repeated three times (SDT1, SDT2, SDT3). This test is standardised [4].
To assess a relationship between the temperament dimensions (extraversion and neuroticism) and performance in the SDT, the participants were divided into three groups, according to their score in the EPI test. This resulted in creating a group of introverts (extraversion dimension score $0 \geq 9$), ambiverts (extraversion dimension score 10-14), and extraverts (extraversion dimension score $15 \geq 24$). In the neuroticism dimension, there was a group of neuropsychologically stable individuals (neuroticism dimension score $0 \geq 9$), ambiverts (neuroticism dimension score 10-14), and neuropsychologically labile individuals (neuroticism dimension score $15 \geq 24$).
Statistically evaluated variables have a normal distribution. Statistical comparisons between the men's and the women's performance in the SDT were made using the Student's t-test for independent samples ($p \leq \alpha \leq 0.05$). To compare the performance of the three groups on each of the dimensions, the one-way ANOVA was used, followed by the Scheffé's post hoc test for the neuroticism dimension, to establish the relationship between the groups in the men's and women's groups.
Substantive significance was verified by calculation of the Cohen's d coefficient. If the value of Cohen's d is up to 0.2, it is a small effect size, values up to 0.5 belong to a medium effect size. A large effect size includes values

up to 0.8, while values above 0.8 indicate a very large effect size [8].

Results

By comparing the performance of the women's group and the men's group on the SDT, it has been found that the men demonstrated significantly better performance than the women. The substantive significance of these results has a mean effect (see Table 1).

Table 1. Comparison of men's and women's performance in the support drawing t-test and Cohen's d value

	M (women)	M (men)	t-value	p-value	Cohen's d
SDT1	83.4	69.8	3.02	0**	0.44*
SDT2	66.5	56.1	3.72	0**	0.54*
SDT3	59.8	50.5	3.36	0.001**	0.49*
EXTRA	14.1	14	0.05	0.96	0
NEURO	10.1	9.6	1.82	0.07	0.26

** ($p \leq \alpha \leq 0.05$), significant difference between men and women,
* mean substantially significant difference

The frequency analysis was used to determine relative frequencies of the men and the women in each group, divided according to the achieved scores on the extraversion (see Figure 1) and neuroticism dimensions (see Figure 2).

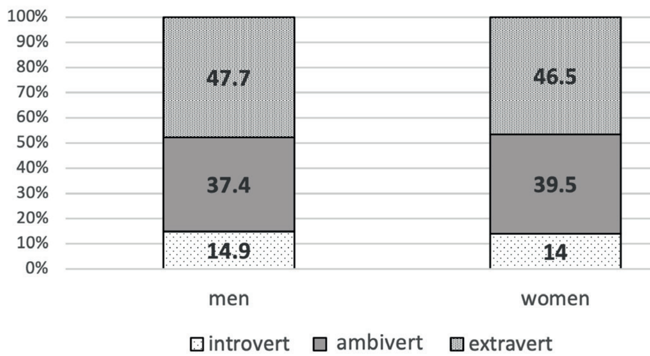

Figure 1. Percentage representation of the frequency of introverts, ambiverts, and extroverts in the groups of men and women

Figure 1 shows that the differences in the frequency distribution of the extraversion dimension in both groups are almost the same, and extraverts predominate in both samples.
The one-way analysis of variance (ANOVA) was employed to compare the performance on the SDT of the groups created by dividing the participants according to the achieved extraversion dimension scores. The result supports the null hypothesis, i.e., there is no difference in the performance on the SDT between the groups of introvert, ambivert, and extravert participants.

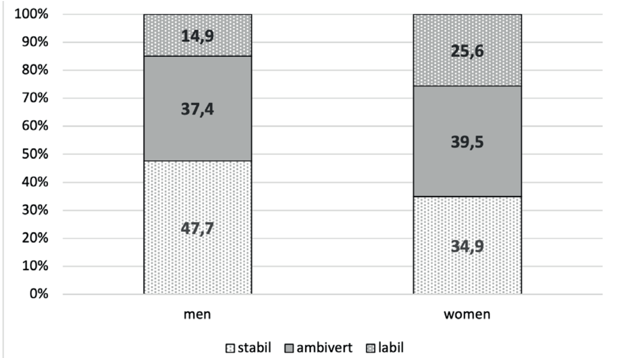

Figure 2. Percentage representation of the frequency of stable, ambivert, and labile probands in the groups of men and women

Figure 2 presents that 25.6% individuals of the female group were labile, while in the male group it was only 14.9%.
The analysis of variance used to compare the groups, which were created by dividing the participants according to the scores achieved on the neuroticism dimension, shows the significant difference between at least two of the three groups (see Table 2).

Table 2. Results of the analysis of variance (ANOVA) of the groups in the neuroticism dimension

	F	p-value
SDT1	6.5	0.002
SDT2	7.1	0.001
SDT3	10.5	0.000

Note: F – test criterion, p – statistical significance value; $p \leq \alpha \leq 0.05$

Table 3. Summary of the means and standard deviations of the times achieved in the individual retests in the groups of stable, ambivert, and labile probands

	Stable M ± SD	Ambivert M ± SD	Labile M ± SD
SDT1	69.6 ± 20.7	73.9 ± 24.9	91.6 ± 51.8
SDT2	55.2 ± 17.6	61 ± 18.7	70.1 ± 23.8
SDT3	49.5 ± 14.4	53.4 ± 14	66.7 ± 31.6

The Scheffé's post hoc test was used to determine if there is a difference between the groups of stable, ambivert, and labile participants.

Table 3 indicates that the group of labile participants shows the greatest differences in terms of performance. This group demonstrates significantly different results on all three retests of the SDT. The substantive significance is assessed as a mean (see Table 4).

The values of the Scheffé's test specified in Table 4 indicate the significant differences between the groups of stable and labile individuals, and between the groups of ambivert and labile individuals, in all three retests. The substantive significance, the Cohen's d coefficient,

Table 4. The matrix arranges the values of statistical significance of the Scheffé's post hoc test and Cohen's d substantive significance values between the individual groups of probands according to the value in the neuroticism dimension in each of the retests (SDT1, SDT2, SDT3)

		Stable		Ambivert		Labile	
		p-value	Cohen's d	p-value	Cohen's d	p-value	Cohen's d
SDT1	Stable	–	–	0.69	0.19	0.002*	0.61**
	Ambivert	0.69	0.19	–	–	0.01*	0.46
	Labile	0.002*	0.61**	0.01*	0.46	–	–
SDT2	Stable	–	–	0.19	0.32	0.001*	0.75**
	Ambivert	0.19	0.32	–	–	0.05*	0.43
	Labile	0.001*	0.75**	0.05*	0.43	–	–
SDT3	Stable	–	–	0.44	0.28	0*	0.75**
	Ambivert	0.44	0.28	–	–	0.002*	0.58**
	Labile	0*	0.75**	0.002*	0.58**	–	–

* $p \leq \alpha \leq 0.05$; ** substantive significance with a mean effect

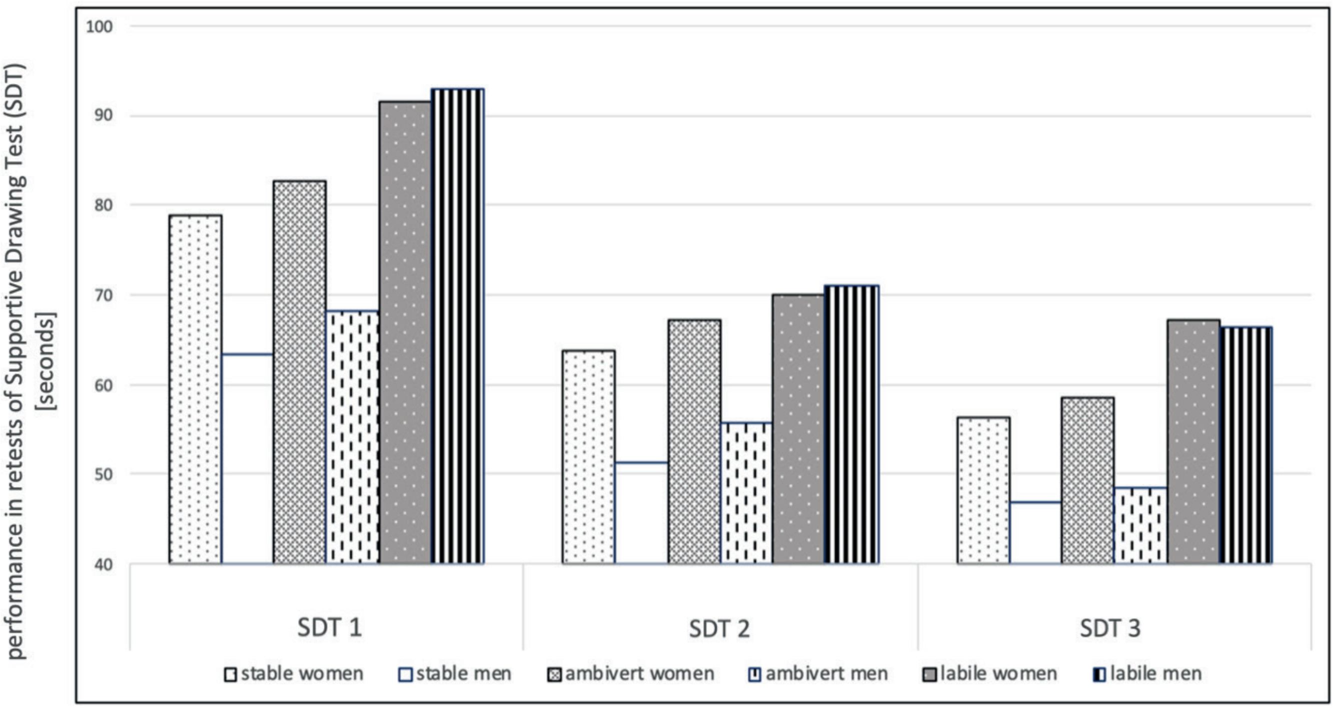

Figure 3. Average times achieved in individual retests of the support drawing test (SDT1, SDT2, SDT3) in the stable, ambivert, and labile groups of men and women

indicates the mean significance of the differences in the performance on each retest in the groups of stable and labile individuals. There were mean substantively significant differences in the performance between the ambivert and labile individuals only on the third retest.

Having obtained these results, and having determined the difference between the groups created by dividing the participants according to the neuroticism dimension, the next aim was to establish whether there are differences between the stable, ambivert, and labile men and women.

Figure 3 shows that the greatest differences in the individual retest times are primarily between the stable women, and the stable and ambivert men. The stable and ambivert men demonstrated the better performance in the individual retests of the SDT. In the case of the labile participants, the performance of the men and the women are almost identical in the individual retests.

The results have been further analyzed using the same procedure as in the previous case. Statistically and substantively highly significant differences were obtained by means of the ANOVA, the Scheffé's post hoc test, and the Cohen's d coefficient for each group of the neuroticism dimension in the men and the women. In the first retest of the SDT (SDT1: $F = 4.84$, $p = 0$) significant differences were observed. Specifically, the differences were also observed between stable and labile men groups ($p = 0.04$, $d = 0.79$), and between the groups of stable men and labile women ($p = 0.02$, $d = 0.84$). In the second retest of the SDT (SDT2: $F = 6.00$, $p = 0$), the results were very similar: the stable and labile men ($p = 0.02$, $d = 0.96$), the stable men and the labile women ($p = 0.01$, $d = 0.96$). There was also a significant difference between the stable men and the ambivert women ($p = 0.03$, $d = 1.02$). In the third retest of the SDT (SDT3: $F = 6.36$, $p = 0$), there were also statistically and substantively highly significant differences between the performance of the stable and labile men ($p = 0.02$, $d = 0.87$), the stable men and the labile women ($p = 0.003$, $d = 0.94$), and the ambivert men and the labile women ($p = 0.02$, $d = 0.85$).

Discussion

A number of studies have shown that men are more successful than women in performing tasks involving bimanual coordination [2, 24]. The relationship between gender and neuroticism has also been demonstrated [16, 18].

In this study, the effect of neuroticism on performance in the SDT was demonstrated. A sample was homogeneous in terms of experience with physical and sports activities in order to exclude one of the possible intervening factors. The influence of gender has also been confirmed. The score achieved in the neuroticism dimension did not show any significant differences between the groups of men and women. Nevertheless, the median of the male and female groups' data for this variable indicates a difference. The female group has the median value of 11 on the neuroticism dimension, while the male group has the median value of 9. There are 10% more labile women than the labile men in the sample, and the same difference is shown in the case of the relative frequency of the stable men and women in favor of the relative frequency of the stable men. In all three retests of the SDTs, there was the significant difference between the stable men and the labile women, but also the labile men. The labile men and the labile women performed very similarly in the individual retests. The stable men performed better on the retests compared to the stable women, which was not significantly different from the women's performance (SDT1: $p = 0.37$, SDT2: $p = 0.11$, SDT3: $p = 0.35$), but the significance value indicates a mean effect size (SDT1: $d = 0.76$, SDT2: $d = 0.67$, SDT3: $d = 0.60$). The mean changes observed in the individual retests of the SDT indicate that motor learning of the labile individuals group is also the slowest on average.

There is evidence that bimanual coordination is influenced by a number of other factors. One of them is attention to the influence of laterality, where a dominant hand produces faster rhythm of movements than a nondominant hand [21]. This fact can be observed mainly in asynchronous asymmetrical bimanual movements when perceptual information is in conflict or intermingled. This results in slowing or stopping a movement [21, 23], which is consistent with the main focus of the test presented in this study. The other factor influencing bimanual coordination concerns differences between men and women in cognitive and motor skills that may be caused by effects of sex hormones on a brain [3, 19]. A women's brain is less lateralized than a men's [13]. Studies which utilize neuroimaging and electrophysiological methods show that brain activity in bimanual tasks is different in men and women. Women demonstrate higher involvement of the visuo-motor centers of both hemispheres [12, 14]. In tasks focused on speed and accuracy, women perform them more slowly, but more accurately. In terms of accuracy, the task presented in this study was quite simple, and no errors occurred during the test. There are some studies that confirm women's advantage in this regard [1, 17]. It is also important to note a level of experience with a performed or similar bimanual task. In terms of general movement tasks and experience, the research sample was relatively homogeneous. It consisted of the students of the Physical Education and Sport study programs of the Centre of Physical and Sports Education, Faculty of Education of the University of West Bohemia in Pilsen. The test is sufficiently specific, and no previous training was performed. It can be clearly seen from the results of the individual retests that retraining affects performance on the test in all groups, divided according to the scores on the neuroticism dimension.

Conclusions

The results of the research indicate that a higher degree of neuroticism negatively affects performance in a bimanual coordination test focused on asymmetric asynchronous hand movements. The stable and ambivert women performed worse compared to the stable and ambivert men. The labile individuals performed similarly, regardless of gender. On average, the group of labile individuals performs the worst on all three retests. The research results point that for neuropsychically labile individuals an unfamiliar test with specific demands on bimanual coordination may be challenging. These findings lead to the conclusion that conditions of a pedagogical process connected with performing bimanual tasks should be optimized. There is a need to support and frequently correct more labile individuals, or even to inform them about correctness of their behavior. The results of this research have the following limitations: The results are applicable to a regularly exercising population aged 20-26 years.

Conflict of Interest

The authors declare no conflict of interest.

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