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Differences in Some Aspects of Co-Ordination Between the Twin and Single-Born Subjects

by

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In this paper an attempt is made to measure the intra-pair differences in performance of monozygotic (MZ) twins, and to compare them with single-born subjects of the same gender and age.
Thirty right-handed, male subjects aged 21, were divided into two subgroups: monozygotic twins subgroup of 6 subjects and a control group of 24 single-born subjects. The hand dominance of each subject was established by means of a questionnaire (selection from Edinburgh Handedness Inventory) and verified by simple motor tasks. Self reported hand dominance was also recorded. The level of psychomotor performance of each subject was evaluated by the use of chosen tests from the computerized Vienna Test System (VST, Vienna, Austria).
The experiment showed differences in some aspects of co-ordination between twin and single-born subjects, with the majority of tasks showing an advantage with single-born subjects. The motor control of MZ twins seems to differ from single-born subjects in some aspects, and thus, it needs further scientific research.
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Introduction

Monozygotic (MZ) twins are formed by the splitting of a single, fertilized egg. The two individuals thus created are genetically identical, in contrast to dizygotic twins (DZ) and single-born brothers or sisters. The incidence of twin births among white populations is currently about 1 in 87 deliveries. Monozygotes comprise about 30% of these pairs (Shephard, 1981). Calculation of correlation for twin pairs indicates a great concordance of fine motor skills in MZ twins. But the present knowledge on the connection between motor behavior and genetics is still incomplete. Researches on twin pairs are valuable in this matter. The genotype seems to affect the ability to master new skills. In 1954, Von Verschauer found a 69% concordance in the time of learning to walk for MZ twins, and only the 35% concordance in DZ (Shephard, 1981). The rate and level of motor learning is assumed to have more genetic control in boys than in girls. However, the inherited ability is rather task specific (Skład, 1972). There is little information about intra-pair differences in motor performance, as well as comparisons between single-born subjects and twins. The intra-pair variance of speed in MZ twins is reported to be very small – about 5% (Klissouras, 1973). The rhythm of movement is also reported to have a great similarity, as well as a kinematics structure of movement (Skład, 1972). Studies on single-born subjects have described some differences in dominant and non-dominant hand performance during visuomotor reaction time (Carson et. al., 1990; Tan &Kutlu, 1991; Teixeira et. al., 1999). However, there is still no clear information about the asymmetry of motor performance in MZ twin pairs. In the large majority of population, motor performance in unilateral tasks is dependent on hand preference. Both right-handers and left-handers have a faster rate of movement with the dominant hand, independent of the index of task difficulty (Agnew et. al.,2004; Elliot & Heath, 1999; Flowers, 1975; Peters, 1991).The between-hand scores are significant in performing the aiming, difficult tasks. The dominant hand advantage has also been shown in rhythm – adapting tasks with various frequency of signals (Jancke et. al., 2000; Olex, 2000) and visuomotor reaction time (Riolo–Quinn, 1991). The accuracy of movement in many experiments was measured by the error rates (Flowers, 1975; Plamondon & Alimi, 1997). In some cases, differences between the hands in the number of errors made (i.e. in classical Fitts' movement task – tapping between two targets) were small and insignificant, while there was strong dependence on speed of movement, as in Fitts' law principle (Elliot & Heath, 1999; Flowers, 1975). But other authors reported the dominant hand as a more accurate assessment (Anett, 1992; Skład, 1975). The gender – related differences in the asymmetry of aiming with dominant and non-dominant hand have been reported. In tasks requiring both speed and precision, women tend to trade off speed for accuracy. In some experiments, women slowed movement to reach a suitable level of precision. In right-handed subjects, the dominant hand advantage in accuracy was observed only in men, while in women no differences in terminal accuracy of hand performance were observed. (Barral & Debũ, 2004). In left-handed females, the decrease of accuracy in preferred hand movement was observed as hand speed increased. In men, the left dominant hand accuracy did not depend on speed (Tan, 1993). The gender–related effect on movement time, accuracy and on velocity profiles were reported, but not for reaction time. In movement time and peaks of velocity, the advantage of men was significant; however, in accuracy women had the advantage (Barral & Debũ, 2004). In bilateral tasks, involving rhythmic interlimb co-ordination, the strength of interaction between the hands decreased with increasing movement frequency (Paper & Beek, 1998). The within-hand variability was reduced on a repetitive tapping task when tapped bilaterally in comparison to single-handed tapping (Helmuth & Ivry, 1990). The movement accuracy and consistency has been shown to be affected by concurrent visual feedback. The movement error in many experiments was expected to increase when vision was occluded in situations of closed eyes or lack of vision (Elliot & Heath, 1999).

In this paper, an attempt is made to measure the intra-pair differences in performance of MZ twins, and to compare them with single-born subjects of the same gender and age. The conclusions from this study, using the sample of twins, are expected to throw new light to the discussion of motor control within voluntary movements in humans.

Material and method

Thirty right-handed, male subjects aged 21, were divided into two subgroups: monozygotic twins subgroup of 6 subjects and a control group of 24 single-born subjects. The hand dominance of each subject was established by means of a questionnaire (selection from Edinburgh Handedness Inventory by Oldfield, 1971), and verified by simple motor tasks. Self reported hand dominance was also recorded. All subjects gave informed consent for their participation in experiment and were naive as to the purpose of research.

The level of psychomotor performance of each subject was evaluated by the use of chosen tests from computerized Vienna Test System (VST).

The aforementioned diagnostic tool is relatively well-known, described and verified with regard to validity and reliability, and its usefulness was presented in earlier publications (Raczek et al., 2001). Vienna Test System (Dr

G.Schuhfried GmbH, Mödling, Austria) consists of computer supplemented tests constructed in assumptions to diagnose neurophysiological predispositions of human movement. It was used successfully in clinical psychology, psychiatry and work psychology and physiology from 1978, and currently it is adopted in many scientific disciplines. It allows to test the large area of human abilities with the use of 60 specific procedures.

VTS consists from main system (PC, interface, managing system – MENUE and operation system – RSX) and peripheral panels (configurable and adjustable) where the test can be performed. Some of tests may be conducted with the use of the computer screen and other devices. In this experiment, Reaktiongerät (RG), Tapping (TAP) and Motorische Leistungsserie (MLS) were used.

The reaction test (RG) enabled the assessment of simple and complex reaction for visual and auditory stimuli. On the subject's panel there were five colored lamps and two different sounds were given. Testing procedure consisted of two parametric blocks. In the first block, the subject had to release the "stand -by" button and press the "reaction" button when the visual stimulus appeared (yellow light) as quickly as possible. This trial was repeated several times, separately for the dominant and non-dominant hand. In the second block, of trials the complex reaction for both visual and auditory stimuli was tested. The subjects were obliged to react (release the "stand – by" button and press the "reaction" button) only when the yellow light and selected sound have appeared, neglecting other combinations of lights and sounds The block of trials was done separately for dominant and non-dominant hand. The variables included: reaction time, reaction speed and the time of movement (in *ms*) for simple reaction, as well as for the complex reaction.

The tapping test (TAP) enabled the assessment of rhythm capability, as a part of overall co-ordination in human. The subject had to accomplish was to adapt a tap-rhythm to a given rhythm of sounds. This acquired tap-rhythm should then have been maintained for a given period of time. The sounds were created by a sound-generator. Their frequency was either 833 or 417 milliseconds, which corresponded to 72 or 144 beats per minute. For the input of the tap-rhythm, the green and red buttons of the subject's panel were used. Testing procedure consisted of two phases: practice phase and the test. In the practice phase, subjects had to adapt their tap-rhythm, which is input from the buttons of the subject's panel, to a given rhythm of sounds. In the subsequent test, the same rhythm should have been maintained, first with and then without sound presentation ("guided" and "unguided" phase). The test variables included: sequence errors in guided and unguided phase, and tendency toward rhythm changing (acceleration or deceleration) in the unguided phase.

The only parametric block from the MLS was the manual dexterity test connected with the frequency of hand movement. The amount of taps done with a special pen on the special deck (300x300x15 mm) within the total time of 32 seconds divided into two periods: the first 16 seconds, and the next 16 seconds of trial. All trials were done unilaterally. Results were recorded separately for dominant and non-dominant hand.

To measure the intra-pair differences in performance the following mathematical method was used: xA – xB/ xA + xB:2 x 100%. The statistics included mean (M), standard deviation (SD), standard error (SR) and variance analysis (ANOVA). The pair sequence Wilcoxon's test (T) was also used. All statistics were done by means of Statistica 7.0 software.

Results

The simple reaction

In simple reaction speed, the intra-pair differences in performance were not significant, however, the medium difference for dominant hand was 10.92%. An interesting observation seem was that, the second-born twin performed slightly better with both dominant and non-dominant hand in all tested twin pairs. The major intra-pair differences in motor performance were recorded in the time of movements. The medium difference was 20.4% for the time of dominant hand movement. Differences between hands in all subjects were rather small and were statistically insignificant, according to the Wilcoxon's pair sequence test.

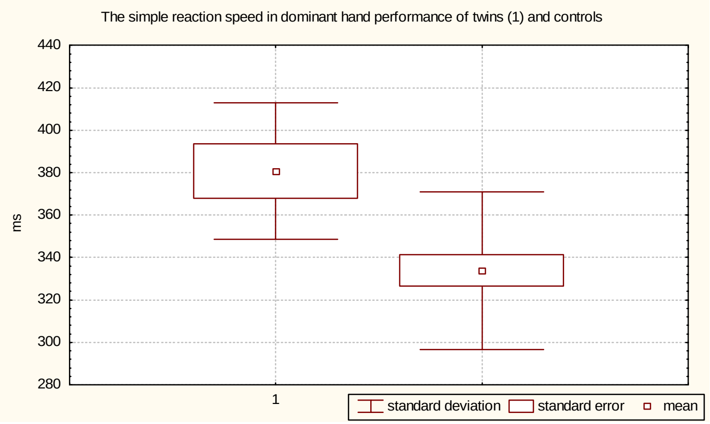

Fig. 1

The single-born subjects presented significant advantage in simple reaction speed in comparison to their twin contemporaries (Fig 1). However, no similar effect in speed of complex reaction was seen.

The complex reaction

In the complex reaction task, the movement time (time from releasing the “stand-by” button to the pressing of the “reaction” button) and the reaction time (the time from the stimulus appearance to the releasing the stand – by button), as well as the overall speed of reaction, were recorded. In general, the speed of complex reaction in left and right hand performance was almost the same in all twin pairs taken into consideration. Very small differences with dominant hand advantage were not statistically significant. The medium intra-pair difference in dominant hand performance was only 5.3%. Analogously to simple reaction task, the second-born twin in all pairs performed better with both hands.

The comparison of performance between the twin and single-born subjects allowed for findings statistically important differences in the movement time in dominant hand performance, by means of the ANOVA analysis of variance (p= 0.0052).

The advantage of single-born males in dominant hand movement time was very distinct in all subjects (Fig 2).

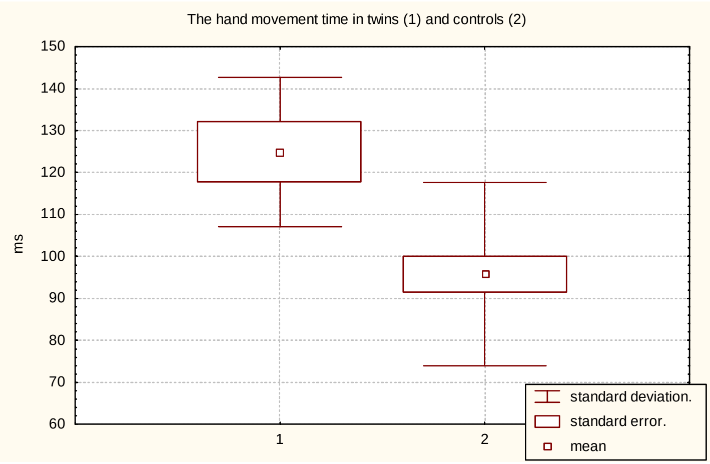

Fig. 2

No difference between two groups of subjects in complex reaction speed and reaction time had been recorded. However, the medium results in single-born males were better than in twins in both parameters.

The rhythm – adapting

In the rhythm test, results were recorded for guided and unguided phases. In the guided phase, great intra-pair differences in results were recorded, when the number of sequence errors were taken into consideration. The medium difference between the twins from one pair was computed on the level of 65% for right (dominant) hand. The non-dominant hand performance was connected with greater intra-pair differences, with a medium value 69.5%. The Wilcoxon's pair sequence test confirmed differences between dominant and non-dominant hands in subjects as statistically significant (T=0.0464; p< 0.05).

The group of single-born subjects performed better in the guided phase of the test with dominant as well as with the non-dominant hand. In the right hand, the difference in number of sequence errors were substantial, but analysis of variance between groups of subjects indicated the results of ANOVA test were only tending toward significance (p=0.0508).

Analyzing the amount of errors in the unguided phase, it was found that all subjects (twins and single-born) performed worse than in guided phase of the test, with both hands. Here, differences between performing extremities (dominant and non-dominant) were relatively small in all subjects, and not statistically significant.

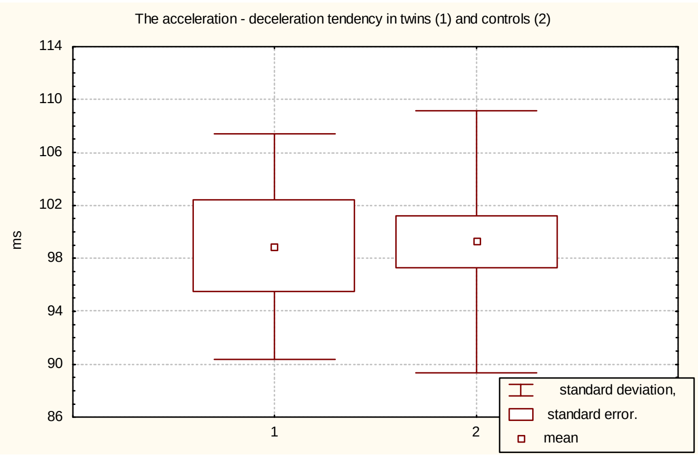

Fig. 3

The next element of analysis was the comparison of acceleration-deceleration tendency in the unguided phase of the rhythm test. The intra-pair differences in twins were quite small, with the medium of 12.6 % difference for dominant, and 10.12 % of difference in non-dominant hand performance. Surprisingly, the single-born subjects' performance with the dominant hand was nearly identical to those of the twin subjects (Fig 3).

The frequency of movements

Analyzing the frequency of hand movements measured by the amount of taps made within a period of 16 seconds of performance, the dominant hand advantage was seen in all subjects, which was in concordance with previous findings (Peper & Beek, 1998). The difference between the dominant hand performance in twin and single-born subjects was substantial significant (Fig 4), with a great superiority of twin subjects. The variance analysis ANOVA confirmed the significance of such results (p=0.0474).

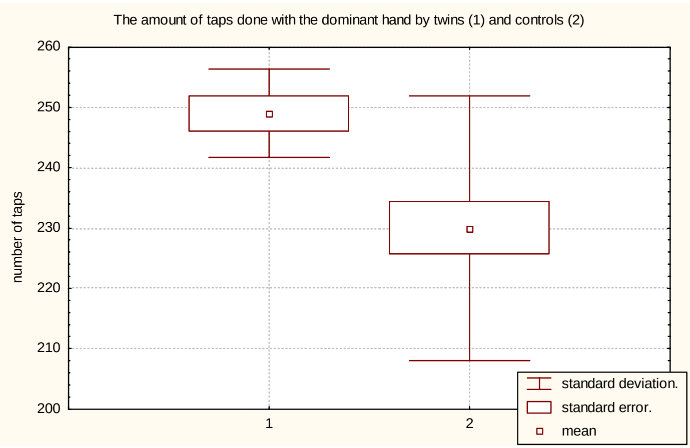

Fig. 4

Discussion

The experiment confirmed the intra-pair differences in motor performance of MZ twins as task dependant. The greatest similarity of movements in MZ, male twins is observed in complex reaction speed. The greatest intra-pair differences in MZ twins are connected with the rhythm adapting tasks. In this experiment the intra-pair differences (especially in number of errors made in the guided phase of the rhythm test) were quite large (up to 69%). Such results are in strong contrast to the results of Skład (1975), who found great similarity of rhythm in MZ twin pairs. In the large majority of the population, the motor performance in unilateral tasks is dependent on hand preference (Agnew et. al., 2004; Elliot & Heath, 1999; Flowers, 1975; Jancke et. al., 2000; Olex, 2000; Peters, 1991). This experiment confirmed the dominant hand advantage in the majority of tests, but contrary to previous findings with single-born subjects, the hand dominance seems to be a rather insignificant factor in the level of performance in MZ twins. The only exception in our study was in the rhythm adapting task, where the number of sequence errors were attached to hand dominance, and the dominant hand advantage was confirmed statistically. However, this result should be confirmed on a larger sample of twin subjects.

The research on twin subjects was described in literature to be a valuable tool in the area of genetic background of human motor behavior (Jones & Martin, 2000; Klissouras, 1973; Shephard, 1981). The similarity of movements in MZ twins was greater in comparison to both DZ twins and single-born individuals, but results obtained by us and other authors distinctly indicate the individual character of movement – both simple and complex (Hoffman, 1965; Skład, 1972). However, some of co-ordination characteristics seem to be stronger conditioned genetically than others. In our experiment, such a characteristic was complex reaction speed, which is in concordance with the results obtained by Skład (1975) and Ljach (Raczek et. al., 1998), but contrary to the findings by Szopa and Mleczko (1987).

Differences in motor co-ordination of twins and single-born subjects may be caused by several factors, including individual processes of neuromotor maturation, genetic background, environmental determinants, such a birth order or intrauterine environment (less comfortable for maturation in twins) and the influence of motor activity of each subject (Agnew et. al., 2004; Bishop, 2001; Raczek et. al., 1998; Shephard, 1981). The problem of performance differences between the twin and single-born subjects needs further scientific research on larger groups of people of different ages. The level of twin subjects' motor performance, in comparison to other groups of subjects, seems to be a scientific problem worth further research.

From this experiment, the following conclusions can be made:

1. There are differences in some aspects of co-ordination between twin and single-born subjects – the majority of tasks showing an advantage with single-born subjects.
2. In that research group, the only aspect of co-ordination with twin subjects advantage found was the frequency of movement.
3. The acceleration-deceleration tendency in rhythm-adapting task seemingly reveals no difference in twin and single-born subjects.

4. The motor control of MZ twins seems to differ from single-born subjects in some aspects, thus requires further scientific research.

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