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AGILITY PERFORMANCE OF IPSILATERAL AND CONTRALATERAL DIRECTION OF TABLE TENNIS PLAYERS AND SEDENTARY SUBJECTS OF DIFFERENT AGES

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ABSTRACT

In the study, agility time of ipsilateral and contralateral direction of table tennis players and sedentary subjects of different ages were compared. Forty-nine young, early middle-aged, late middle-aged and older table tennis players and forty-six sedentary subjects of matched age performed the agility test. FiTRO Agility check consisting of movement reactions to visual stimuli to the ipsilateral and contralateral direction was used. The independent samples t-test revealed a significantly lower agility time to the ipsilateral than contralateral direction in both groups in almost all categories. However, the differences between directions in agility time (delta AT) were not significant among any of the age-matched categories. Nevertheless, small effect sizes indicate that playing table tennis contributes to smaller delta AT with increasing age. This effect was mainly observed between players and sedentary subjects of late middle (22.0%) and older age (23.4%). In addition, delta AT between late middle-aged and older subjects showed a tendency of midline-crossing inhibition compared with the ipsilateral direction in older age in both groups. Table tennis can be recommended particularly for subjects over 45 years to reduce differences in agility time between the ipsilateral and contralateral direction and to restrict the development of midline-crossing inhibition in older age.

Keywords: Ageing; Agility test; Bilateral coordination; Midline-crossing inhibition.

INTRODUCTION

The human brain consists of two anatomically and functionally asymmetric hemispheres. One of these asymmetries is in grey and white matter, which is greater in the left than in the right hemisphere (Good *et al*., 2001; Pujol *et al*., 2002). The right hemisphere is more sensitive to the harmful effects of ageing than the left hemisphere and it could account for one of the effects of ageing on lateralisation (Dolcos *et al*., 2002). This view predicts that age-related cognitive decline should be more pronounced on cognitive functions associated with the right hemisphere. Cognitive performance is positively correlated with age-related asymmetry reductions (Rosen *et al*., 2002; Daselaar *et al*., 2003). This reduced hemispheric asymmetry is specific to the high-performing rather than low-performing older adults. This reduction is also more pronounced in older (75-80 years) than in young-old adults (60-70 years) because of more advanced forms of neurocognitive decline (Logan *et al*., 2002; Stebbins *et al*., 2002; Daselaar *et al*., 2003). Such a decline appears in reaction time as a reflection of cognitive function which, as known, gets inferior with increasing age (Der & Deary, 2006; Jacobsen *et al*., 2011; Woods *et al*., 2015).

Authors who follow a life-span development found that there are a variety of changes in functioning during the later stages of adulthood (Huston-Stein & Baltes, 1976; Baltes, 1987). One of these age-related changes may be reflected in the movements that cross the midline of the body. Contralateral movements (or midline crossing) appear to represent more complex movements than ipsilateral movements because of greater neurological organisation. This may be explained by the fact that contralateral movements require more response-processing time and greater neurological organisation than is necessary for movements that did not cross the midline of the body (Surburg & Eason, 1999). More specifically, ipsilateral movements are for example catching the ball with your right hand on the right side and contralateral movements are catching the ball with your right hand on the left side, where you have to cross the midline of your body.

Lombardi *et al*. (2000) compared reaction and movement times of the foot to the ipsilateral (without midline crossing), midline and contralateral direction (with midline crossing) and found movement-related ipsilateral positivity and contralateral negativity. Subjects aged 20-35 years exhibited no midline crossing effects (MCI) in reaction time. Subjects aged 65-79 years exhibited MCI effects compared with ipsilateral direction and subjects aged over 80 years exhibited MCI effects compared with both ipsilateral and midline directions. More specifically, reaction and movement time were slower among individuals over 80 years of age for all three directions. Subjects aged 65-79 years had significantly slower reaction time (but not movement time) to the contralateral and midline direction compared with ipsilateral direction. On the other hand, there were no significant between-direction differences in reaction and movement time among the youngest subjects from 20 to 35 years.

Similarly, the agility time consisting of both reaction and movement time increases with advancing age. However, playing table tennis contributes to significantly shorter agility time in early middle-aged, late middle-aged and older adults compared to those with a predominantly sedentary lifestyle (Horníková *et al*., 2018). Table tennis players have shorter agility time than badminton players, fencers, karate or tennis players (Zemková & Hamar, 2015).

PURPOSE OF RESEARCH

Table tennis players require quick reaction speed and movement response because of the small playing area and high speed of the ball, which distinguishes them from the above-mentioned players. However, there is a lack of information about differences in agility time to the ipsilateral and contralateral direction with increasing age. Another question that remains is whether table tennis contributes to smaller differences between these directions. Therefore, the purpose of this study is twofold. Firstly, to compare the agility time to the ipsilateral and contralateral direction in young, early middle-aged, late middle-aged and older table tennis players and sedentary subjects. Secondly, to compare differences in agility time between these directions in players of different age categories and sedentary subjects of different age categories, as well as between players and sedentary subjects of particular age categories.

METHODOLOGY

Ethical clearance

The procedures presented were in accordance with ethical standards on human experimentation stated in compliance with the Helsinki Declaration and were approved by the ethical committee of the Faculty of Physical Education and Sport of the Comenius University (No. 3/2017).

Participants

Forty-nine male competitive table tennis players were recruited for this study. Their level of performance is within the 3rd and 4th national regional league. They regularly participate in the competitions and have three practice sessions per week that last for 2 hours. The control group consisted of 46 males classified as sedentary because of no leisure-time activity and less than 30 minutes of physical activity each day (Booth & Chakravarthy, 2002).

Both groups were divided into four age-related categories (Gregor, 2014): young (20-29 years, 9 players and 10 sedentary); early middle-aged (30-44 years, 19 players and 12 sedentary); late middle-aged (45-59 years, 12 players and 13 sedentary); and older adults (60-70 years; 9 players and 11 sedentary). The sample size in some of these groups was relatively small due the fact that only a small number of participants met the inclusion criteria, which were defined as: active table tennis players (training at least 3 times a week), active participation in a competition and at least 6 months injury free. However, the data were normally distributed.

The participants' age, height and body mass are described in the Table 1. Participants were informed about the procedures and the main purpose of this study. Prior to the study, written informed consent was obtained from all of them. All experimental procedures were in accordance with the ethical standards on human experimentation stated in compliance with the Helsinki Declaration.

Table 1. **CHARACTERISTICS OF PLAYERS AND SEDENTARY SUBJECTS**

Age category	n	Age (years)	Height (cm)	Body mass (kg)
Table tennis players				
Young	9	26.4±5.1	185.3±9.9	80.6±12.2
Early middle-aged	19	38.3±5.1	180.0±5.9	90.1±16.2
Late middle-aged	12	52.2±3.6	174.4±4.6	91.1±18.9
Older	9	62.7±2.1	173.9±3.7	87.3±14.2
Sedentary subjects				
Young	10	24.1±3.3	184.1±8.1	86.3±12.6
Early middle-aged	12	34.8±4.2	179.6±6.7	87.5±14.4
Late middle-aged	13	52.0±5.1	175.1±5.8	88.4±14.2
Older	11	65.0±3.1	175.5±6.5	87.9±16.9

Procedure

Participants were tested in a table tennis gym. They performed a modified agility test using FiTRO Agility check. The reliability of the test procedure was verified and the protocol was standardised by the examination of 196 subjects in one of the former studies (Zemková & Hamar, 1998). Analysis of the repeated measures showed a measurement error of 7.1%, which is within the range comparable to the common motor tests. The test was adjusted to the specific conditions of table tennis. They started at 50cm from the table tennis table. The starting position was with their dominant hand opposite to the centreline while standing in a starting position with a slight inclination. Their task was to respond as fast as possible with their dominant hand (playing hand) to the ipsilateral (forehand) or contralateral (backhand) direction in accordance with the stimulus appearing in one of the corners of the PC screen. After each movement reaction, they had to move back into the starting position.

Agility test

The test consisted of two sets of 32 visual stimuli (16 to the ipsilateral and 16 to the contralateral direction) with random generation of their location and generation time from 200 to 500ms. As a stimulus, a yellow circle on a blue background was used. The result was the average agility time of the best 16 movement reactions (8 in each direction) in the better of two trials. Data were collected using FiTRO Agility check (FiTRONIC, Bratislava, Slovakia) consisting of contact mats and interface connecting with a PC. Contact mats were placed in two corners of the standard table tennis table (width 1.525 m).

Analysis of data

The data were analysed using SPSS statistical programme for Windows (Version 20.0; SPSS, Inc., Chicago, IL, USA). The Shapiro-Wilk test was performed on all variables and revealed that data was normally distributed. The independent samples t-test was conducted to determine significant differences in agility time between the ipsilateral and contralateral direction of table tennis players and sedentary subjects of different ages. The same test was used to determine significant differences in agility time between these directions between table tennis players and sedentary subjects of different ages. The level of significance was set at $p \leq 0.05$. Cohen´s *d* was used to determinate the effect size (the value of $0.2 \leq d < 0.5$ – small effect; $0.5 \leq d < 0.8$ – medium effect; $0.8 \leq d$ – high effect). Data on agility time for all examined groups were presented as mean±standard deviation.

RESULTS

Agility time was significantly lower to the ipsilateral than the contralateral direction in both table tennis players (p=0.04; p=0.02; p=0.02) and sedentary subjects (p=0.01; p=0.04; p=0.01; p=0.013) of almost all age categories except for late middle-aged (p=0.07) table tennis players (Table 2; Figure 1 & 2).

Table 2. **AGILITY TIME OF IPSILATERAL AND CONTRALATERAL DIRECTION FOR EACH AGE CATEGORY OF TABLE TENNIS PLAYERS AND SEDENTARY SUBJECTS**

Age category	Agility time (ms)		Direction differences (p-value)	Cohen´s *d*
	Ipsilateral	Contralateral		
Table tennis players				
Young	415.5±36.9	453.6±35.3	0.04	1.06
Early middle-aged	418.5±29.9	451.8±49.3	0.02	0.82
Late middle-aged	461.2±37.0	492.8±45.3	0.07	0.76
Older	474.0±22.9	518.2±26.4	0.002	1.79
Sedentary subjects				
Young	442.9±22.8	482.8±23.6	0.001	1.72
Early middle-aged	465.7±46.1	502.0±33.4	0.04	0.90
Late middle-aged	505.6±38.5	546.1±40.2	0.01	1.09
Older	535.6±48.1	593.3±51.8	0.013	1.15

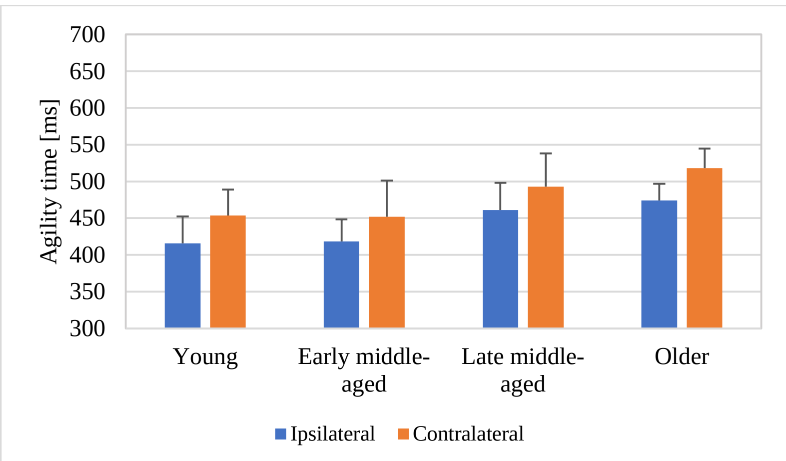

Figure 1. **AGILITY TIME OF IPSILATERAL AND CONTRALATERAL DIRECTION FOR TABLE TENNIS PLAYERS OF DIFFERENT AGES**

Agility time between the ipsilateral and contralateral direction (delta agility time) did not differ significantly between particular age categories of table tennis players (Table 3). Similar results were observed between sedentary subjects of matched age. However, there was a small effect size in delta agility time between young and late middle-aged (*d*=0.21), early middle-aged and older players (*d*=0.33). The medium effect sizes in delta agility time were found between young and older (*d*=0.67), early middle-aged and older sedentary subjects (*d*=0.71). The small effect sizes in delta agility time were observed between late middle-aged and older subjects in both groups (*d*=0.45 and *d*=0.43) respectively. This increase of delta agility time from late middle-aged to older subjects can be ascribed to the greater increase in agility time to the contralateral rather than ipsilateral direction in both players (12.8ms and 25.2ms, respectively) and sedentary subjects (30ms and 47.2ms, respectively).

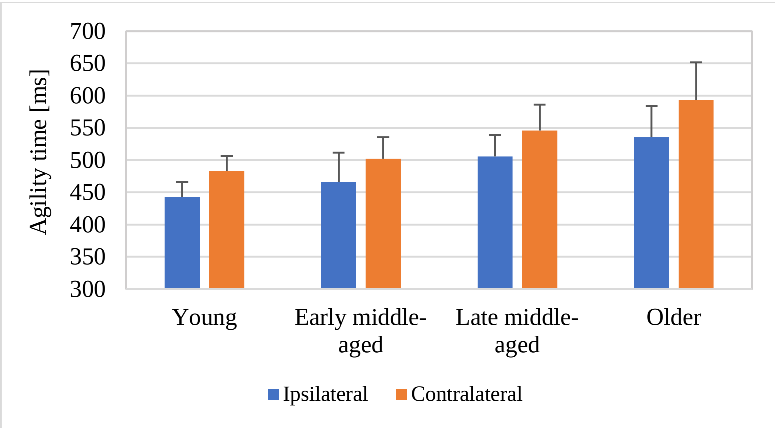

Figure 2. **AGILITY TIME OF IPSILATERAL AND CONTRALATERAL DIRECTION FOR SEDENTARY SUBJECTS OF DIFFERENT AGES**

Table 3. **BETWEEN-DIRECTION DIFFERENCES (DELTA) IN AGILITY TIME OF TABLE TENNIS PLAYERS AND SEDENTARY SUBJECTS OF DIFFERENT AGES**

	Table tennis players		**Sedentary subjects**	
Age categories	Age differences (p-value)	Cohen´s *d*	Age differences (p-value)	Cohen´s *d*
Young vs. Early middle-aged	0.74	0.14	0.71	0.17
Young vs. Late middle-aged	0.63	0.21	0.97	0.17
Young vs. Older	0.70	0.19	0.15	0.67
Early middle-aged vs. Late middle-aged	0.89	0.06	0.78	0.11
Early middle-aged vs. older	0.43	0.33	0.10	0.71
Late middle-aged vs. older	0.32	0.45	0.32	0.43

A between-group comparison in delta agility time between table tennis players and sedentary subjects of particular age categories showed that these values did not differ significantly (p=0.89; p=0.80; p=0.56; p=0.36) (Table 4). However, there were small effect sizes in delta agility time between late middle-aged players and sedentary subjects and older players and sedentary subjects (*d*=0.24 and *d*=0.42) respectively. The largest differences were observed between older adults (23.4%) followed by late middle-aged (22.0%), early middle-aged (8.0%) and young adults (4.5%) (Figure 3).

Table 4. **BETWEEN-GROUP DIFFERENCES IN DELTA AGILITY TIME OF TABLE TENNIS PLAYERS AND SEDENTARY SUBJECTS OF DIFFERENT AGES**

Age categories	**Between-group differences (p-value)**	**Cohen´s *d***
Young players vs. young sedentary subjects	0.89	0.07
Early middle-aged players vs. Early middle-aged sedentary subjects	0.80	0.09
Late middle-aged players vs. Late middle-aged sedentary subjects	0.56	0.24
Older players vs. Older sedentary subjects	0.36	0.42

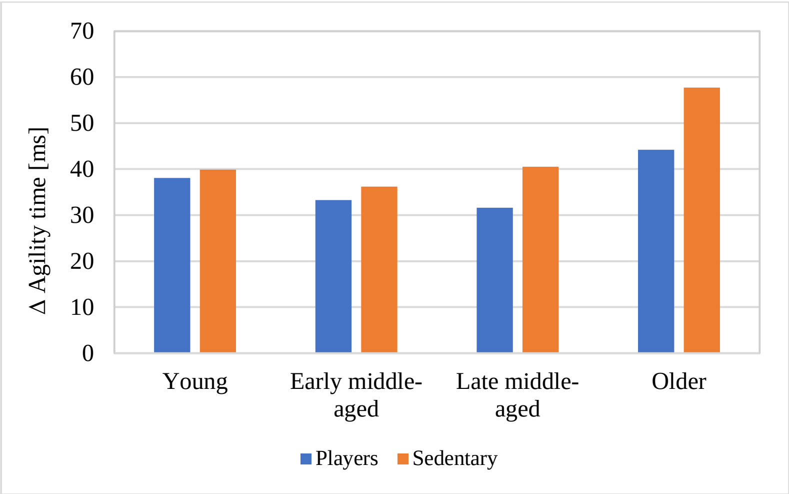

Figure 3. **BETWEEN-DIRECTION DIFFERENCES (DELTA - Δ) IN AGILITY TIME FOR TABLE TENNIS PLAYERS AND SEDENTARY SUBJECTS OF DIFFERENT AGES**

DISCUSSION

The agility time of ipsilateral direction was significantly lower than the contralateral direction for both table tennis players and sedentary subjects in each age category except for late middle-aged players. This finding is in accordance with the original assumption because backhand on the contralateral direction has higher demands on coordination than forehand and, therefore, requires more complicated processing of the response (Grasso, 2011).

Differences in agility time between these directions (delta) did not differ significantly in either of age categories of table tennis players. However, the small effect size in delta agility time between young and late middle-aged, early middle-aged and older and between late middle-aged and older table tennis players indicated more pronounced between-direction differences in agility time in the older age group.

Similarly, delta agility time did not differ significantly in sedentary subjects in any of the age categories. However, medium effect size in delta agility time between young and older, early middle-aged and older and small effect size between late middle-aged and older sedentary subjects suggests more pronounced between-direction differences in agility time in older age. This may be ascribed to the slower processing speed of older adults in the tasks that require more complicated action to initiate an appropriate response (Amrhein *et al*., 1991; Melis *et al*., 2002).

The effect of midline-crossing inhibition reflects a regressive step leading away from bilateral coordination and toward more unilaterally organised movement in individuals aged 65 years and older (Lombardi *et al*., 2000). This may be one of the reasons why the agility time increases more profoundly to the contralateral than to the ipsilateral direction from late middle-aged to older players and sedentary subjects. However, the medium effect size in delta agility time between young and older, early middle-aged and older sedentary subjects indicate that playing table tennis contributes to less pronounced between-direction differences in agility time in young and early middle-aged compared to older subjects. While agility time to the contralateral direction increased by 18.6% from young to older sedentary subjects, for table tennis players it was only by 12.4%. Presumably, contralateral movements (or midline crossing) are more difficult movements for sedentary individuals and as a result may require greater neurological organisation than ipsilateral movements (Surburg & Eason, 1999).

A between-group comparison revealed no significant differences in delta agility time between young (4.5%), early middle-aged (8.0%), late middle-aged (22.0%) and older (23.4%) players and sedentary subjects. However, there were small effect sizes in delta agility time for late middle-aged and older subjects. While its values started to increase already in early middle-aged sedentary subjects, in players it was in late middle-aged age. Backhand, which is performed to the contralateral direction (on the side of the non-dominant hand) has higher demands on coordination and thus it is a more difficult stroke in comparison with forehand performed to the ipsilateral direction (on the side of dominant hand). In addition, the force of backhand is lower than the force of forehand (Grasso, 2011).

It seems that the adaptation to long-term practice in table tennis consisting of a large number of repeated reactions to the visual stimuli in both directions could play a role in there being smaller differences in agility time between these directions. A previous study showed that playing table tennis contributes to better agility performance in middle-aged and older subjects as compared to those with a predominantly sedentary lifestyle (Horníková *et al*., 2018). The findings of the present study extended the contribution of playing table tennis as there is a tendency to have smaller between-direction differences in agility time in late middle-aged and older subjects. It also seems that this contribution may be observed in the restriction in development of midline-crossing inhibition for the older age.

A limitation of this study is a low sample size of table tennis players over 60 years old who regularly participate in league competitions. Therefore, the results confine generalising the findings to the whole population of table tennis players.

PRACTICAL APPLICATION

These results completed the findings of a previous study that playing table tennis contributes to better agility performance in middle-aged and older subjects. The current study showed a tendency to smaller between-direction differences in agility performance in late middle-aged and older players compared to sedentary subjects. Consequently, table tennis can be recommended for persons over 45 years to reduce between-direction differences in agility time and to restrict the development of midline-crossing inhibition in older age.

CONCLUSION

The agility time of ipsilateral direction was significantly lower than that of the contralateral direction in almost all age categories of table tennis players and sedentary subjects. However, there were no significant differences in agility time between these directions among each age category of both the players and the sedentary subjects. The between-direction differences in agility time did not differ significantly between the players and the sedentary subjects of particular age categories. However, small effect sizes indicate that playing table tennis contributes to smaller between-direction differences in agility time in late middle-aged and older subjects. It seems that playing table tennis can contribute to constrain the development of midline-crossing inhibition, especially in middle-aged and older subjects.

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