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Proprioceptive indicators (precision, speed and personality) of age-depended differences for traffic security

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Abstract

This study analyses age-dependent differences in proprioceptive fine motor precision and related features of personality and individual differences in order to define more critical ages for higher risks for traffic accidents. The Proprioceptive Diagnostics of Temperament and Character was applied to 196 participants (12-95 years old). Observable variables (deviations in spatial orientation and size reproduction in different movement types) were registered for both hands and analysed for the precision mechanics and their corresponding meaning in a personality test. Sex effects were also controlled. The results describe the most critical periods for having higher risks for traffic accidents.

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Keywords: age-dependent risks for accidents; Proprioceptive Diagnostics of Temperament and Character; traffic safety; proprioception; personality; individual differences

1. Introduction

A comparative study in personality differences between traffic offenders and non-offenders found the former to be more extraverted (Lev, Hershkovitz, & Yechiam, 2008). It was also confirmed by the fact that countries with high extraversion scores were shown to have more traffic fatalities than those with moderate or low extraversion scores, whereas neuroticism was negatively correlated to road fatalities (Lajunen, 2001).

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Since verbal tests reflect only one part of our behaviour (mainly that we consciously understand or recognize), other methods, e.g. the graphomotoric one, could be more objective or complementary in describing the personality construct (Tous & Liutsko, 2014). Proprioception not only describes personality and individual differences (Liutsko, 2013) and detects differences in aggressiveness, e.g. Tous, Viadé, Chico, & Muñños, 2002, but it is also related to movement control and attention (Ingram, van Donkelaar, Vercher, Gauthier, & Miall, 2000; Liutsko, Segura, Tous, 2014), visual memory (Liutsko, Tous, & Muñños, 2012) and such diseases as Parkinson (Gironell, Liutsko, Muñños, & Tous, 2012).

Myokinetical psychodiagnostic (Mira, 1958; Wechsler, 1963) was used to observe proprioceptive states for both movement control and personality for security questions in drivers and pilots (Rotker, 1972; Seperiza, 1951); however, there have recently been no or very few studies made in this direction. Moreover, graphomotor methods have proved effective in assessing danger in general since they are sensitive to both personality dispositional behavioural features (Tous, Muñños, & Liutsko, 2014) and to mental illnesses or pathological and delinquent behaviours (Mira, 1942). Rantanen and Rosenbaum (2003) observed drifts in blind reciprocal aiming movements among aviators and questioned that this behaviour should have some explanation since it was systematic for each person.

Thus, individual differences in the proprioceptive state are very important in behavioural assessment and should be taken into account in life safety issues, including drivers and pilots. Our previous study showed significant age-related effects on size performance (Liutsko, Muñños & Tous, 2014) that corresponded to the scale of Irritability in the DP-TC. The current study aims to analyse spatial orientation in fine motor precision (with control for sex differences). We would like to test the following questions: a) Does age significantly affect the proprioceptive state measured as a feedback in the graphomotor tasks on fine motor precision for spatial orientation? and b) What observable variables are to be affected most of all and which personality features from the DP-TC are related to them? c) Are there any significant sex/gender differences in fine motor performance in both size and spatial orientation? Our hypothesis is that similarly to the size changes, biases in spatial orientation are to be affected by an age group. It is an exploratory study and we are not sure whether age will affect all the observable parameters and whether there will be any sex differences in both size and spatial orientation performances.

2. Method

2.1. Instruments

The computerized test (DP-TC, Tous, 2008; Tous Ral, Muñños, Tous Rovirosa, Tous López, 2012) was designed on the basis of the original manual version proposed by Mira (1940, 1958) as a myokinetic psychodiagnosis (M.K.P.) with use of new technologies after applying the confirmatory factor analysis and selecting the most descriptive parts (Tous, Viadé, Muñños, 2007; Muñños, 2008). To carry out the test the following material is needed: a tactile screen (a resolution of 1280x1024; an optimal frequency of 60 Hz) with a sensory stylus; a laptop computer; specifically designed test software for data recording and analysis; a piece of cardboard (or an opaque screen) for the non-vision part of the test to conceal the active hand and movement feedback; a stool adjustable to a participant’s height, and a table; written or oral instructions for the correct task procedure and performance (Tous, Muñños, Liutsko, Forrero, 2012; Tous et al., 2012, Tous, 2008).

2.2. Participants

The study group comprised volunteers with normal vision (N=196, age: 33±21 years old, range: 12÷95, 75 % men, 95% were with right-handed dominance). For this study’s analysis the participants were split into the following age groups: 1) 12-17 (N=40; 73% men); 2) 18-29 (N=63; 75% men); 3) 30-64 (N=67; 88% men), and 4) 65-95 (N=25; 44% men) that are related to their main activities: school age, university and young professionals; working and professional period, and retirement. The participants had been previously informed of the aim of the research and duly consented. All the tests were carried out as per ethical committee agreements in accordance with the WMA Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects.
2.3. Observable Variables and Data Analysis

The precision of fine motor performance (hand drawings over model lines) was measured with use of the Proprioceptive Diagnostics of Temperament and Character (DP-TC, Tous et al., 2012) in the following directions: 1) transversal movements in an interior to exterior direction (horizontal lines in the horizontal position of the screen); 2) sagittal movements in the from inner to outer direction (vertical lines in the horizontal position of the screen), and 3) frontal movements in from lower to upper direction (vertical lines in the vertical position of the screen).

The following variables were obtained for this study: size (line length –LL, included from a previous study to obtain a complex picture and interpret all the DP-TC dimensions; checked for sex differences in this study and spatial deviations (D – directional, which is performed parallel to the model; F – formal, which is performed perpendicular to the model).

The use of the DP-TC allows to measure the mechanics of the traced or drawn movement on the touch screen and to interpret the graphomotor biases as proprioceptive features of personality, as the following dimensions of dual poles (Tous et al., 2012; Tous & Liutsko, 2014): 1) Mood (pessimism – optimism); 2) Decision making (submission – dominance); 3) Style of attention (intra-tension – extra-tension); 4) Emotivism (cold/distant – warm/affiliated); 5) Irritability (inhibition – excitability), & 6) Variability (rigidness – variability). The instrument has both types of variables: normative (T-scores that were standardized for the Spanish population) and raw data (Tous et al., 2012).

Descriptive statistics, Kolmogorov-Smirnov tests for data normality and MANOVA with Bonferroni correction for multiple comparisons and post-hoc effects were performed with use of SPSS (v.19).

3. Results and Discussion

Table 1. Descriptive statistics for precision for different age groups and both sexes (raw data)

| Observable variables | Line length, mm | Directional bias, mm | Formal bias, mm |
|----------------------|----------------|----------------------|-----------------|
|                      | sex            |                      |                 |
|                      | Male           | Female               | Male           | Female           | Male           | Female           |                 |
| MT                   |                |                      |                 |
| Hand                 |                |                      |                 |
| age_gr               |                |                      |                 |
| nd                   |                |                      |                 |
| 12-17                | 41             | 9                    | 35             | 7               | -6.0           | 18             | -11.6           | 14              | 13.3           | 10              | 11.9           | 9              |
| 18-29                | 40             | 13                   | 41             | 12              | -4.1           | 12             | -8.6            | 13              | 9.8            | 9               | 9.4            | 5              |
| 30-64                | 40             | 9                    | 39             | 13              | -0.1           | 10             | -2.9            | 7               | 10.4           | 9               | 16.7           | 5              |
| 65-95                | 66             | 40                   | 48             | 15              | -7.3           | 19             | 4.6             | 15              | 27.9           | 35             | 26.3           | 26             |
| 12-17                | 41             | 14                   | 36             | 7               | -14.1          | 17             | -11.7           | 13              | 17.1           | 18             | 14.2           | 11             |
| 18-29                | 39             | 10                   | 39             | 11              | -11.5          | 14             | -9.3            | 11              | 9.7            | 8               | 10.6           | 7              |
| 30-64                | 40             | 7                    | 39             | 11              | -7.2           | 12             | -8.0            | 7               | 8.2            | 7               | 10.1           | 9              |
| 65-95                | 61             | 36                   | 50             | 18              | -15.2          | 16             | -5.0            | 25              | 22.9           | 26             | 37.5           | 29             |
| d                   |                |                      |                 |
| 12-17                | 52             | 17                   | 49             | 28              | 2.9            | 21             | 10.8            | 21              | -4.7           | 7              | 5.8            | 25             |
| 18-29                | 30             | 7                    | 31             | 7               | -1.7           | 11             | -1.4            | 12              | -1.0           | 7              | -0.7           | 8              |
| 30-64                | 35             | 7                    | 47             | 21              | 0.2            | 13             | -0.2            | 38              | -3.5           | 9              | -2.7           | 10             |
| 65-95                | 97             | 71                   | 78             | 39              | -17.0          | 47             | 9.6             | 30              | -16.9          | 14             | -24.7          | 30             |
| 12-17                | 45             | 16                   | 39             | 11              | -3.1           | 15             | 2.0             | 16              | -0.9           | 7              | 2.3            | 9              |
| 18-29                | 29             | 9                    | 29             | 9               | -1.1           | 11             | 5.7             | 14              | 0.7            | 7              | -1.2           | 5              |
| 30-64                | 33             | 9                    | 43             | 15              | 2.9            | 11             | 2.0             | 22              | -1.6           | 8              | -2.0           | 8              |
| 65-95                | 84             | 45                   | 88             | 40              | -8.6           | 28             | -22.9           | 31              | -11.6          | 11             | -13.6          | 18             |
| nd                   |                |                      |                 |
| 12-17                | 36             | 9                    | 29             | 5               | 12.5           | 12             | 13.7            | 10              | 1.1            | 16             | 3.9            | 18             |
| 18-29                | 33             | 8                    | 34             | 9               | 15.3           | 12             | 14.8            | 12              | 3.7            | 9               | 1.2            | 12             |
| 30-64                | 36             | 8                    | 33             | 9               | 14.3           | 12             | 11.3            | 12              | -2.3           | 10             | -2.8           | 23             |
| 65-95                | 50             | 28                   | 48             | 17              | 11.3           | 16             | 17.3            | 27              | -10.3          | 21             | -2.9           | 29             |
| d                   |                |                      |                 |
| 12-17                | 36             | 27                   | 26             | 3               | 19.3           | 25             | 15.8            | 10              | -4.5           | 29             | -2.9           | 11             |
| 18-29                | 32             | 9                    | 34             | 9               | 15.7           | 11             | 16.6            | 12              | -1.4           | 8              | 0.7            | 11             |
| 30-64                | 35             | 7                    | 33             | 10              | 14.1           | 11             | 13.5            | 12              | -3.8           | 10             | 3.3            | 12             |
| 65-95                | 51             | 23                   | 48             | 19              | 8.7            | 14             | 20.8            | 22              | -2.3           | 23             | -5.9           | 17             |

Legend: nd – non-dominant (hand), d – dominant (hand), MT – movement type.

The size or line length performance changes through different age groups were shown to be greater both in the mean value (M) and variability (SD) in the older age subgroup. As per DP-TC test, this movement type reflects the balance between inhibition and excitability, thus showing a more balanced performance (compared to the model line.
length of 40 mm) in the young and middle age groups with a greater tendency to inhibition in the middle ages (18-29 and 30-64) and higher excitability in the older group in both sexes (except on performance in non-dominant hand and frontal movement).

As far as the directional bias in precision performance is concerned, the common tendency for the majority of variables was a change from greater imprecision (and variability in performance) in the youngest group (12-17) to the minimum error rate in the middle age and an increased error in the older group. In frontal movement and non-dominant hand, the women had a slightly higher tendency towards pessimism compared to the men in the first three age subgroups, whereas the situation was controversial in the older age group.

In transversal movement and non-dominant hand, the women outperformed the men in the mean value in ages 12-17, showing a higher tendency towards temperamental Extra-tension. In the middle ages, the performance was quite equal in both sexes and with less error, indicating a balance between both the poles in the Attention style dimension (Intra-tension and Extra-tension). In the older group, while the women had similar values to the age of 12-17 with a tendency towards Extra-tension, the men changed their movements, as an average value of group, towards a higher Intra-tension. In the dominant hand of the same movement, the women’s performance in the older group had a greater tendency towards Intra-tension compared to that of themen.

In formal bias precision, which is related to proprioceptive condition to Emotivism in the DP-TC test, we can observe a higher emotional instability and variability in the older group (65-95) in both hands. The women had higher error compared to the men in the older group in frontal movement (with more positive bias) and transversal movement (with more negative bias for an average value); however, they showed less bias in the average group value in transversal movement compared to the men, although they performed with greater variability (with a more negative bias for the mean value).

The MANOVA analysis with Bonferroni correction for multiple comparisons showed significant age effects on precision. Although statistically significant differences were observed for the size reproduction (line length, LL) for all movement types and both hands; in spatial deviations they were observed in only some of them: 1) one of six in directional bias: in transversal movement and dominant hand, and 2) in four of six in formal bias: in frontal and transversal movements and both hands (p<.001). Significant sex effects were performed in size (LL) in frontal movement and non-dominant (p=.013) and in directional bias in transversal movement and non-dominant hand (p=.020), thus showing only biological differences effects since they were observed only in the non-dominant hand as per the DP-TC interpretations. No significant interactive effects (age*sex) were shown in this study.

Further post-hoc analysis revealed which age-groups were different from the others in comparative analysis.

The 65-95 group was the worst in performance for majority of observable variables compared to the others followed by the group of 12-17 which was less precise for some variables compared to the middle age groups, especially 18-29.

In sum, the dynamics of fine motor precision performance changes as a quadratic polynomial (for those variables where age had statistically significant effects) with higher age effects, firstly, on the older group and, secondly, on the younger one. This pattern could be explained by developmental changes in the proprioceptive sense – firstly, imprecision due to the maturation process, secondly, the highest precision and velocity in the middle age groups and followed by a decline due to aging processes.

4. Conclusions

The older age group (65-95) has been found to be more imprecise in the proprioceptive task fine motor performance, followed by the younger group (12-17). We conclude that the older age group, in the first place, and the younger age groups, in second place, have higher risks in traffic accidents due to the shown age-dependent features in proprioceptive fine motor performance. However, spatial orientation precision was better performed compared to size since age effects were not observed in all the variables. The personality proprioceptive dimensions affected by age changes most of all, were Irritability and Emotivism, also Style of Attention. Sex differences in performance were found solely in the following two observable variables: the first one in size performance (Irritability: higher excitability among men in the older age group, non-dominant hand) and the second one in the directional bias (Style of Attention: a tendency to be more oriented to the external world in women in the younger and older age groups, non-dominant hand). It is an exploratory study and more research is required in this direction.
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