Psychology in Russia: State of the Art
Volume 12, Issue 3, 2019

Russian Psychological Society
Lomonosov Moscow State University

Individual Differences in Fine Motor Precision in Participants from Different Countries and their Psychological Meaning

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Background. Despite the global tendency toward multidisciplinary research, there is still an abyss between some areas of human science. For example, in the motor control area, psychology should contribute to a better comprehension of human movement, and vice versa, the motor control in the psychological branch should also be considered more. Comparative studies on individual and personality differences in the representatives of various cultures are less biased if studied with the use of motor control or graphical methods because these methods do not require any linguistic or cultural adaptation.

Objective & Methods. In this study, which aims to observe the individual characteristics of the participants (170 in total) from different cultures (by countries of birth and residence), we used the graphomotor method, the Proprioceptive Diagnostics of Temperament and Character (Tous et al, 2012) that evolved within the traditional Miokinetical Psychodiagnosis of Mira y Lopez (1958).

Design. Individual cultural differences (participants by origin or residence from Spain, Morocco, East Europe and Latin America) in graphical test performance (fine motor precision) were measured in the proprioceptive sensory condition (without visual guidance) for both hands (dominant and non-dominant) in three movement types (Frontal, Transversal and Sagittal). Sex differences were also observed and discussed. The related psychological meaning of these individual differences is also discussed.

Results. The results of this study are discussed in the article. They included not only the description of the specific test conditions (hand use, movement, and bias types) but also the explanation of the psychological meaning of differences (personality dimensions) compared with the cultural groups or sex subgroups levels. Moreover, the differences between men and women within each cultural subgroup are also analyzed. Better comprehension of cultural differences would help in obtaining more qualified therapeutic, educational and judicial help, by reducing of the derived possible negative biases or misinterpretations in human behavior. This can result in such benefits, for example, as better adaptation of immigrants in other cultures.

Conclusion. The majority of significant differences between representatives of various cultural subgroups in this study were obtained in the non-dominant hand, meaning that such differences were more at the basic level. Further adaptive behavior to the environmental changes in their lives led to disappearance of such differences, especially in those who were residing in the same country.

Keywords:
fine motor precision; proprioceptive diagnostics; individual differences; personality; cultural differences; sex differences; perception

ISSN 2074-6857 (Print) / ISSN 2307-2202 (Online)

http://psychologyinrussia.com

Introduction

The current motor control studies have a predominant orientation to the mechanistic approach that sometimes cannot explain everything. Thus, in the study performed on the pilots, "unexplainable systematic drift was observed in blind reciprocal aiming movements" as described by authors (Rantanen & Rosenbaum, 2003). However, Mira y Lopez, working with pilots before WWII, observed individual differences in space perception; when the visibility was low, vision was limited (due to high density fog). Further work led Mira to create Miokinetic Psychodiagnosis (Mira, 1958) (partially under the influence of Luria's work "Nature of human conflict" (1932), and partially by personally observing the amplitude of movements of different participants under the "lie detector"). In his work, Mira explains the psychological meaning of such systematic drifts (based on individual differences in nervous, perceptive, emotional, and executive systems), which was further developed by different followers. With the help of his colleagues, Prof. Tous from the University of Barcelona made great efforts to advance the methodology by creating the digitalized version of the Miokinetic Psychodiagnosis (MKP) subtests "lineograms" and "parallels", after the statistic validation of the original test performed by Ruben Muiños in his PhD thesis (Muiños, 2008). Although several studies were performed (more than 300) (Liutsko, 2014) with the use of this methodology of exploring the psychological and neuropsychological meaning of fine movements (Tous & Liutsko, 2014), including children (Liutsko, Igelsias, Tous Ral, & Veraksa, 2018) and neurological patients, such as those with Parkinson's disease, for example (Gironell, Luitsko, Muiños, & Tous, 2012), the role of motor control in psychology has been rather underestimated (Rosenbaum, 2005).

Studies performed in the area of motor control related to cognition or emotions are scarce. Motor control performance has been found to have a relationship with cognitive performance in the previous studies: some fine motor precision parameters were significantly related to working memory performance (Liutsko, Muiños & Tous, 2013), and changes occurred toward higher impression in the transversal movement type when the single task (motor precision task) was compared with a dual task (precision plus cognitive task of counting numbers backward) (Liutsko, Segura, Tous, 2014). Other researchers observed nonlinear, quadratic relationships between mental ability for spatial reasoning (Cattell's Culture Fair Intelligence Test) and hand skill assessed by peg-moving tasks in normal left-handers exhibiting different characteristics according to sex and writing hand (Tan, 1990).

Concerning cultural differences in motor performance, very few studies have been performed. In one of them, the results showed that French participants demonstrated a leftward bias in drawing (side views of faces, vehicles, self-centered tools, and animals) with their dominant and non-dominant hands, whereas their Syrian counterparts displayed a rightward bias. However, no differences between two cultural groups were observed in the 6-year-olds, since they did not present any systematic directional bias in their drawings. (Kebble & Vinter, 2013). Some cultural differences were found in the starting positions and directionality in drawing figures (a circle, a pentagon, and a rhombus in one stroke) in the dominant right hand between German and Japanese right-handed students, which may reflect the influence of writing habits (Taguchi, 1985). The previous studies showed that fine motor precision changes depending on the hand used, sensory condition, movement type (Tous-Ral, Muiños, Liutsko, & Forero, 2012), and the preliminary results of existing individual differences between the participants residing in the same country, but from different countries of origin (Liutsko, Malova, Guitierez, & Tous, 2018). We would like to further explore individual differences due to different cultural background and expand the study, which includes participants residing in different countries and immigrants from different countries. These results could contribute to the construction of the integrative model of personality linked to their social and cultural environment (Liutsko, 2019).

In summary, the aim of the current study was to contribute more to the research related to individual differences of participants of both sexes and different cultural subgroups in performing tasks on fine motor precision realized without visual guidance and under different test conditions. In addition, our goal was also to provide the psychological meaning of these behavioral trends in accordance with the tradition of Mira y Lopez's Miokinetic Psychodiagnosis (Mira, 1958); the latest updated version elaborated by Prof. Tous et al. (Tous, 2008; Tous et al., 2012) is included.

Methods

Participants

One hundred seventy participants from four cultural subgroups (Spain, East Europe, and immigrants to Spain from Morocco and Latin America) of a middle age (from 17 to 55 years old) with a similar education level performed the individual test of fine motor precision for both hands and under different test conditions. This study is a secondary analysis of polled data, obtained from different previous studies in different countries using the same methodology and tools. In total, 96% of participants were right-handers (as per self-reports). Criteria of admission to this study were as follows: not having any severe neurological or motor impairments or being forcefully changed in the hand dominance. The participants took part in the studies voluntarily. The studies were realized in conformity with the ethical rules stipulated in the Declaration of Helsinki.

Procedure

The precision of fine motor performance (hand drawings over the model lines of 40 mm — lineograms and parallels in the ascendant and descendent order) was measured by Proprioceptive Diagnostic of Temperament and Character (DP-TC) in mm (Tous et al. 2012, Tous & Liutsko, 2014). The instructions and full description of the procedure as well as the psychological interpretations of the observed results can be read in the manual (Tous et al., 2012) in Spanish or in the articles (Tous & Liutsko, 2014), either lineograms and parallels based on the MKP of Mira y Lopez (Mira, 1958).

DP-TC is based on graphomotor application, where only the instructions for its use are required to be translated into other languages. It can be used in all cultures or even for people who do not know how to read or write (as the original method of Mira y Lopez was used by Dr. Berezin (1976) in an illiterate indigenous population in an adaptation study), or it can be used by psychologists for checking school readiness in pre-school age children. This methodology allows the exploration of the individual and cultural differences because no adaptation of the test is required, and it has no biases produced by falsifying data (social desirability observed while replying to the verbal tests).

Participants were instructed to trace the model which appeared on the touch screen with maximum precision. First movements were performed with the use of vision; then (in the proprioceptive part of the test), the screen (cartoon) was set in order to hide the movement feedback and active hand position.

The observable variables and study design

The observable variables, such as fine motor precision biases, measured in the proprioceptive (without a visual guidance) sensory condition are the following:

- from lineograms: LL — line length, D — directional bias (deviation performed in parallel to the model) and F — formal bias (deviation performed perpendicularly to the model), and
- from parallels: dLL — variability in line length in the parallels (a sum of the ascendant and the descendant ones).

The observable variables were performed by both hands (1 — non-dominant, 2 — dominant), and for the lineogram part, in three movement types (MTs): frontal, transversal, and sagittal. Six dimensions corresponded to different precision bias types described in the DP-TC method by Tous (Tous et al., 2012; Tous & Liutsko, 2014). They were represented by specific movement type, and observable variables corresponded to their psychological meanings: 1) Mood (pessimism — optimism); 2) Decision-making (submission — dominance); 3) Style of Attention (intra-tension — extra-tension); 4) Irritability (inhibition — excitability); 5) Emotivism (cold — warm), and 6) Behavioral Variability (rigidness — variability/flexibility).

The descriptive analysis and multivariate analysis of variance (MANOVA) were run with the use of SPSS v. 20.

Results

The descriptive statistics for fine motor precision (raw measures in mm) in directional bias (see *Table 1*) and in formal, line length performance, and variability of line lengths (see *Table 2*) are presented per hand (non-dominant and dominant), sex (male, female), and cultural group (1 — immigrants to Spain from Morocco, 2 — Spaniards, 3 — Eastern Europeans, 4 — immigrants from Latin America to Spain).

Table 1

Descriptive statistics of fine motor precision (primary deviation or directional bias) in men and women from four cultural groups

			ND hand				D hand			
Bias	**Mov. Type**	**Group/ Sex**	**Male**		**Female**		**Male**		**Female**	
			M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Directional	**F**	1	−7.21	13.79	−1.25	9.56	−4.57	16.63	−3.38	19.33
		2	−8.71	17.55	−4.82	13.9	−3.29	15.2	−7.36	7.82
		3	−4.36	14.65	−4.7	17.25	−6.79	20.15	−7.16	14.39
		4	−4	13.45	−2.5	7.87	−19.67	19.14	−6	4.29
	T	1	−3.5	14.52	−0.13	21.87	2.86	8.13	−2.75	14.42
		2	−10.43	11.43	−4.71	24.96	−4.07	6.03	−1.68	26.26
		3	7.29	17.43	1.48	21.5	−0.71	15.07	−0.23	20.01
		4	−10.33	18.23	−3.83	10.8	2.67	5.51	−0.67	5.57
	S	1	13.07	7.28	20.88	12.18	10.07	10	9.13	11.08
		2	13.29	13.89	14.54	11.35	18.43	9.92	17.46	12.46
		3	9.04	11.02	15.49	14.13	12	11.43	12.2	12.27
		4	18	13	14.83	12.17	16.33	13.58	11	7.04

Notes. M and SD, in mm; Mov. Type (movement type): F — frontal, T — transversal, S — sagittal
1 — Morocco, 2 — Spain, 3 — East Europe, 4 — Latin America**
** — immigrants to Spain.*

The significant individual differences in fine motor precision performance between participants of different cultures with the corresponding psychological dimension are represented for the whole cultural groups (see *Figures 1-2*), for sex subgroups between different cultural groups (see *Figures 3-5*), and for sex differences within each cultural group (see *Table 3*).

Line length representation (lineograms)

The model line length is 40 mm. In the graph, the mean values for all four cultural groups are presented for both hands (see *Figure 1*). The statistically significant difference was found between the participants from Spain and East Europe, and only in the non-dominant hand. The corresponding dimension to this observable variable is *Irritability* (inhibition — excitability).

Table 2

Descriptive statistics (mean and standard deviation) of secondary deviations, line length, and line length variability for both sexes and four tested cultural groups

Bias	Mov. Type	Group/ Sex	ND hand				D hand			
			Male		Female		Male		Female	
			M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Formal	Frontal	1	7.71	4.6	9.25	7.46	7.71	5.8	12.75	16.57
		2	9.07	6.76	17.36	20.19	10.14	8.76	13.5	21.35
		3	8.43	8.06	10.38	14.55	13.36	11.72	12.03	14.78
		4	13	17.35	12	11.14	9	8.89	4.33	2.94
LL	average	1	44.14	10.44	42	12.15	38.07	6.2	40.25	8.68
		2	38.93	11.01	39.36	8.29	39.21	8.33	36.75	8.25
		3	47.07	8.52	44.91	11.14	42.11	8.01	40.9	8.94
		4	44	12.53	32.5	7.5	44.67	10.41	29.83	8.75
ΔLL	average	1	19.93	8.23	22.13	7.74	21.29	9.11	17.5	3.89
		2	13.5	6.61	12.93	6.39	15	7.65	14.61	7.7
		3	19.82	9.49	18.61	7.78	22.14	8.14	20.62	8.76
		4	14.33	5.51	16.67	3.39	27.33	20.53	18.67	3.67

Note. M and SD, in mm; Mov. Type (movement type): F — frontal, T — transversal, S — sagittal
1 — Morocco, 2 — Spain, 3– East Europe, 4 — Latin America**
** — immigrants to Spain.*

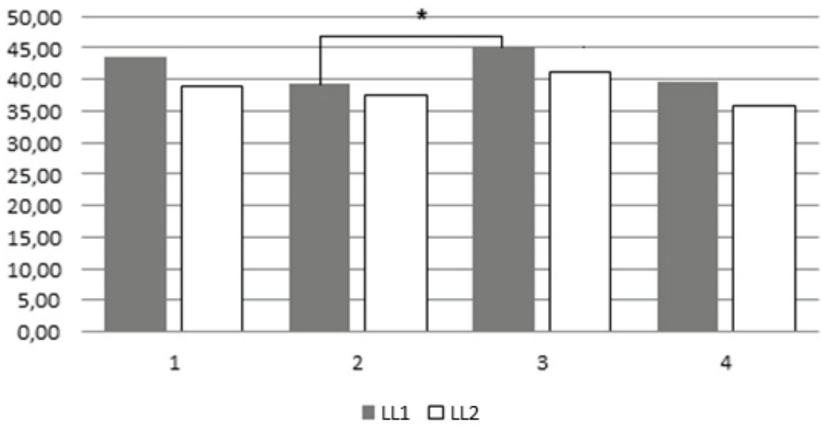

Figure 1. Line length biases for four tested groups in mm (the significant differences are marked with*, $p < .05$)

Note: LL1 — non-dominant hand; LL2 — dominant hand. Cultural groups: 1 — Morocco, 2 — Spain, 3 — East Europe, 4 — Latin America* (* — immigrants to Spain).*

Differences in line length performances (from parallels)

According to the results of MANOVA analysis with Bonferroni correction for post hoc effects, the statistically significant differences are presented with * in *Figure 2*.

The corresponding dimension is *Behavioral Variability* (rigidness — variability/flexibility).

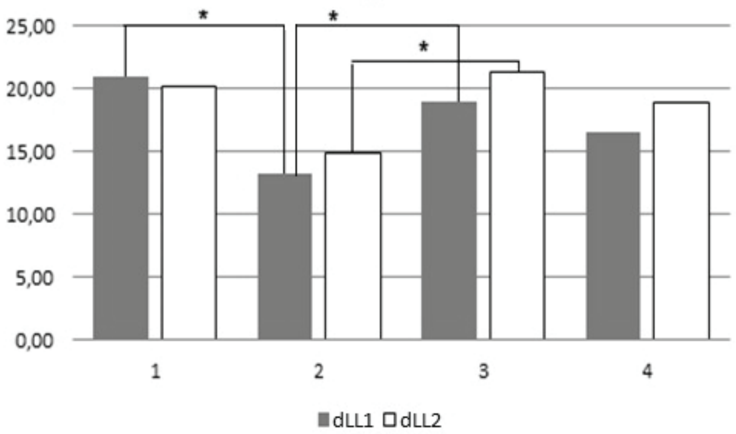

Figure 2. Line length biases for four tested groups (the significant differences are marked with*, $p < .05$).

Note: dLL1 — non-dominant hand; dLL2 — dominant hand. Cultural groups: 1 — Morocco, 2 — Spain, 3 — East Europe, 4 — Latin America* (* — immigrants to Spain).*

Differences in the transversal movement (directional bias) in men

One statistically significant difference ($p<0.05$) in directional bias/transversal movement type was found between men from Spain and East Europe (in the non-dominant hand) (see *Figure 3*).

The corresponding dimension is *Attention Style* (intra-tension — extra-tension).

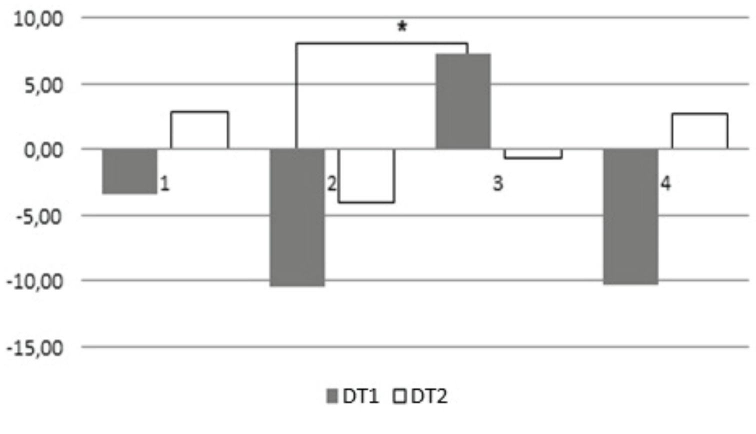

Figure 3. Directional biases in transversal movement type in men for four tested groups (the significant differences are marked with*, $p < .05$)

Note: DT1 — non-dominant hand; DT2– dominant hand. Cultural groups: 1 — Morocco, 2 — Spain, 3 — East Europe, 4 — Latin America* (* — immigrants to Spain).*

Line length variability from the parallels in women

The statistically significant differences in line length variability (from the parallels) in women from four cultural groups are presented in *Figure 4.*

The corresponding dimension is *Behavioral Variability*: (rigidness — variability/flexibility).

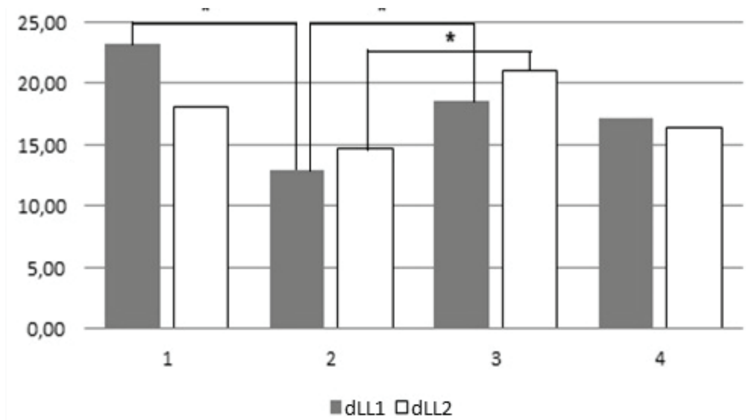

Figure 4. Line length variability in women for four tested groups (the significant differences are marked with*, $p < .05$)

Note: dLL1 — non-dominant hand; dLL2 — dominant hand. Cultural groups: 1 — Morocco, 2 — Spain, 3 — East Europe, 4 — Latin America* (* — immigrants to Spain).*

Differences in a sagittal movement (directional bias) in women from different cultural subgroups

The statistically significant difference in the directional bias in a sagittal movement type in women were found between immigrants from Latin America to Spain compared to native Spaniards (*Figure 5*).

The corresponding dimension is *Decision-making* (submission — dominance).

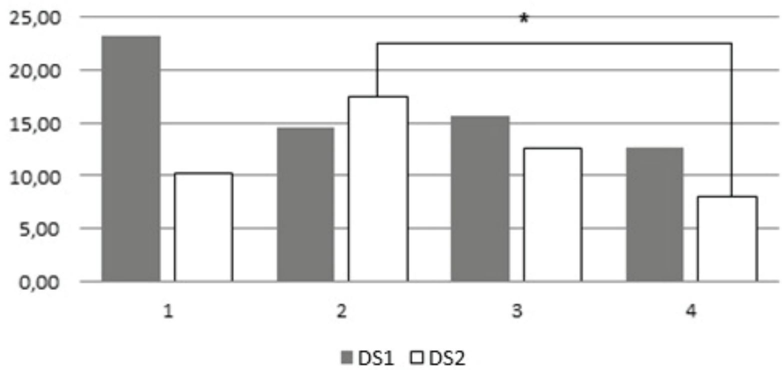

Figure 5. Directional biases in sagittal movement type in women for four tested groups (the significant differences are marked with*, $p < .05$)

Note: DS1 — non-dominant hand; DS2 — dominant hand. Cultural groups: 1 — Morocco, 2 — Spain, 3 — East Europe, 4 — Latin America* (* — immigrants to Spain).*

Fine motor precision differences in men vs. women in different cultural groups

The corresponding dimension is *Decision-making* (submission — dominance).

Table 3

Significant differences between men and women within one cultural subgroup (DS1: directional deviation, sagittal movement, and non-dominant hand)

		Men		**Women**		**ANOVA**	
DP-TC	Group	*Mean*	*SD*	*Mean*	*SD*	*F*	*p*
DS1	1	13.07	7.28	23.14	11.19	**6.25**	**0.022**
	2	13.29	13.89	14.54	11.35	0.1	0.757
	3	9.04	11.02	15.71	14.37	**4.83**	**0.03**
	4	18	13	12.6	10.16	0.58	0.461

Discussion

The systematic drifts appeared here as per individual differences of each participant. Other researchers observed these drifts in the fine motor tasks without visual guidance (Rantanen & Rosenbaum, 2003). Because the mechanistic approach is still the predominant technique in motor control scientific research, it has some limitations in explaining such types of evidence. There also exists some neglect of motor control in psychological science (Rosenbaum, 2005). Thus, the mutual contribution of motor control and psychology could be beneficial and make progress toward new integrative models of human behavior.

Nevertheless, the research in general is changing and evolving. The multidisciplinary or integrative approach has become a potential area of new insights into what was found in the past. Human organisms are not an arithmetical sum of their parts, so the synthetic or integrating views of human organisms are closer to the reality. Movements are linked not only by the mechanistic concept of an optimization task, but are also closely linked to other areas of perception, vision, proprioception, equilibrioception, or balance, which are, in their turn, linked to emotions and individual behavioral differences on the whole.

Hence, those drifts in size and spatial biases in the proprioceptive condition (when we cannot observe and correct our fine motor behavior) in this study are also linked to individual intrinsic and dispositional differences in behavior. The bases of the first conclusions can be traced back to distinguished scientists, such as Mira y Lopez (1923; 1958) and Luria (1932). Luria observed that the person who verbally suppressed the truth, created "internal emotional conflict," which changed the amplitude of his movements by the "lie detector." Mira y Lopez, working with this technique, observed that in general, the patterns of the amplitudes or magnitude of fine movements were different in different persons; this suggests individual differences that influence them. Later, this fact was postulated in his work "Miokinetical Psychodiagnosis" (Mira, 1958) attributing their psychological meanings to movements. This work was based on many years of Mira's work experience — psychological interpretations of different types of biases and different movement types. Further observational and research studies of the matter were evolved by Prof. Tous et al. (Tous et al., 2012; Tous & Liutsko, 2014) in the Laboratory of Mira y Lopez of the University of Barcelona.

According to these interpretations, the significant individual differences observed in the current study in the participants from different cultures have the psychological meanings described below.

I. *For the whole groups:*

1) Line length (from lineograms) — the higher tendency toward excitability in the East Europeans was observed in the non-dominant hand (endogenous) only in comparison with Spaniards; though it is a balance in life adaptation since no statistical differences were shown in the dominant hand see *Figure 1*.

2) Line variability (from parallels) — both the immigrants from Morocco (but not from Latin America) to Spain and residents from East European countries have significant differences, indicating more variability, impulsivity, and flexibility in behavior compared with those from Spain in the non-dominant hand (*Figure 2*). This difference was also persistent in the dominant hand in Eastern Europeans compared with Spaniards showing the same trend conservation during life. The absence of differences in immigrants from Morocco into Spain in the dominant hand compared with the performance of the participants from Spain suggests that the immigrants have adapted in this context to the social or cultural environment of the country they reside in. No significant difference in both hands between Spanish people and immigrants from Latin America into Spain confirms, for this behavioral dimension, that they are similar as per endogenous (temperamental features, non-dominant) and exogenous ones (character, dominant hand) (Tous et al., 2012; Tous & Liutsko, 2014; Mira, 1958).

II. *In the sex subgroups:*

In the male subgroup, the only statistical difference observed was the one in directional bias and transversal movement, between the Spanish and the East European subjects, showing higher tendency to extra-tension or more orientation in attention toward the external world in the latter (Tous et al., 2012; Tous & Liutsko, 2014; Mira, 1958).

In the female subgroup, the differences in line variability were identical to the whole group outputs (*Figure 2* — for the whole group, and *Figure 4* — for the women subgroups); indicating that the differences for the whole group were mainly due to the contribution to women. Another significant difference evident in the women subgroup only — in the directional bias and sagittal movement — indicating the trend of less dominance in women who were immigrants from Latin America in Spain compared with Spanish natives (*Figure 5*) (Tous et al., 2012; Tous & Liutsko, 2014; Mira, 1958). Since this difference was shown to be significant only in the dominant hand, this was the reactive behavior to changes in the environment and/or individual ones.

III. *Differences between men and women in different cultural subgroups:*

The only statistically significant differences between men and women within each cultural subgroup were found in the immigrants from Morocco to Spain and East European residents' group (see *Table 3*) and only in the non-dominant hand, indicating higher tendency (temperamental or endogenous) to dominance in women compared to men (Tous et al., 2012; Tous & Liutsko, 2014; Mira, 1958).

The behavior, observed by the fine motor precision in the proprioceptive condition (without a visual guidance), provides insights into dispositional human behavior. It is free of the conscious control and thus provides information more related to "who we are", which may or may not be closely related to the "what we think we are" obtained by the verbal tests. However, both parts — the verbal one, which reflects more the self-perception and — the motor one — as expression of the dispositional behavior of people, could perfectly complement each other to form an integrated picture of human behavior as a whole. Thus, to see the combination of verbal and motor human behavior, more studies should be done in the future to better understand these individual differences.

Conclusion

This preliminary study explores individual differences of the representatives of different cultures in the proprioceptive behavior reflected by the precision performance or fine motor indicators. Some differences were found in distinct sex subgroups within different and the same cultural subgroups. The majority of significant differences between representatives of various cultural subgroups in this study were obtained in the non-dominant hand, meaning that such differences were more at the basic level, and the adaptive behavior to the changes in the environment in their lives led to their disappearance, especially in those who were residing in the same country. The better comprehension of intrinsic individual and personality differences in behavior will help relevant professionals (psychologists, therapists, social and educational workers, etc.) to reduce the bias or misinterpretation of human behavior of people who come from other cultures and provide better social integration.

Limitations

This was an exploratory study. The methods used were also constructed on observational and exploratory studies, which are still required to construct the explanatory theory. Further investigations in this direction of "embodied" individual and cultural differences are needed to complement the information obtained by other frequent methods (usually verbal tests) and help to construct the relevant theory.

Acknowledgments

My deepest gratitude to Prof. Josep Maria Tous and Dr. Ruben Muiños for their support in this study. Thank you very much to Nina Rachidova for her help in correction of English. The study was partially supported by the Russian Scientific grant № 19-78-10134.

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Original manuscript received April 14, 2018
Revised manuscript accepted June 18, 2019
First published online September 30, 2019

To cite this article: Liutsko, L. (2019). Individual Differences in Fine Motor Precision in Participants from Different Countries and their Psychological Meaning. *Psychology in Russia: State of the Art, 12*(3), 41–53. DOI: 10.11621/pir.2019.0304