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*Article*

# Fine motor precision tasks: Sex differences in performance with and without visual guidance across different age groups

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**Abstract:** Previous studies have reported certain sex differences in motor performance precision. The aim of the present study was to analyse sex differences in fine motor precision performance for both hands in different tests conditions. 220 Spanish participants (ages: 12-95) performed fine motor tasks - tracing over the provided models – lines of 40 mm for both hands, two sensory conditions (PV – proprioceptive-visual; P – proprioceptive only) and three movement types (F – frontal, T – transversal and S - Sagittal). Differences in line length (the task focused on precision) were observed through MANOVA analysis for all test conditions, both sexes and different age groups. Sex differences in precision were observed in F and T movement types (statistically significance level and higher Cohens' d was observed in condition with vision). No any statistically significant differences were observed in both hands and sensory conditions in sagittal type. Sex differences in fine motor precision were more frequently observed in the PV sensory condition in the frontal movement type and less in the sagittal one.

**Keywords:** fine motor precision; vision; proprioception; sex differences; individual differences; personality

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## 1. Introduction

Recent studies on sex differences in motor precision are scarce, with most studies found in Google Academic search having been carried out in the past century (80's-90's). The suggested model that best fits such differences (including gender differences) is a biopsychosocial model that optimally combines both nature and nurture approaches [1,2], where Halpern [2] precisely pointed out that "differences are not deficiencies". Thus, studying and describing sex differences is similar to that of any other individual difference or personality, way of existing or being. For example, it was found that men are better in some spatial tasks performances (mental spatial rotation) compared to women; whereas women were found better in test on fine motor skills in women [2].

The complexity of comparing the results obtained by different studies consists not only of the important factor of age, as shown by the above literature review, but also of other aspects, such as the type of tasks and sensory conditions used in tests. Sometimes, other factors can influence also on fine motor performance in men and women, such as socio-economical status [3], individual [4] and cultural differences [5] among others; and should be considered in interpretations if it is possible. The important role of proprioception for motor tasks and perception of space was observed in the previous studies, together with the crucial role of the integrative system vision with proprioception [6]. Since cognitive performance in spatial tasks is the main difference in sex performance, especially underling not the final results [7], but the way both groups perform; the motor and cognition performances could be interrelated.

The aim of the present study was to explore sex differences in fine motor precision performance tasks in both hands, with different age subgroups and test conditions. Both tested sensory conditions – with a visual guidance (PV – proprioceptive-visual) and without (P - proprioceptive only) - have input from a proprioceptive sense (in the first one, integrated with vision).

The questions of the study are as follows:

1. Are there any sex differences in fine motor precision across the entire sample in different age subgroups? Our hypothesis as per previous studies – that there should be some differences in fine motor precision in men and women.

2. Are there any sex differences in fine motor precision across the different test conditions (movement types: F – frontal; T – transversal, and S – sagittal) and sensory conditions (PV – proprioceptive-visual and P – proprioceptive only)? Would any movement type/s or sensory condition be more sensible for sex differences?

## 2. Materials and Methods

### *2.1. Participants and data analysis*

220 Spanish participants from the general population (ages: 12-95, 63% men) performed the Proprioceptive Diagnostics of Temperament and Character (DP-TC in Spanish, [12]) test. Participants were self-reported as healthy people who were not undergoing any medical treatments. All participants took part voluntarily, were informed about the aims of the research and gave their consent prior to their inclusion in the study. All tests were administered in line with ethical guidelines on human research according to the Helsinki Declaration.

### *2.3. Tools*

The Proprioceptive Diagnostics [8] was used to register and measure the graphical movements - line tracings in different test conditions (Figure 1).

(**a**) (**b**)

**Figure 1.** Lineograms test: in frontal movement type (a) and in transversal movement type (b).

### *2.4. Stimuli, observable variables and data analysis*

The stimuli were 40 mm lines (Lineograms) represented under different test conditions. Precision in fine motor precision was measured under different test conditions, three movement types (F –

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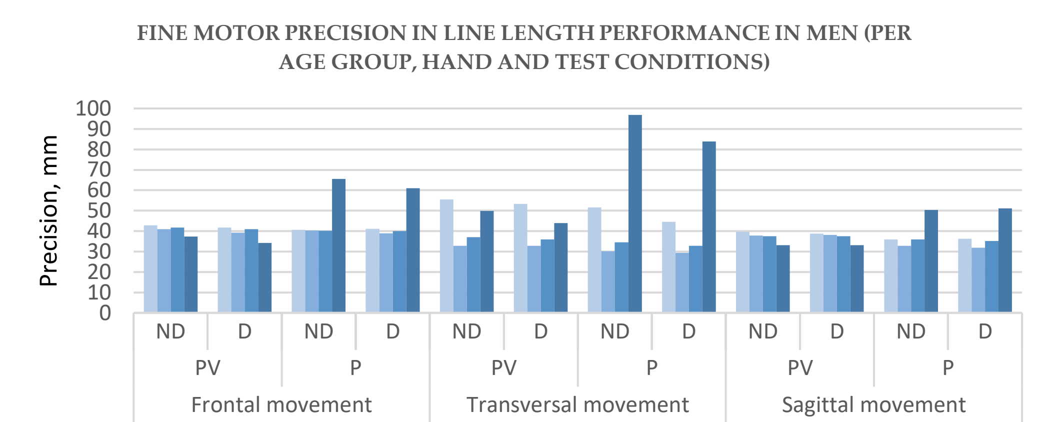
frontal, T – transversal and S – sagittal), both hands (ND – non-dominant and D – dominant) and two sensory conditions (PV and P), as observable variable LL – line length– in men and women and at different age groups. Thus, the complete model was described by variables of precision (LL –line length) that depended on three factors of test conditions (MT – movement type, SC – sensory condition and Hand) and sex (in different age subgroups). For the analysis, the participants were grouped to four age groups, representing different stages of developmental and professional activities: 1) 12-17 – adolescents (scholars) (N=41); 2) 18-29 – young adults (mainly students) (N=63); 3) 30-64 – adults (mainly professional workers) (N=72), and 4) 65-95 – elder group age (mainly retired) (N=44). The statistical analysis (descriptive and MANOVA with Bonferroni pot-hoc analysis) was performed with use of SPSS.

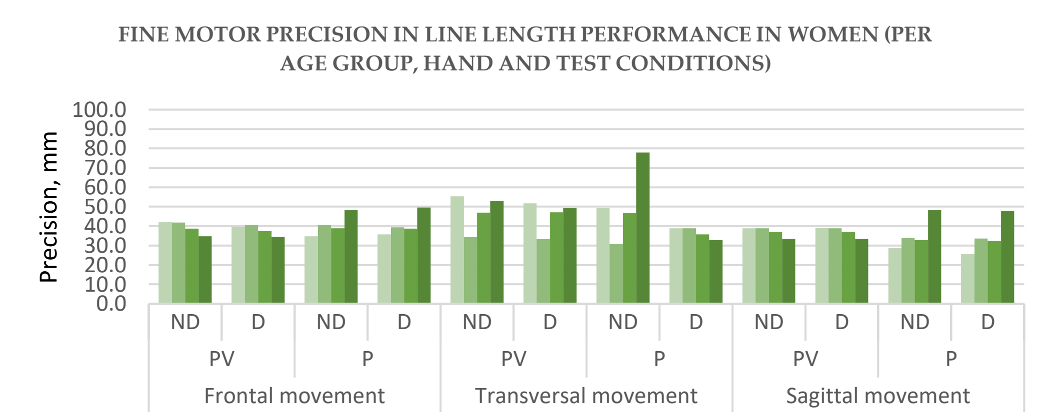
## 3. Results

The descriptive statistics for fine motor precision is given for men (Figure 2) and women (Figure 3) depending on age group (12-17, 18-29, 30-64, and 65-95), hand (ND – non-dominant and D – dominant) and test conditions: Movement type (Frontal, Transversal and Sagittal) and Sensory condition (PV – proprioceptive-visual and P – proprioceptive only).




| | Frontal movement | | | | Transversal movement | | | | Sagittal movement | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PV | | P | | PV | | P | | PV | | P | |
| | ND | D | ND | D | ND | D | ND | D | ND | D | ND | D |
| 12-17 | 42.9 | 41.7 | 40.7 | 41.1 | 55.6 | 53.3 | 51.6 | 44.6 | 39.7 | 38.7 | 35.9 | 36.2 |
| 18-29 | 40.9 | 39.3 | 40.3 | 39 | 32.9 | 32.9 | 30.2 | 29.4 | 37.9 | 38.2 | 32.9 | 31.9 |
| 30-64 | 41.8 | 41 | 40.2 | 40.1 | 37 | 36 | 34.6 | 32.9 | 37.5 | 37.5 | 35.9 | 35.1 |
| 65-95 | 37.4 | 34.3 | 65.6 | 61 | 49.9 | 44 | 96.9 | 83.8 | 33.1 | 33.1 | 50.3 | 51.1 |

**Figure 2.** Fine motor precision in men / Note: The model line length is 40 mm.




| | Frontal movement | | | | Transversal movement | | | | Sagittal movement | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PV | | P | | PV | | P | | PV | | P | |
| | ND | D | ND | D | ND | D | ND | D | ND | D | ND | D |
| 12-17 | 42.0 | 39.7 | 34.8 | 35.7 | 55.4 | 51.7 | 49.4 | 38.9 | 38.9 | 39.1 | 28.6 | 25.5 |
| 18-29 | 41.8 | 40.6 | 40.5 | 39.4 | 34.4 | 33.4 | 30.8 | 38.9 | 38.9 | 38.9 | 33.8 | 33.7 |
| 30-64 | 38.7 | 37.4 | 38.9 | 38.7 | 47.0 | 47.2 | 46.7 | 35.7 | 37.1 | 37.1 | 32.8 | 32.5 |
| 65-95 | 34.8 | 34.5 | 48.3 | 49.5 | 53.0 | 49.2 | 77.9 | 32.7 | 33.5 | 33.5 | 48.4 | 47.9 |

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**Figure 3.** Fine motor precision in women / Note: The model line length is 40 mm.

The MANOVA analyses of sex differences in the graphical performance of line length size under different test conditions are shown in the Table 1.

**Table 1.** MANOVA analyses results for the factor "sex".

| **Test conditions** | | **MANOVA results for LL (line length)** | | **Title 3** | |
|---|---|---|---|---|---|
| **MT** | **Hand** | **SC** | ***F*** | ***p*-value** | **Cohen's *d*** |
| Frontal | ND | PV | **5.80** | .017 | 0.38 |
| | | P | **6.24** | .013 | 0.08 |
| | D | PV | **4.26** | .040 | 0.54 |
| | | P | 3.52 | .062 | 0.02 |
| Transversal | ND | PV | **15.68** | <.001 | 0.66 |
| | | P | 0.28 | .599 | 0.36 |
| | D | PV | **15.80** | <.001 | 0.63 |
| | | P | 0.41 | .521 | 0.47 |
| Sagittal | ND | PV | 0.61 | .437 | 0.29 |
| | | P | 2.10 | .149 | 0.05 |
| | D | PV | 0.19 | .665 | 0.15 |
| | | P | 2.01 | .158 | 0.02 |

[1] *Legend*: MT – movement type; SC – sensory condition; ND and D – non-dominant and dominant; PV – proprioceptive-visual, P – proprioceptive only. The statistically significant differences are in **bold**.

No statistically significant difference between both sex subgroups was found in the Sagittal movement type. The statistically significant differences in fine motor precision were shown for frontal movement (with the exception of dominant hand and P-only sensory condition, where the statistically significant level was not reached, p=0.62) and transversal movement type (only in PV sensory condition with visual guidance) (Table 1). The interaction of sex by age group was significant only in precision and PV sensory condition in Frontal (p<.045 in ND and p<.001 in D hands) and Transversal movement types (p<.001 for both hands).

## 4. Discussion

In the majority of cases, men drew longer lines compared to women. Men had a tendency to overperform the model line length (40 mm) and women showed a tendency to underperform it; but the absolute precision – the precision bias without taking into account a sign - was better or worse – alternatively changing in favour of one or the other sex subgroup depending on test conditions and age.

The statistically significant differences found for the precision performance between representatives of both sexes in the non-dominant hand that reflect more constitutional or biologically determined indicators [8] favoured both men and women, depending on age group in the PV sensory condition in the Frontal movement. However, sex differences were attributed more to the opposite direction of average group bias; thus resulting in different ways of approximation to the model line.

Since the P-only sensory condition performance is underlying individual differences and personality, as well followed by Tous and colleagues [8] works; such differences – outperforming line length in men and underperforming in women – suggest the interpretation of balance excitability – inhibition, and in the present study's case - a more inhibited nature of girls of 12-17 compared to the same age boys.

Among the present study's limitations, the self-reported vision and health state can be mentioned. In both cases, those who considered they had normal vision or those who wore glasses to correct vision to normal, actual vision was not verified before the study.

As there are very few studies carried out in this direction, the findings represented here can contribute to a greater understanding of sex and age differences in fine motor tasks. These findings can also help to understand the relationship between two sensory modalities in performance: PV – proprioceptive-visual and P- proprioceptive only. Moreover, age-dependent trends are also important to see the evolution of precision in both sexes. For example, in Frontal and Sagittal movement types, at the elder age group of 30-64, the trend to underperform line length in the PV sensory condition, and outperform in the P-only one can be observed and this trend is similar in men and women (Figures 2 & 3). This inverted relationship could suggest the existence of compensatory mechanisms between the two sensory modalities and requires further study to confirm the hypothesis.

## 5. Conclusions

In this context – with regards to test conditions and age-dependent disclosure of the results – this is a pioneer study as far as we are aware. The sex differences reported by the current study in fine motor precision are linked to the average individual differences of both sex groups and could shed light on the understanding of the different ways to perform and perceive between both sex subgroups in general. If the performance of both groups is compared with the model, the precision (being better or worse) alternates for one sex subgroup compared to the other, depending on age group and test conditions. In general, men had a tendency to outperform the model line length and women showed a tendency to underperform it for the majority of the observed cases as per different test conditions. However, generally more effects were observed according to age groups rather than sex.

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**Availability of Data and Materials:** The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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