

Supplementary Material

Movements Within Gravity Condition

Examining each movement (M1-M9), both absolute hand positions and velocities exhibit qualitative similarities across various subjects and trials.

The initial hypothesis suggests that when performing movements in the same direction against gravitational force, the proposed kinematic features remain unaffected by the starting and target positions of the three objects.

Movement Time

The duration of the movement across each subject and repetition does not present a normal distribution, therefore non-parametric tests were employed.

For g^- condition, Friedman test calculated over M1, M2, and M3 did not show any statistically significant effect ($p = 0.32$, $\chi^2(2) = 2.28$). Pairwise Mann-Whitney tests performed over M1-M2, M1-M3, and M2-M3 resulted in non-statistically significant differences, presenting $p = 0.59$, $p = 0.43$, and $p = 0.76$ respectively.

For g^+ condition, Friedman test calculated over M4, M5, and M6 presented a statistically significant effect ($p = 0.003$, $\chi^2(2) = 11.6$). Pairwise tests performed over M4-M5, M4-M6, and M5-M6 resulted in non-statistically significant differences, showing $p = 0.12$, $p = 0.13$, and $p = 0.94$ respectively.

For g^0 condition, Friedman test calculated over M7, M8, and M9 presented a statistically significant effect ($p = 0.0005$, $\chi^2(2) = 15$). Pairwise tests performed over M7-M8 and M7-M9 resulted in a statistically significant difference ($p = 0.006$ and $p = 0.0096$ respectively) meanwhile M8-M9 did not result in any statistical significance ($p = 0.83$).

The overall mean and interquartile range for MT in g^- , g^+ , and g^0 conditions are respectively 1.46 ± 0.43 , 1.59 ± 0.53 , and 1.78 ± 0.53 .

Percent Time to Peak Velocity

PTPV metric across each subject and repetition presented overall a normal distribution, therefore parametric tests were employed.

For g^- condition, repeated measures ANOVA test calculated over M1, M2, and M3 did not show any statistically significant effect ($p = 0.06$, $F(2)(2) = 3.9$). Pairwise t-tests performed over M1-M2, M1-M3, and M2-M3 resulted in non-statistically significant differences, presenting $p = 0.03$, $p = 0.24$, and $p = 0.34$ respectively.

For g^+ condition, repeated measures ANOVA test calculated over M4, M5, and M6 did not present a statistically significant effect ($p = 0.06$, $F(2)(2) = 2.93$). Pairwise tests performed over M4-M5, M4-M6, and M5-M6 resulted in non-statistically significant differences, showing $p = 0.74$, $p = 0.14$, and $p = 0.08$ respectively.

For g^0 condition, repeated measures ANOVA test calculated over M7, M8, and M9 presented a statistically significant effect ($p < 0.0001$, $F(2) = 15$). Pairwise tests performed over M7-M9 resulted in a statistical significance ($p < 0.0001$), M7-M8 in a mild statistical significance ($p = 0.018$), and M8-M9 in a non statistically significant difference ($p = 0.03$).

The overall mean and standard deviation for PTPV in g^- , g^+ , and g^0 are respectively 26.9 ± 8 %, 42.3 ± 8.7 %, and 26.75 ± 6.6 %.

Percent Time to Peak Standard Deviation

PTPSD metric across each subject and repetition presented overall a normal distribution, therefore parametric tests were employed.

For g^- condition, repeated measures ANOVA test calculated over M1, M2, and M3 did not show any statistically significant effect ($p = 0.58$, $F(2) = 0.55$). Pairwise t-tests performed over M1-M2, M1-M3, and M2-M3 resulted in non-statistically significant differences, presenting $p = 0.59$, $p = 0.48$, and $p = 0.85$ respectively.

For g^+ condition, repeated measures ANOVA test calculated over M4, M5, and M6 did not present a statistically significant effect ($p = 0.76$, $F(2) = 0.27$). Pairwise tests performed over M4-M5, M4-M6, and M5-M6 resulted in non-statistically significant differences, showing $p = 0.55$, $p = 0.92$, and $p = 0.58$ respectively.

For g^0 condition, repeated measures ANOVA test calculated over M7, M8, and M9 did not present a statistically significant effect ($p = 0.87$, $F(2) = 0.14$). Pairwise tests performed over M7-M9, M8-M9, and M7-M8 did not result in a statistically significant difference, showing $p = 0.45$, $p = 0.57$, and $p = 0.98$ respectively.

The overall mean and standard deviation for PTPSD in g^- , g^+ , and g^0 are respectively 33 ± 11.4 %, 44.5 ± 15.9 %, and 34.2 ± 9.1 %.

Spatial Arc Length

SPARC metric across each subject and repetition presented overall a normal distribution, therefore parametric tests were employed.

For g^- condition, repeated measures ANOVA test calculated over M1, M2, and M3 did not show any statistically significant effect ($p = 0.95$, $F(2) = 0.05$). Pairwise t-tests performed over M1-M2, M1-M3, and M2-M3 resulted in non-statistically significant differences, presenting $p = 0.87$, $p = 0.93$, and $p = 0.81$ respectively.

For g^+ condition, repeated measures ANOVA test calculated over M4, M5, and M6 did not present a statistically significant effect ($p = 0.39$, $F(2) = 0.94$). Pairwise tests performed over M4-M5, M4-M6, and M5-M6 resulted in non-statistically significant differences, showing $p = 0.66$, $p = 0.31$, and $p = 0.58$ respectively.

For g^0 condition, repeated measures ANOVA test calculated over M7, M8, and M9 did not present a statistically significant effect ($p = 0.33$, $F(2) = 2.43$). Pairwise tests performed over M7-M9, M8-M9, and M7-M8 did not result in a statistically significant differences, showing $p = 0.84$, $p = 0.21$, and $p = 0.13$ respectively.

The overall mean and standard deviation for SPARC in g^- , g^+ , and g^0 conditions are respectively -1.54 ± 0.057 %, -1.6 ± 0.068 %, and -1.54 ± 0.057 %.

General Conclusion

96% (104 out of 108) of pair-wise post-hoc comparisons performed among MT, PTPV, PTPSD, and SPARC metrics did not result in any statistical significance ($p < 0.017$) therefore the previously posited hypothesis is not rejected.