Disabling Mouse Acceleration: Long-Term Effects on Pointing Speed and Accuracy

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Abstract

Mouse acceleration, a default feature in modern operating systems, implements a non-linear control-display gain that maps hand movement velocity to cursor displacement. Although prior research shows that gain manipulation influences pointing performance, existing studies primarily examine short-term effects and do not address long-term motor adaptation. Motor learning theory suggests that stable sensorimotor mappings are necessary for the development of automatic motor control, raising the question of whether disabling acceleration facilitates performance improvements over time.

This study investigates how disabling mouse acceleration influences pointing performance in everyday computer use. A longitudinal between-subjects design is employed (N = 19). Following a baseline session under default settings, participants are assigned to either maintain acceleration (control) or disable it (experimental) for two weeks using stratified randomization. Across 10 sessions, participants complete a web-based task battery consisting of clicking, slider, and dragging tasks. Performance is measured using Fitts' Throughput as the primary metric, alongside submovement count, path length ratio, and hit rate. Group differences in learning trajectories are analysed using Linear Mixed-Effects Models with Bonferroni correction across 12 tests.

The experimental group showed significantly steeper throughput gains across all three task types and greater reductions in submovement count for dragging and slider tasks, while no significant effects were found for path length ratio or hit rate, although effect sizes were small. These findings provide longitudinal empirical support for the hypothesis that a stable linear control-display mapping

facilitates motor adaptation, extending prior single-session CD gain research into a real-world longitudinal context.
Keywords: mouse acceleration, control–display gain, motor learning, pointing performance

1 Introduction

The computer mouse is one of the most used input devices for navigating digital spaces and performs strongly in pointing tasks [11]. Given the large amount of time users spend interacting with computers, small differences in pointing speed and accuracy may accumulate into meaningful performance effects over time.

Pointer behavior is influenced by hardware, operating system, and software settings. One default feature in most operating systems is 'mouse acceleration' or 'enhanced pointer precision', which implements an exponential control-display gain, rather than a linear one. Under acceleration, cursor displacement depends not only on movement distance but also on movement velocity. Originally introduced to compensate for limited desk space, this mapping allows slow movements to enable fine control while fast movements produce larger cursor displacements.

However, non-linear acceleration may reduce movement predictability because identical hand movements can result in different cursor displacements depending on speed, thus introducing a new factor the user needs to adjust their muscle memory on. Within gaming communities, acceleration is frequently disabled to promote more consistent motor control, although this practice is largely supported by anecdotal rather than empirical evidence.

This study addresses the lack of longitudinal evidence on this topic by empirically testing whether disabling mouse acceleration alters performance in standard target acquisition tasks over time. We address the following research question: How does disabling mouse acceleration influence pointing speed and movement accuracy in everyday computer use? Based on prior research on control-display gain and motor learning, we formulate the following hypotheses:

Primary hypothesis (Throughput)

H_0: Disabling mouse acceleration does not lead to different improvements in Fitts' Throughput over time compared to maintaining default acceleration settings.

H_1: Disabling mouse acceleration leads to steeper improvements in Fitts' Throughput over time compared to maintaining default acceleration settings.

Secondary hypotheses (Submovement Count, Path Length Ratio, Hit Rate) For each secondary metric, we hypothesize that disabling mouse acceleration leads to greater improvement over time compared to maintaining default settings (H_1), against a null hypothesis of no difference (H_0).

2 Literature Review

2.1 Foundations of mouse pointing

There is extensive research into pointer accuracy and task completion time. The earliest and most foundational research was conducted by [4], who demonstrated that movement time depends on the distance to a target and the size of that target. This relationship was formalized as Fitts' Law, which predicts movement time as a function of the Index of Difficulty, defined by the ratio between target distance and width. Movements to distant or small targets require more time than movements to large or nearby targets. Fitts' Law was translated into the HCI domain by [9], who established it as a primary research and design tool for evaluating pointing performance with a computer mouse. [10] extended the model to two-dimensional pointing tasks. To ensure comparability across studies, [16] introduced throughput as a standardized performance metric combining speed and accuracy using effective target measures. More recent control-theoretic perspectives suggest that pointing is not merely a ballistic movement but a continuous feedback-controlled process [13]. This modern understanding reinforces the idea that factors influence pointer control, such as software-level precision or acceleration.

2.2 Control-Display Gain and Mouse Acceleration

Control-display (CD) gain defines the mapping between the physical movement of an input device and the resulting movement of the on-screen pointer. It is expressed as the ratio between pointer displacement on the display and device displacement in physical space [2]. A higher gain means that a smaller physical movement produces a larger pointer displacement, whereas a lower gain requires larger physical movements to achieve the same on-screen distance.

A distinction is made between linear (constant) gain and non-linear (velocity-dependent) gain. In linear gain, a fixed ratio is maintained between device and pointer movement, such that identical physical movements produce identical pointer displacements regardless of speed. In contrast, non-linear gain varies as a function of movement velocity. In such systems, gain increases with movement speed, allowing rapid long-distance movement while preserving fine control at lower speeds [12]. Modelling work shows that velocity-dependent gain alters the dynamic relationship between hand movement and pointer motion, which may influence movement stability and predictability [17, 18].

From a performance perspective, CD gain interacts directly with Fitts' Law, which captures the speed-accuracy trade-off in pointing tasks. Casiez et al. demonstrate that manipulating CD gain significantly affects movement time, error rate, and overall pointing efficiency [2]. Performance does not consistently improve with higher gain. Rather, an optimal gain range exists where throughput is maximised. Similarly, Ren et al. show that different gain settings influence movement time, error rate, and effective operation frequency, with intermediate gain levels yielding the highest efficiency [15]. Because mouse acceleration modifies the input-output mapping between hand movement and pointer motion, changes to this mapping may influence how motor patterns are learned and stabilized over time.

2.3 Motor Learning and Adaptation

An important theoretical justification for this study is the relationship between mouse acceleration and the formation of stable motor representations. Motor learning research describes how the brain constructs internal models, which are models that predict the sensory consequences of motor commands, through repeated exposure to a consistent sensorimotor mapping [3]. Movements become automatic once such a model is established and no longer require conscious control. When mouse acceleration is introduced, the same physical movement produces different pointer displacements depending on movement speed. Consequently, the mapping is less consistent for the motor system to learn. Evidence from competitive gaming contexts supports this reasoning, as players often disable acceleration to enable consistent motor patterns that rely on movement repeatability [1, 6]. Disabling acceleration, therefore, creates a stable linear mapping that aligns with internal model theory.

Motor skill learning is characterised by at least two temporal stages. A fast learning stage produces substantial improvements within a single session, whereas a slower stage involves incremental gains across multiple sessions over days or weeks [3]. Improvements also continue between sessions through consolidation processes. Meta-analytic evidence confirms that genuine automatization of motor skills requires distributed practice across longer timescales rather than a single session [8]. Furthermore, practice structure influences retention, with distributed practice producing more stable performance than massed practice [14].

In the context of this study, disabling mouse acceleration constitutes a change in visuomotor mapping that requires participants to adapt previously automatised motor patterns. Based on the literature, such adaptation cannot be expected to stabilise within a single session. A longitudinal design spanning multiple sessions over several weeks is therefore necessary to capture both initial adaptation and subsequent consolidation into stable performance.

2.4 Research Gap

The literature reviewed above establishes two relevant bodies of knowledge: the effects of CD gain and mouse acceleration on pointing performance, and the principles of motor learning and visuomotor adaptation. However, these areas have not been studied in conjunction. Existing work on CD gain and pointer acceleration evaluates performance at a single point in time, measuring immediate differences in movement time, error rate, and throughput under different gain conditions [2, 12, 15]. While these studies show that gain influences performance, they do not address how users adapt to changes in gain over time, nor the long-term motor learning consequences of operating under linear versus non-linear mappings.

Motor learning research establishes that genuine automatization of a visuomotor skill requires distributed practice across multiple sessions and extended timescales [3, 8]. Yet no longitudinal study has examined whether disabling mouse acceleration, and thereby introducing a stable linear mapping, facilitates this automatization process in everyday computer users. Competitive gaming contexts provide anecdotal motivation for disabling acceleration [1, 6], but empirical evidence for its long-term motor benefits remain absent.

This study addresses that gap by adopting a longitudinal between-subjects design spanning multiple weeks of real-world use to test whether disabling mouse acceleration produces lasting improvements in pointing performance relative to maintaining default settings.

3 Method

3.1 Participants

Participants were adult computer users recruited through convenience sampling. Inclusion criteria were: (1) age between 18 and 60 years, (2) regular computer use (minimum of 10 hours per week), and (3) use of an external mouse. Participants with physical impairments affecting hand or arm movement were excluded. Handedness was recorded but not used as an inclusion criterion.

Of the participants who completed the baseline session ($N = 25$), $N = 19$ completed at least seven sessions and were included in the final analysis, resulting in 8 control and 11 experimental participants.

3.2 Materials

3.2.1 Questionnaire

Two brief questionnaires were administered. The baseline questionnaire recorded demographics (age, gender, handedness), primary operating system, average computer usage per week, and physical impairments affecting hand or arm movement. Each subsequent session included a short follow-up questionnaire administered before the task battery, assessing computer use since the previous session, confirmation of the assigned acceleration setting, and any hardware or software changes.

3.3 Apparatus

The experiment was conducted remotely using participants' own hardware.

3.3.1 Hardware

Participants used their own desktop or laptop computer with an external mouse, and were instructed to use the same mouse and screen throughout the study and to refrain from changing pointer sensitivity or DPI settings.

3.3.2 Software

The task battery was implemented as a custom web application built in Svelte and hosted on a private server to ensure data security. Pointer coordinates were sampled at 60 Hz using `requestAnimationFrame` with millisecond timestamps. The application automatically detected screen resolution and logged session metadata and trial-level data. A screen calibration procedure was included, in which participants matched an on-screen rectangle to the size of a physical credit card, ensuring consistent scaling of task elements across different screen sizes and resolutions. Participants were identified by an anonymous participant ID. Data was stored in a PostgreSQL database and later exported to a CSV file and analyzed using Python. All materials and analysis code are publicly available at `https://github.com/ablos/MouseAccelerationExperiment`.

3.4 Experiment Design

3.4.1 Overview

Participants completed a standardised task battery consisting of three task types: clicking, slider, and dragging. These represent fundamental mouse interactions in everyday computer use (point-and-select, precise positional control, and object manipulation), supporting the ecological validity of the findings. Each session consisted of 54 trials (18 per task type) and took approximately 2-3 minutes to complete.

3.4.2 Task Descriptions

All task dimensions were specified in millimeters and scaled to each participant's screen using the calibration factor described in Section 3.3.

Clicking Task. A circular target appeared at a randomised screen location. Participants clicked the target as quickly and as accurately as possible. Target radius and distance from previous target were varied across three levels each (radii: 3, 5, 10 mm; distances: 30, 60, 120 mm), producing nine difficulty combinations based on Fitts' law. Each combination was presented twice in randomised order, yielding 18 trials.

Slider task. A horizontal slider appeared with the handle at a randomised start position and a highlighted target zone. Participants dragged the handle into the target zone as accurately and quickly as possible. Zone width and distance from handle start to zone centre were varied across three levels each (zone widths: 16, 20, 25 mm; distances: 30, 60, 120 mm), again with each combination presented twice in randomised order.

Dragging Task. A file icon appeared at a randomised screen position alongside a target folder zone. Participants dragged the icon into the folder zone as quickly as possible. Target radius and drag distance were varied across three levels each (radii: 9, 15, 30 mm; distances: 40, 75, 140 mm), with each combination presented twice in randomised order.

3.4.3 Measurements

The following metrics were recorded for every trial across all three task types. Where tasks differ in dimensionality, the slider task was treated as one-dimensional (x-axis only), while clicking and dragging used two-dimensional Euclidean calculations.

Throughput. The primary dependent variable was Fitts' throughput, computed following ISO 9241-9 as:

$$TP = \frac{ID}{MT}, \quad ID = \log_2\left(\frac{2D}{W}\right) \tag{1}$$

where D is the distance to the target, W is the effective target width (diameter for clicking and dragging; zone width for slider), MT is movement time in seconds, and ID is the index of difficulty in bits. Higher throughput indicates better performance.

Path Length Ratio (PLR). The ratio of actual cursor path length to the optimal straight-line distance between start and end positions. For the slider task, this is computed along the x-axis only. A value of 1 indicates a perfectly straight movement; higher values reflect more corrective movement.

Submovement Count. The number of corrective movement phases within a trial, detected via velocity peak detection on a Gaussian-smoothed ($\sigma = 1.5$ samples) speed profile. Peaks were identified using a minimum inter-peak distance of 100 ms and a minimum height and prominence of 5% of the maximum speed within the trial. Lower values indicate more efficient, smooth movement.

Hit Rate. The proportion of trials in which the cursor endpoint fell within the target region. For clicking and dragging, a trial was counted as a hit if the endpoint fell within the target radius; for the slider, if the horizontal distance from the zone centre was at most half the zone width.

3.5 Execution Procedure

3.5.1 Procedure

Each session followed an identical structure. Participants opened the web application and logged in using their participant ID, completed the screen calibration procedure, and filled in the short pre-session questionnaire before starting the task battery. Tasks were completed in a fixed order: clicking, slider, and dragging. The baseline session was otherwise identical to subsequent sessions and served as the individual performance reference, with all participants completing it under their default mouse acceleration settings.

3.5.2 Group Assignment

After the baseline session, participants were randomly assigned to one of two conditions using stratified randomisation based on baseline performance [5]. Participants were first assigned to one of three performance bands (low, medium, high) based on composite baseline score:

$$\text{score} = \overline{MT} \cdot \bar{\epsilon} \tag{2}$$

where $\overline{MT}$ is mean completion time and $\bar{\epsilon}$ is mean Euclidean distance error. Lower scores indicated better performance. Within each band, participants were randomly assigned to either the control group (maintain default acceleration settings) or the experimental group (disable mouse acceleration settings). OS-specific instructions for disabling acceleration were provided in the application.

3.5.3 Longitudinal Phase

Over two weeks, participants completed one session on each weekday, resulting in 10 sessions including the baseline. Both groups maintained their assigned setting throughout the entire study, not only during testing sessions, and confirmed this via the pre-session questionnaire. Weekends were excluded to allow for consolidation processes between sessions [8].

3.5.4 Statistical Analysis Plan

The primary aim of the analysis was to determine whether disabling mouse acceleration leads to different performance trajectories over time. Models were fitted directly on trial-level observations using linear mixed-effects models (LMM) with participant as a random intercept, implemented in Python using `statsmodels`. This approach accounts for repeated measurements within participants and individual differences in baseline performance.

For each dependent variable and task type, the model included fixed effects for group (control vs. experimental), standardised session number (slot), their interaction, and standardised hours of computer use since the previous session as a covariate. Both continuous predictors were Z-score standardised prior to model fitting to improve optimizer convergence and ensure comparability of coefficients. The group × slot interaction captures whether performance trajectories differ between groups over time.

Participants who missed the first session had their slots 2-5 shifted to slots 1-4 to preserve the within-week structure, with slots 6-10 left unchanged as the weekend break was the same for all participants.

Prior to model fitting, trial-level outliers were removed using a modified z-score based on median absolute deviation (MAD) [7], applied per participant per task type on throughput with a threshold of 3.5. This method makes no normality assumption and is robust to the outliers it detects. Approximately 1% of trials were removed.

To control for multiple comparisons across 12 simultaneous tests (4 metrics × 3 task types), a Bonferroni-corrected significance threshold of $\alpha = 0.05/12 \approx 0.004$ was applied. For each model, estimated coefficients, 95% confidence intervals, p-values, and incremental Cohen's f^2 for the group × slot interaction term are reported. Missing observations due to dropout were handled without imputation; the LMM estimates group-level effects from all available data without requiring a complete dataset per participant.

4 Results

After excluding participants with fewer than 7 completed sessions, the final sample contained 19 participants (8 control, 11 experimental). Overall mean throughput was higher in the experimental group across all three task types (clicking: 3.27 vs. 3.09 bits/s; dragging: 1.53 vs. 1.38 bits/s; slider: 1.37 vs. 1.21 bits/s), with a larger improvement from baseline to final session (clicking: +11.4% vs. −5.1%; dragging: +16.8% vs. +2.6%; slider: +26.1% vs. +2.1%). Descriptively, the experimental group improved by +18.1% on average across all tasks from baseline to final session, compared to −0.1% in the control group

4.1 Primary Outcome: Throughput

The group × slot interaction was statistically significant for all three task types (see Table 1), indicating that the experimental group improved at a steeper rate over sessions than the control group. For clicking $\beta = 0.172$ ($SE = 0.035$, $z = 3.90$, $p < 0.001$). Effect sizes were small across all three tasks (Cohen's $f^2 = 0.005$, 0.003, and 0.004 for clicking, dragging, and slider, respectively). No significant effect of self-reported hours since the previous session was found for any task (all $p > 0.20$).

`figures/throughput_normalized.png`

Figure 1: Mean throughput per session for control and experimental groups across task types.

Table 1: Linear mixed-effects model results for throughput (bits/s) across task types. Cohen's f^2 is reported for the Group × Slot interaction only. Bonferroni-corrected significance threshold: $\alpha \approx .004$.

Task	Term	β	SE	z	p	95% CI	f^2
Clicking	Intercept	3.090	0.241	12.84	$< .001$	$[2.618,\ 3.562]$	
	Group	0.183	0.316	0.58	.562	$[-0.436,\ 0.803]$	
	Slot	-0.082	0.026	-3.08	.002	$[-0.134,\ -0.030]$	
	Group × Slot	0.172	0.035	4.96	$< .001$	$[0.104,\ 0.240]$	.005
	Hours	<0.001	0.026	-0.01	.993	$[-0.050,\ 0.050]$	
Dragging	Intercept	1.377	0.103	13.32	$< .001$	$[1.174,\ 1.579]$	
	Group	0.154	0.136	1.13	.259	$[-0.113,\ 0.420]$	
	Slot	-0.010	0.017	-0.61	.544	$[-0.044,\ 0.023]$	
	Group × Slot	0.074	0.022	3.34	$< .001$	$[0.031,\ 0.118]$	.003
	Hours	0.021	0.016	1.28	.201	$[-0.011,\ 0.053]$	
Slider	Intercept	1.206	0.098	12.35	$< .001$	$[1.014,\ 1.397]$	
	Group	0.158	0.128	1.23	.218	$[-0.093,\ 0.410]$	
	Slot	0.013	0.012	1.00	.316	$[-0.012,\ 0.037]$	
	Group × Slot	0.064	0.016	3.90	$< .001$	$[0.032,\ 0.096]$	.004
	Hours	0.007	0.012	0.59	.556	$[-0.017,\ 0.031]$	

4.2 Secondary Outcomes

4.2.1 Path Length Ratio (PLR)

No significant group × slot interactions were found for PLR in any task type after Bonferroni correction (Table 2). Effect sizes were negligible ($f^2 \leq 0.001$ for all tasks), and neither group showed a consistent change in movement efficiency over sessions.

4.2.2 Submovement Count

Significant group × slot interactions were found for dragging ($\beta = -0.108$, $SE = 0.023$, $z = -4.66$, $p < 0.001$, $f^2 = 0.006$) and slider ($\beta = -0.149$, $SE = 0.026$, $z = -5.79$, $p < 0.001$). In both cases, the experimental group showed a steeper reduction in submovement count over sessions, indicating progressively smoother movements. For clicking, the interaction did not survive Bonferroni correction ($\beta = -0.040$, $p = 0.051$).

4.2.3 Hit Rate

Hit rates were uniformly high across both groups and all tasks (all $> 93\%$), indicating a ceiling effect. No significant group × slot interactions were found after Bonferroni correction (Table 2). Hit rate was therefore uninformative as a discriminating metric in this study.

`figures/submovement_count_normalized.png`

Figure 2: Mean submovement count per session for control and experimental groups across task types.

Table 2: Group × Slot interaction term from linear mixed-effects models for secondary outcomes across task types. Bonferroni-corrected significance threshold: $\alpha \approx .004$.

Metric	Task	β	SE	z	p	95% CI	f^2
PLR	Clicking	-0.056	0.034	-1.63	.103	$[-0.123,\ 0.011]$	.001
	Dragging	-0.022	0.027	-0.81	.417	$[-0.075,\ 0.031]$	<.001
	Slider	-0.010	0.007	-1.42	.154	$[-0.024,\ 0.004]$	.001
Submovement Count	Clicking	-0.060	0.031	-1.95	.051	$[-0.121,\ 0.000]$	.001
	Dragging	-0.108	0.023	-4.66	$< .001$	$[-0.153,\ -0.063]$	.006
	Slider	-0.149	0.026	-5.79	$< .001$	$[-0.200,\ -0.099]$	<.001
Hit Rate	Clicking	-0.007	0.004	-1.75	.080	$[-0.015,\ 0.001]$	.001
	Dragging	-0.019	0.008	-2.51	.012	$[-0.034,\ -0.004]$	.002
	Slider	-0.007	0.003	-2.23	.026	$[-0.014,\ -0.001]$	.002

5 Discussion

Disabling mouse acceleration resulted in greater performance improvements over time compared to maintaining default settings. The experimental group showed significantly steeper gains in throughput across all tasks and reductions in submovement count for dragging and slider tasks. No significant effects were found for path length ratio or hit rate.

5.1 Interpretation of Results

These results suggest that disabling mouse acceleration influences pointing performance over time. The group × slot interaction was statistically significant for throughput across all three task types, indicating that participants in the experimental group improved at a steeper rate than those in the control group. This pattern was further corroborated by significant reductions in submovement count for dragging and slider tasks, suggesting that movements became progressively smoother in the experimental group. These findings are consistent with motor learning theory, which predicts that a stable linear visuomotor mapping facilitates the formation of internal models and the automatization of motor skills [3]. The absence of a corresponding effect on path length ratio suggests that adaptation manifested primarily in movement efficiency and speed rather than trajectory straightness.

Although statistically significant, effect sizes were small across all tasks (Cohen's $f^2 \leq 0.006$), which warrants caution in interpreting the practical relevance of the findings. Hit rates exceeded 93% in both groups throughout the study, indicating a ceiling effect that limited the sensitivity of accuracy as a dependent measure. The steeper improvement in the experimental group is nonetheless consistent with prior work showing that CD gain manipulation affects movement time and efficiency [2], and extends those findings to a longitudinal context.

While prior studies on CD gain and mouse acceleration have primarily examined immediate performance differences with single-session settings [2, 15], the present findings extend this work by demonstrating how these effects evolve over time. Specifically, the results provide longitudinal evidence that users adapt differently to linear and non-linear mappings, with linear mappings supporting greater improvement across repeated use.

The findings also have broader implications for research and practice. From a scientific perspective, this study contributes to the understanding of motor learning in HCI by providing longitudinal evidence that linear mappings may support more effective skill acquisition than non-linear mappings. From a practical perspective, the results suggest that default OS settings, which include mouse acceleration, may not be optimal for tasks requiring fast and accurate cursor movements. This is particularly relevant for domains such as gaming and other high-precision interaction contexts, where users often disable acceleration to improve performance. This suggests that disabling mouse acceleration by default could be a worthwile consideration for organizations where employees spend substantial time on cursor-intensive tasks, though this remains speculative until replicated in more ecologically valid settings with real workplace workflows and larger samples.

5.2 Strengths and Limitations

A key strength of this study is its longitudinal design, capturing motor adaptation over time rather than immediate performance differences. Conducting the study in participants' natural environments using their own hardware increases ecological validity. Screen calibration and baseline normalisation mitigated variability introduced by differences in hardware and display settings.

However, several limitations apply. While participants confirmed their acceleration setting at the start of each session via a questionnaire, compliance between sessions could not be objectively verified, leaving the possibility of undetected deviations. Second, the remote setup meant that mouse quality, screen characteristics, and environmental conditions could not be fully controlled. This variability likely introduced additional noise into the data, reducing measurement precision and statistical power, and potentially reducing observed effect sizes. Third, the two-week duration may not capture the full extent of long-term motor adaptation, as consolidation processes may extend beyond this window [8].

5.3 Future Research

Future work should examine longer timescales to determine whether performance differences stabilise or increase with sustained use. More controlled laboratory settings would allow tighter isolation of acceleration effects from hardware and environmental variability. Additionally, individual differences such as gaming background and professional computer use may moderate adaptation and warrant further investigation. Extending the task battery to more complex real-world interactions, such as multi-step workflows or design tasks, would provide a more comprehensive picture of how acceleration affects everyday computer use.

5.4 Conclusion

This study provides longitudinal evidence that disabling mouse acceleration produces measurable improvements in pointing performance relative to maintaining default settings. The experimental group showed significantly steeper throughput gains and greater reductions in submovement count across multiple task types, consistent with the formation of more stable motor representations under a linear control-display mapping. While effect sizes were small, the findings offer empirical grounding for a practice that has long been adopted in competitive gaming contexts on largely anecdotal grounds, and motivate further longitudinal research into visuomotor adaptation under linear control-display mappings.

6 Contributions of Individual Team Members

Reinier wrote the introduction and literature on Fitt's Law section. Hidde wrote the section on control-display gain. Abel wrote the section on motor learning and muscle memory. Aris wrote the section on the research gap. Aris and Abel wrote the methods and procedure sections of the paper. Abel created and hosted the web application, and Aris created some of the tasks within the application. All members actively recruited participants. Abel monitored the participant's progress. Aris, Abel, and Reinier were involved in the data pre-processing. Abel conducted the statistical analysis and wrote the results section, and Hidde made the discussion. All team members were involved in the last adjustments of the text before handing in.

7 Declaration of AI and Other Software

We used Claude (Anthropic) to support code writing during the development of the web application and task battery. Furthermore, it was used for brainstorming and idea validation during the research design phase. All ideas, decisions, and implementations were conceived and verified by us. Additionally, Grammarly was used for spelling and grammar correction before submitting. The web application was built using SvelteKit. Statistical analyses and visualisations were performed in Python using pandas, numpy, scipy, matplotlib, seaborn, and statsmodels. All materials and analysis code are publicly available at `https://github.com/ablos/MouseAccelerationExperiment`.

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Appendix A Additional Figures

`figures/plr_normalized.png`

Figure 3: Mean path length ratio per session (relative to baseline) for control and experimental groups across task types.

`figures/hit_rate_normalized.png`

Figure 4: Mean hit rate per session (relative to baseline) for control and experimental groups across task types.

figures/summary_heatmap_group.png

figures/summary_heatmap_interaction.png

figures/baseline_equivalence_1.png

figures/baseline_equivalence_2.png

Table 3: Participant demographics: sample size, age, and weekly computer use per group.

Group	**N**	**Age (mean ± SD)**	**Hours/week (mean ± SD)**
Control	8	33.8 ± 14.4	30.0 ± 13.1
Experimental	11	25.8 ± 6.9	32.3 ± 8.1

`figures/demographics_categorical.png`

Figure 7: Participant demographics: distribution of sex, handedness, and gaming experience per group.

Table 4: Descriptive statistics (mean ± SD) per group per task for all metrics.

Group	Task	Throughput (bits/s)	PLR	Submovements	Hit Rate
Control	Clicking	3.091 ± 1.02	1.506 ± 0.850	2.013 ± 0.871	0.991 ± 0.095
	Dragging	1.383 ± 0.62	1.096 ± 0.228	1.461 ± 0.774	0.976 ± 0.152
	Slider	1.213 ± 0.45	1.076 ± 0.222	1.714 ± 0.836	0.995 ± 0.073
	All tasks	1.897 ± 1.12	1.226 ± 0.560	1.730 ± 0.858	0.987 ± 0.112
Experimental	Clicking	3.267 ± 1.20	1.496 ± 1.006	1.947 ± 0.882	0.986 ± 0.116
	Dragging	1.531 ± 0.68	1.093 ± 0.956	1.218 ± 0.627	0.937 ± 0.243
	Slider	1.365 ± 0.55	1.047 ± 0.161	1.478 ± 0.671	0.989 ± 0.102
	All tasks	2.055 ± 1.21	1.212 ± 0.831	1.548 ± 0.795	0.971 ± 0.168

Table 5: Mean percentage improvement from baseline (average of last two sessions vs. slot 1) per group per task. Positive = better for all metrics.

Group	Task	Throughput	PLR	Submovements	Hit Rate
Control	Clicking	−5.1% ± 18.6%	−0.3% ± 11.7%	−5.6% ± 23.7%	+1.5% ± 2.7%
	Dragging	+2.6% ± 9.1%	+4.3% ± 7.4%	−2.7% ± 15.0%	+2.2% ± 8.7%
	Slider	+2.1% ± 10.5%	−0.1% ± 3.8%	−11.9% ± 14.5%	+0.8% ± 2.6%
	All tasks	−0.1% ± 13.3%	+1.3% ± 8.2%	−6.7% ± 17.8%	+1.5% ± 5.3%
Experimental	Clicking	+11.4% ± 21.5%	+9.4% ± 18.3%	−1.5% ± 29.2%	−1.3% ± 2.6%
	Dragging	+16.8% ± 16.8%	+5.1% ± 14.7%	+15.8% ± 14.0%	−3.4% ± 11.0%
	Slider	+26.1% ± 33.4%	+3.9% ± 5.7%	+17.5% ± 17.6%	−0.5% ± 3.3%
	All tasks	+18.1% ± 24.9%	+6.2% ± 13.7%	+10.6% ± 22.4%	−1.7% ± 6.7%

Appendix B Systematic PRISMA literature review method

B.1 Foundations of Mouse Pointing

For the current study, a search was done in the Scopus database with a Utrecht University account. To show the amount of existing work, the initial search string was: TITLE-ABS-KEY ((”Fitts’ Law” OR ”Fitts’ Law”), this query returned 1606 results. To narrow this down, the query was extended to filter on relevant tasks: (”Pointer task” OR ”pointer” OR ”cursor” OR ”mouse” OR ”target acquisition”) and the relevant domain: (”Human Computer Interaction” OR ”HCI”). Lastly, the subject area filter was used to include work from: Computer Science, Engineering, Mathematics, Social Sciences and Psychology. The paper also had to be available in English. This search string returned 153 articles. These articles were then screened for relevance in two stages. First, the titles were reviewed to exclude studies clearly unrelated to interactive pointing tasks, human-computer interaction, or Fitts' Law. This step removed articles focused on specific populations, rehabilitation, alternative input devices, or feedback mechanisms, leaving 45 articles. Next, the abstracts of the remaining papers were examined to ensure they applied Fitts's Law in the context of human-computer interaction, measuring movement time, throughput, or target acquisition performance. Studies that mentioned Fitts's Law only conceptually or focused on unrelated experimental contexts were excluded. After this process, 16 articles were retained for full-text review, the 7 most foundational of which were used for this section.

B.2 Control-Display Gain and Mouse Acceleration

A systematic literature search was conducted on 17 February 2026 in Scopus, the ACM Digital Library, and WorldCat via Utrecht University Library. The query combined terms related to mouse and pointer acceleration and control-display gain with performance-related terms such as pointing, target acquisition, movement time, throughput, accuracy, and performance. Searches were restricted to peer-reviewed journal articles and conference papers published in English after 1980. In Scopus, the search was limited to title, abstract, and keywords. Scopus yielded 67 records, WorldCat 66 records with substantial overlap, and the ACM Digital Library 265 records. Due to limited filtering options in the ACM Digital Library, Scopus and WorldCat were used as the primary screening sources. After deduplication, 68 unique records remained. Title and abstract screening reduced this set to 22 studies. Articles were excluded if they focused on non-mouse inputs, purely theoretical modelling without empirical performance measures, or unrelated interaction techniques `figures/prismaone.png`

Figure 8: Literature Search Strategy For Control-Display Gain and Mouse Acceleration

B.3 Motor Learning and Adaptation

For this section, three searches were conducted using Google Scholar. For each search query, only the first page (10 entries) was included, since these represent the most relevant results to the search query. For these 10 papers, the abstracts were reviewed to find the most relevant papers for this study. Exclusion criteria were: non-peer-reviewed sources, papers not available in English, and papers focused exclusively on clinical populations without relevance to healthy motor learning.

`figures/motor.png`

Figure 9: Literature Search Strategy for muscle memory

Appendix C Work Plan

To investigate the effect of disabling mouse acceleration on task completion time, accuracy, submovement count, and path efficiency across multiple sessions.

Work Packages

WP1 – Literature Review

Lead: Shared
Planned period: Week 8–9
Tasks:

- Research and draft Fitts' Law section
- Research and draft Control-Display Gain and Mouse Acceleration section
- Research and draft Motor Learning and Adaptation
- Research and draft research gap section
- Draft abstract
- Draft introduction + hypotheses

Deliverable:

- Finalised introduction + literature review (phase 1)

Milestone:

- Research proposal part 1 complete

Dependency:

- None

WP2 – Experiment Design Finalisation

Lead: Shared
Planned period: Week 8–9
Tasks:

- Set task parameters / metrics

- Define statistical model
- Define participation criteria
- Design test procedure
- Ethics quickscan

Deliverable:

- Method section complete

Milestone:

- Research proposal completely finished

Critical decisions:

- Confirm longitudinal modelling approach before data analysis begins

Dependency:

- Literature review (WP1)

WP3 – Supplement Material Creation

Lead: Hidde
Planned period: Week 9
Tasks:

- Draft informed consent
- Draft information sheet
- Draft baseline questionnaire
- Draft session questionnaire

Milestone:

- Supplement material finished

Dependency:

- Literature review (WP1)
- Experimental design finalisation (WP2)

WP4 – Web Application Development

Lead: Abel
Planned period: Week 9–10
Tasks:

- Implement clicking task
- Implement slider task
- Implement dragging task
- Implement scaling logic
- Implement logging
- Database structure
- Export to CSV
- Internal testing

Milestone:

- Functional testing environment

Dependency:

- Experiment design finalisation done (WP2)

WP5 – Data Collection

Lead: Shared
Planned period: Week 11–12
Tasks:

- Recruit $N = 32$ participants (+15%)
- Acquire informed consent
- Baseline session
- Multi-week session

Milestone:

- Complete dataset

Dependency:

- Working web application (WP4)
- Supplement material created (WP3)

Risk:

- Participant dropout

Contingency:

- Recruit +15% extra participants

WP6 – Data Preprocessing & Assumption Checks

Lead: Reinier
Planned period: Week 12–13
Tasks:

- Aggregate per participant per session
- Compute change in metric values
- Check statistical test assumptions

Milestone:

- Cleaned-up and analysis-ready dataset

Critical decisions:

- Which statistical model to use

Dependency:

- Data collection (WP5)

WP7 – Statistical Analysis

Lead: Shared
Planned period: Week 13
Tasks:

- Primary analysis
- Post hoc tests

- Visualisations

Milestone:

- Results section initial draft (no interpretation)

Dependency:

- Data preprocessing & assumption checks (WP6)

Risk:

- Assumption violation

Contingency:

- Switch to RM-ANOVA, LMM, or non-parametric

WP8 – Writing Phase 2 (Results + Discussion)

Lead: Shared
Planned period: Week 13
Tasks:

- Results interpretation
- Comparison with literature
- Strengths & limitations
- Implications
- Update abstract & title

Deliverable:

- Project report (phase 2)

Milestone:

- Final report draft

Dependency:

- Statistical analysis (WP7)

WP9 – Presentation

Lead: Aris

Planned period: Week 13–14

Tasks:

- Slide design (max 6)
- Rehearsal presentation

Deliverable:

- Presentation slides

Milestone:

- Presentation rehearsed and finished

Dependency:

- Writing phase 2 (WP8)

Gantt Management

`figures/gannt.png`

Figure 10: Gantt chart overview of the project planning

Risk	**Impact**	**Likelihood**	**Contingency**
Participant dropout	Reduced power	Medium	Recruit 15% extra
Hardware variability	Increased variance	High	Use improvement-from-baseline metric
Acceleration setting changed	Internal validity threat	Low–Medium	Session questionnaire + reminder
Assumption violation	Invalid test	Medium	Switch to RM-ANOVA or non-parametric

Table 6: Risk management overview

Work Plan Evaluation

Overall, the project was completed on schedule, and all major deliverables were produced. Several deviations from the original plan occurred.

WP5 – Data Collection

- *Planned:* Recruit $N = 32$ participants
- *Actual:* 25 participants completed the baseline session, 19 met the ≥ 7 session criterion and were included in the final analysis (8 control, 11 experimental)
- *Reason:* Participant dropout was anticipated as a risk. Remote participation and daily session requirements possibly burdened the participants
- *Impact:* Reduced statistical power, unequal group sizes (8 vs 11). LMM handled the missing data without imputation, mitigating the impact on validity

WP6 – Data Processing & Assumption Checks

- *Planned:* Aggregate per session, compute metric changes, check assumptions
- *Actual:* Trial-level data was used directly in the LMM rather than aggregated per session. MAD-based outlier removal replaced a standard assumption check pipeline.
- *Critical Decision Outcome:* LMM was selected over RM-ANOVA or non-parametric alternatives, justified by the unbalanced design and continuous time predictor

WP7 – Statistical Analysis

- *Planned:* Primary analysis + post hoc test + visualizations
- *Actual:* LMM analysis completed across 12 models. Post hoc tests were not conducted, as the LMM interaction term directly addressed the research question without requiring post hoc comparisons. Visualizations produced for all metrics.

WP9 – Presentation

- *Planned:* Week 13-14, max 6 slides
- *Actual:* Week 14, 12 slides in total, including the title slide, thank you slide, etc., making it 7 slides that actually present content

Appendix D Logbook

Table 7: Logbook of hours per team member per task.

Member	**Date**	**Hours**	**Task**
All	16-2-2026	1.50h	Discussing research methods and research topics for literature review
Hidde	17-2-2026	1.50h	Drafting and refining search queries for control display gain and mouse acceleration, logging initial results + removing duplicates
Abel	19-2-2026	3.00h	Researching literature for muscle memory
Hidde	19-2-2026	1.50h	Initial draft section 4.2
All	19-2-2026	1.00h	Meeting discussing literature research and experiment setup + Task division for the research proposal
Aris	19-2-2026	2.00h	Researching about relevant papers to our RQ confirm and emphsize the research gap
Reinier	19-2-2026	2.00h	Researching literature about Fitts's Law, determining the query and criteria
Hidde	20-2-2026	0.75h	Finishing section 4.2
Abel	21-2-2026	1.50h	Writing out my part of the literature review in project proposal and started work on the experiment design
Abel	22-2-2026	2.00h	Completed experiment design and wrote it all out, including some parts of the procedure
Aris	22-2-2026	1.50h	Thorougly studying on the procedure phase and connecting it with the experiment design
Aris	23-2-2026	3.00h	Writing the procedure part of the experiment and figuring out which statistical model should apply to answer our RQ
Hidde	23-2-2026	2.00h	Writing on participants, material and apparatus.
All	23-2-2026	1.50h	Discussing what we wrote on and how it connects to each others section. Including what is missing and setting criteria.
Reinier	23-3-2026	2.00h	Doing the final screening of literature review papers and writing the section
Reinier	23-3-2026	1.50h	Writing the introduction
Aris	23-3-2026	1.00h	Merging all the info in one latex document
Hidde	23-3-2026	1.00h	Creating work packages, determining risks, creating gantt chart. Combininng into work plan.
All	23-3-2026	2.00h	Helping compiling the text into LaTeX and LNCS template and scrapping words to meet the word count
Abel	24-2-2026	2.50h	Started work on the web application
Abel	27-2-2026	7.50h	Completed clicking task and database implementation for web app
Aris	27-2-2026	5.00h	Completed slider task and code refactor

Member	**Date**	**Hours**	**Task**
Abel	28-2-2026	9.00h	Completed login page, explanation pages, calibration page, first time survey page, and done page. This almost concludes our experiment setup, Aris will make the dragging task and then it is just some polishing and done. Also started work on our custom made analytics dashboard, where I have made a full participants overview already where we can also invite new participants and track how many sessions they have done (to see if we need to remind our participants).
Aris	1-3-2026	4.00h	Completed Dragging task and and improved visuals
Hidde	1-3-2026	2.00h	drafted and completed participant information sheet and consent form
Abel	2-3-2026	4.00h	Completed survey and session guarding, so participants can only do their sessions when they are supposed to. We also had a meeting about recruiting the participants, which we will start doing shortly
All	2-3-2026	0.75h	Testing enviromnent walthrough and consent form + participant info sheet discussion
Abel	3-3-2026	5.00h	Implemented participant page in dashboard, so we can see the scores for each session and keep track of our participants.
Hidde	4-3-2026	2.00h	Created recruitment survey and added consent and information sheet. Created mouse acceleration setting tutorial for MacOS users.
All	5-3-2026	0.50h	Procedure adjustment and initiall particiant recruitment
Reinier	5-3-2026	1.00h	Participant recruitment
Hidde	6-3-2026	1.00h	Participant recruitment
Abel	9-3-2026	4.00h	Implemented automatic reminders for participants, monitored incoming results, found and fixed bugs (luckily all data is still good)
Hidde	9-3-2026	0.25h	Contacted participants that I recruited to remind them to complete their test today
Abel	10-3-2026	3.00h	Assigned participants to their group and fixed issues with mailing system + made some improvements to the dashboard + monitoring incoming results and emails to make sure everything runs smooth
Hidde	11-3-2026	0.25h	Contacted participants that I recruited to remind them to complete their test today
Abel	11-3-2026	0.25h	Monitored incoming results and sent reminders to participants i invited
Abel	12-3-2026	0.25h	Monitored incoming results and sent reminders to participants i invited
Abel	13-3-2026	0.25h	Monitored incoming results and sent reminders to participants i invited
Hidde	16-3-2026	0.25h	Contacted particiapnts that I recruited to remind them to complete their test today
Abel	16-3-2026	0.25h	Monitored incoming results and sent reminders to participants i invited
Abel	17-3-2026	0.25h	Monitored incoming results and sent reminders to participants i invited

Member	Date	Hours	Task
Hidde	18-3-2026	0.25h	Contacted participants that I recruited to remind them to complete their test today
Abel	18-3-2026	0.25h	Monitored incoming results and sent reminders to participants i invited
Abel	19-3-2026	0.25h	Monitored incoming results and sent reminders to participants i invited
Abel	20-3-2026	0.25h	Monitored incoming results and sent reminders to participants i invited
Hidde	21-3-2026	1.50h	Initial rewrite of methods section based on procedure changes.
Aris	23-3-2026	1.00h	Initiated the python script for the data we collected and starting processing the datasets
Abel	23-3-2026	2.50h	Implemented first data processing step, excluding participants with too few sessions, also implemented aggregation and some visuals to have some preliminary results so we could see if there was something interesting.
All	23-3-2026	1.00h	Meeting discussing the last steps in the research and preparing for part II
Reinier	24-3-2026	2.00h	Looking into data preparation (missing values, outliers, etc.)
Aris	26-3-2026	1.50h	Initiated the logic of outlier filtering in our experiment code wise.
Abel	26-3-2026	4.00h	Improved outlier filtering, implemented statistical analysis, implemented visual generation of results, implemented participant specific visuals to send to the participants as a reward when the paper is finished. With these the significance of the effects and effect size are clearly stated, giving us the results for the study. The visuals complement this by showing an increasing line for the experiment group and a steady line for the control group.
Hidde	26-03-2026	1.75h	Drafted strenghts and limitations section for discussion.
Hidde	27-3-2026	1.50h	Thought about feature research applications and drafted future research section, mostly based on strenghts and weaknesses.
Hidde	28-3-2026	0.75h	update to method section (analysis plan, outcome measures, task battery)
Hidde	28-3-2026	0.50h	Added sections to overleaf document (updated methods, strenghts and weaknesses, future research)
Abel	28-3-2026	2.00h	Improved visuals, and applied corrections to results. Also found an error in calculating effect size, fixed that. Made the skeleton of the presentation and already included the visuals in there.
Abel	29-3-2026	1.50h	Finished presentation
Abel	29-3-2026	4.00h	Rewrote methods section to reflect the actual code we executed, also compacted it down so it fits better in the page limit. Also wrote the results section. Also rewrote discussion section to reflect the actual results we have, compact it down and add a conclusion to it.

Member	**Date**	**Hours**	**Task**
Aris	29-3-2026	1.00h	Specific changes on the slides that I presented plus overall preparation and rehearsal
All	30-3-2026	0.50h	Last meeting before hand in
Hidde	30-3-2026	3.00h	Added summary and made connection to related work more concrete (discussion)
Abel	30-3-2026	1.00h	Finishing touches paper
Reinier	30-3-2026	1.00h	Making sure introducding is in line with changes in phase 2
Aris	30-3-2026	0.50h	Improved overall text of report and minor changes
Aris	30-3-2026	1.00h	Added work plan evaluation

Appendix E Presentation Slides

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