Analyzing The Influence of Environmental and Behavioral Factors on Typing Speed Across Individuals

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Abstract

This study investigates the effects of factors such as time of day, the presence of music, the type of typing device, and posture on typing speed (measured in words per minute). Using a balanced factorial design, data were collected from three participants, examining the main effects and interaction effects of these variables on performance. Preliminary analyses indicate that individual differences and the type of device significantly impact typing speed. Furthermore, the interaction between individuals and device types was found to have a notable effect, suggesting that the tools individuals use can substantially influence their typing performance. Additionally, posture, the presence of music, and the time of day are not significant to typing speed and do not appear to exhibit potential interaction effects, though further exploration may be warranted. These findings provide valuable insights and practical recommendations for optimizing typing efficiency in various settings.

1. Introduction

In contemporary society, typing speed holds significant importance across various professional fields as it directly correlates with workplace productivity and is an essential skill in academic and professional contexts. Faster typing speed enables individuals to complete tasks more efficiently, thereby enhancing their ability to manage additional responsibilities and contribute effectively to organizational success. As noted in a blog on Testlify, “Typing speed is crucial in the workplace because it directly impacts productivity and efficiency. Employees who can type quickly can complete tasks faster, allowing them to handle more responsibilities and contribute to the organization’s success” (Testlify, n.d.). In today’s world, where the internet permeates every aspect of life, communication often occurs via digital devices due to its convenience. Typing speed is intrinsically tied to response time, which is essential for achieving efficient and timely communication.

Recognizing the variability in typing habits among individuals, this experiment aims to evaluate the influence of four factors on average typing speed, measured in words per minute (wpm). The factors under investigation include time of day (morning vs. evening), the presence of music (with or without music), the typing device (laptop vs. phone), and posture (sitting in a chair vs. lying in bed). Through the examination of these factors and their interactions across multiple individuals, the study seeks to identify patterns or conditions that significantly affect typing performance. A full factorial design has been employed, ensuring that all combinations of these factors are included in the data collection process, thereby providing a comprehensive and consistent dataset for analysis. The report is structured as follows: Section 2 details the experimental design, including the factors, levels, and data collection methodology. Section 3 presents the statistical analysis and key findings, while Section 4 discusses the conclusions and offers recommendations based on the results.

2. Details of the Experimental Design

Factors and Response

Response variable:

- Typing speed (wpm): Measured in words per minute (wpm).

Factors:

- Time of the day (Morning vs. Evening)
- Music (With vs. Without Music)
- Device (Laptop vs. Phone)
- Posture (Chair vs. Bed)
- **Blocking factor**: Subject (Participant 1, Participant 2, Participant 3)

Time of the day: Each participant completed a balanced typing test during two specific time intervals: the morning session was conducted between 9:00 AM and 10:00 AM, and the evening session took place between 9:00 PM and 10:00 PM.

Music: For the "with music" condition, participants listened to California Dreamin by Chris Lorenzo featuring High Jinx. This track was selected for its fast and upbeat tempo (128 BPM) and rhythmic consistency, providing a typical background music experience to simulate realistic conditions.

Device: The devices used included a standard laptop equipped with a fully functional, standard keyboard, and a touchscreen smartphone. Both devices were chosen to ensure uniformity and comparability across participants.

Posture: Participants performed the typing tests in two distinct postures: seated upright in a chair and lying on a bed. These conditions were implemented to evaluate the influence of posture on typing performance.

These factors were selected to examine their potential effects on typing speed. A summary of the factors and their respective levels is provided in Table 1.

Experimental Plan

The experimental design follows a 3 × 2 × 2 × 2 × 2 factorial structure, incorporating four independent factors and one blocking factor. This approach ensures a comprehensive analysis of the individual and interaction effects of the chosen factors on typing performance. The factors under investigation—time of day, music presence, typing device, and posture—were selected to evaluate realistic and impactful variations in typing conditions. The choice of time (morning and evening) aimed to capture differences in cognitive performance throughout the day. Music presence was included to assess its potential to enhance or hinder typing performance. Device type and posture levels were designed to reflect common typing scenarios, accounting for differences in ergonomics and technological interfaces. The typing test was administered using the Monkeytype platform, a tool specifically designed to measure typing speed and accuracy.

Each test was standardized to a 60-second duration to maintain consistency in evaluation across all experimental conditions. To account for individual differences in typing speed, each participant was treated as a block in the design. Within each block, the 16 combinations of factors were randomized to mitigate potential bias. Additionally, the run order for the typing tests was randomized for each participant to further ensure the validity and reliability of the results.

Construction details

A data frame will be constructed to analyze both the mean effect and the interaction effect. Initially, the data will be verified using a Box-Cox plot to determine whether a transformation is required. Subsequently, a linear model will be developed and validated through the use of both a QQ plot and a residual plot. This process will enable the identification of the most optimal model. ANOVA tables will be generated to evaluate the significance of the main effect and the interaction effect across various treatments. Additionally, interaction plots and main effect plots will be constructed to provide further insights. If significant results are observed, contrasts will be established to investigate specific differences in greater detail, facilitating a comprehensive assessment and comparison of individual and interaction effects of the treatments. Furthermore, confidence intervals will be constructed and back transformed to draw robust and precise conclusions from the analysis.

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3. Statistical Analysis

In this analysis, we included only the main effects and second-level interaction effects, excluding third-level interaction effects, as they do not provide substantial additional information. As outlined in the construction details in Section 2, a Box-Cox plot was utilized to assess whether a transformation was necessary. Since $\lambda = 1$ λ=1 falls outside the confidence interval, a transformation was deemed required, leading to the application of a logarithmic transformation. Given that a log transformation was applied to the response variable (words per minute), the coefficients in our model must be exponentiated for proper interpretation. In the following code:

```
lm(y_transformed_log ~ ., data = df)
```

A linear model was developed using the log-transformed response variable, incorporating both main effects and second-order interaction effects. Analysis of the QQ plots (Figure 1) revealed that the residuals adhered more closely to normality prior to the transformation, indicating that the log transformation did not significantly enhance normality. However, the deviation observed was minimal. Residual plots (Figure 2), both before and after the transformation, exhibited no discernible patterns or trends, confirming that the model satisfies the assumptions of linearity and homoscedasticity (constant variance). The construction of the ANOVA table (Table 2) revealed that the main effects of individual and device were statistically significant. Furthermore, the interaction effect between individual and device was also significant. Consequently, contrasts were performed to further investigate and interpret these effects in greater detail.

The estimated contrast for the device main effect and the standard error are:

$$\hat{k}_d = -4.096 + 4.403 = 0.307 wpm$$

$$se(\widetilde{k}_d) = 2\sqrt{\frac{0.00986}{48}} = 0.0287wpm$$

The laptop's mean is 0.307 wpm higher than the phone's mean on the log-transformed scale of the response variable.

The t-statistic and p-value:

$$t = \frac{\hat{k}_d}{se(\hat{k}_d)} = \frac{0.307}{0.0287} = 10.715.$$

$$P = 3.005 \times 10^{-12}$$

Both the t-statistic and p-value suggests that a strong effect of the device,the device main effect is highly significant.

A 95% confidence interval for the device main effect is:

$$0.307 \pm (2.0395)(0.0287) = [0.249wpm, 0.366wpm]$$

This interval suggests that the true mean effect of the device lies between 0.249 and 0.366 wpm on the log-transformed scale.

Back-transforming the confidence interval to the original scale gives

$$[1.282wpm, 1.441wpm]$$

The application of the summary() function to the linear model confirmed that the main effect of the device, as well as the interaction between the blocking factor and the device, were statistically significant. The 95% confidence intervals for these effects, back-transformed for interpretability, are provided below and will serve to inform the subsequent discussion.

$$\hat{\beta}_d : [0.431wpm, 0.633wpm] \qquad \hat{\beta}_{bd} : [1.042wpm, 1.139wpm]$$

At a 95% confidence level, it is estimated that using a laptop instead of a phone increases the mean typing speed by 0.431 words per minute (wpm) to 0.633 wpm. Furthermore, switching from a phone to a laptop, depending on the subject, results in an increase in mean typing speed ranging from 1.042 wpm to 1.139 wpm.

Again, the contrast $\hat{k}_d$ estimates the difference in mean performance between using a phone and a laptop. Given that the contrast is both positive and highly significant, this indicates a strong positive interaction effect associated with switching from a phone to a laptop for typing tasks. We also observe that the interaction between the blocking factor and the main effect of the device is statistically significant. The mean typing speed increases when transitioning from a phone to a laptop. However, there is a notable difference between subjects, indicating that the transferability of typing speed varies significantly across individuals.

Recommended Levels

As shown in Table 3. In Block 1, the recommended conditions are nighttime, no music, using a laptop, and typing in bed. Typing in a relaxed nighttime environment, particularly in bed without music, was found to enhance performance. The laptop consistently proves to be a superior device for typing efficiency in this setting, emphasizing the importance of a calm and distraction-free environment for improved speed. Block 2 also involves nighttime, no music, and using a laptop, but the location shifts to a desk instead of a bed. This slight variation suggests that for some individuals, working at a desk during nighttime may provide better posture or improved focus, which could slightly boost typing speed compared to a more relaxed setup like typing in bed. In contrast, Block 3 highlights a morning setup with music, using a laptop, and typing at a desk. This combination demonstrates that optimal conditions can vary by time of day. In the morning, music appears to enhance productivity, possibly by increasing alertness or motivation. Typing at a desk during this time provides a structured and focused environment conducive to higher typing speed. A key finding across all blocks is the consistent advantage of using a laptop over other devices, such as smartphones, for maximizing typing speed.

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4. Conclusions and Discussion

Using a balanced factorial design, we examined the impact of posture, device type, music presence, and time of day on typing speed, measured in words per minute (wpm). Statistical analysis identified device type as a significant factor, with a 95% confidence interval indicating that transitioning from a smartphone to a laptop increases the mean typing speed by 0.431 to 0.633 wpm. For the interaction effect between participants and device type, the mean typing speed increase ranged from 1.042 to 1.139 wpm. This interaction was also statistically significant, suggesting a positive change in typing speed when switching from a phone to a laptop. No interaction effects were observed among the three variables, and the main effects of posture, music presence, and time of day were not statistically significant. The experiment was limited to three blocks, but future research could expand on this by incorporating additional factors, such as the genre of music or differences between natural and artificial lighting. Regarding data collection, the selected platform, Monkeytype, is likely an unbiased tool for recording results. It is worth noting that the repeated exposure to typing practice does not significantly impact typing speed due to the short duration of the data collection process, minimizing potential noise. However, the small dataset presents another limitation. To enhance the reliability of the results, collecting more data would be beneficial, although this was not feasible within the given time constraints. Since time of day was not a significant factor in our study, future experiments could utilize this flexibility to minimize potential confounding effects of repeated exposure. For instance, recording all attempts within a single session could help isolate this variable as a measurable factor.

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5. Tables and Figures

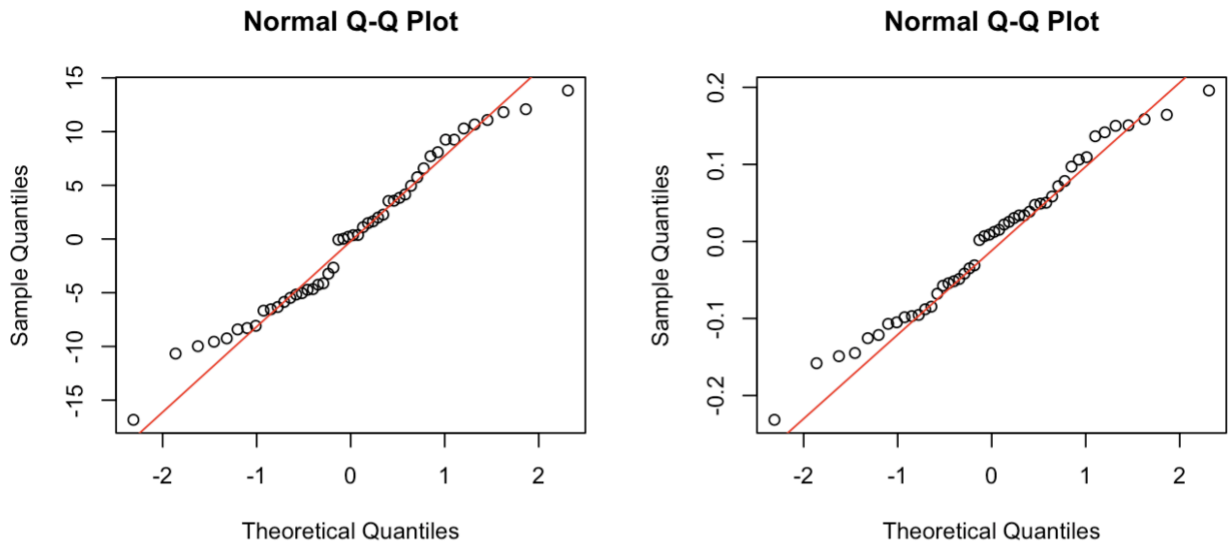

Figure 1: QQ plots (Right: Before transformation, Left: After transformation)

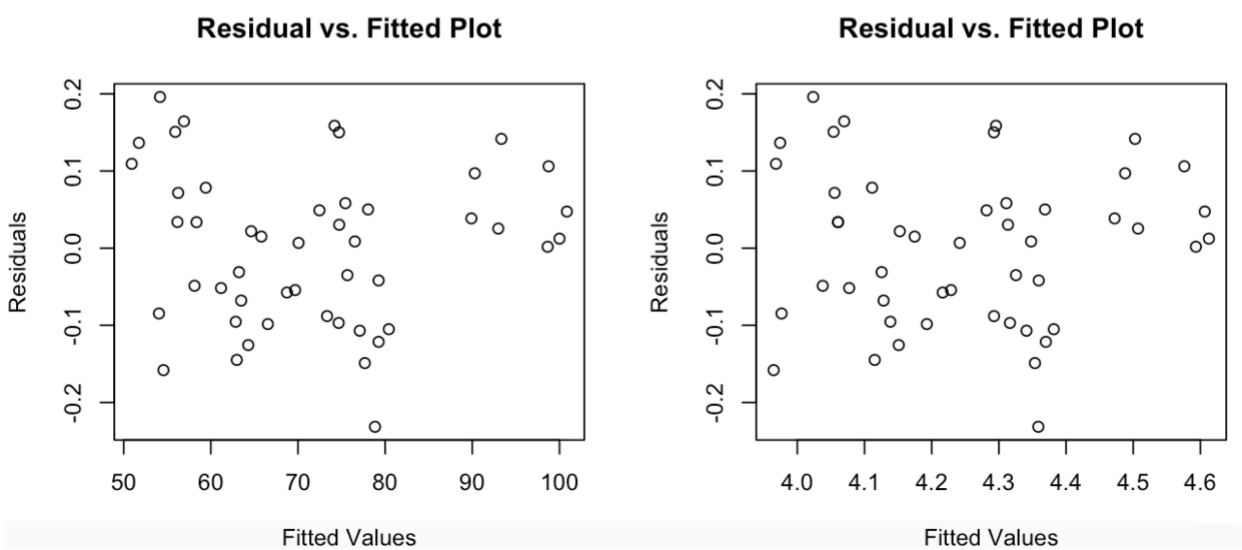

Figure 2: Residual plots (Right: Before transformation, Left: After transformation)

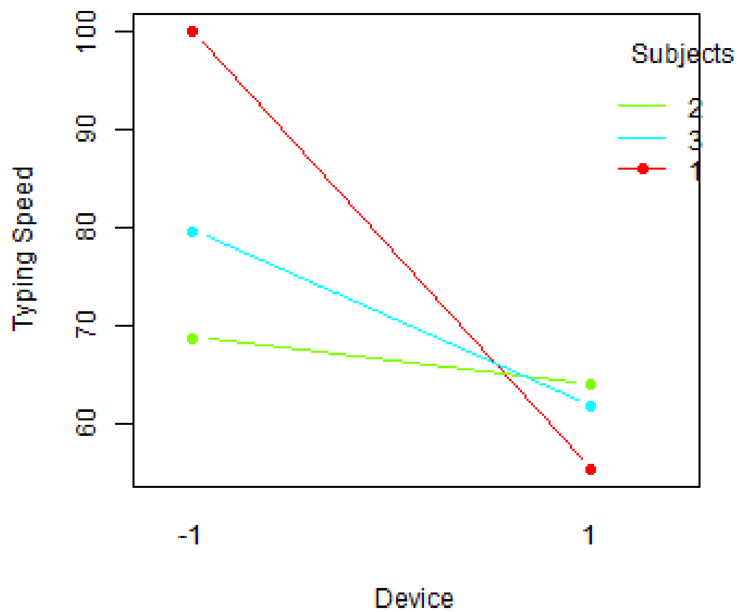

Figure 2: Interaction Plot: Device and Blocking Factor

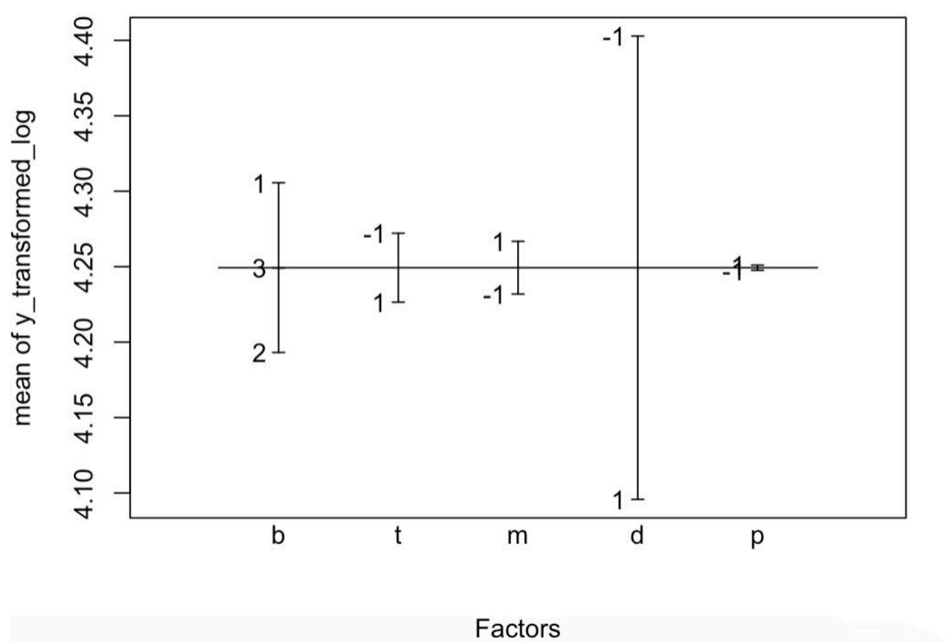

Figure 3: Main Effect Plot

Factor	Description	Levels
Block	Participants in the experiment	Lily, Amar, Minghao
Time	Time of day	Morning (9AM-10AM), Evening (9PM-10PM)
Music	Presence of music	With Music, No Music
Device	Typing device	Phone, Laptop
Posture	Sitting position	In a chair, in bed (with feet supported at hip level)

Table 1: Explanation of Factors, Description and Levels

```
            Df Sum Sq Mean Sq F value   Pr(>F)    
b            2 0.1012  0.0506   3.316 0.049530 *  
t            1 0.0251  0.0251   1.642 0.209554    
m            1 0.0147  0.0147   0.960 0.334794    
d            1 1.1316  1.1316  74.144    1e-09 ***
p            1 0.0001  0.0001   0.009 0.924352    
t_m          1 0.0037  0.0037   0.240 0.627767    
t_d          1 0.0002  0.0002   0.014 0.905129    
t_p          1 0.0040  0.0040   0.263 0.611719    
m_d          1 0.0141  0.0141   0.924 0.343952    
m_p          1 0.0004  0.0004   0.024 0.876853    
d_p          1 0.0053  0.0053   0.350 0.558326    
b_t          1 0.0319  0.0319   2.091 0.158249    
b_m          1 0.0005  0.0005   0.034 0.854041    
b_d          1 0.2346  0.2346  15.370 0.000455 ***
b_p          1 0.0026  0.0026   0.168 0.684302    
Residuals   31 0.4731  0.0153                     
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Table 2: ANOVA Table (Log Transformation)

Block 1: [-1, -1, -1, -1]	Block 2: [-1, -1, -1, 1]	Block 3: [1, 1, -1, 1]
Night time No music On the laptop In bed	Night time No music On the laptop On the desk	Morning time With music On the laptop On the desk

Table 3: Recommended Levels Maximizing Typing Speed for Each Block

6. Reference

Testlify. (n.d.). *The importance of typing speed and accuracy in the workplace*. Retrieved December 6, 2024, from https://testlify.com/the-importance-of-typing-speed-and-accuracy-in-the-workplace/#:~:text=Typing%20speed%20is%20crucial%20in

Monkeytype. (n.d.). *Monkeytype*. Retrieved December 6, 2024, from https://monkeytype.com/