Typing and Pointing in Virtual Reality while Lying Down

Shanpeng Ma
Preferred Networks
Japan
Nara Institute of Science and Technology
Japan
shanpeng.ma@gmail.com

Fabrice Matulic
Preferred Networks
Japan
fmatulic@preferred.jp

ABSTRACT

This work explores the feasibility of using VR for productivity tasks while lying down. We conducted two user studies to evaluate text entry and target selection performance, two essential components of productivity work, in both supine and seated postures. Our results show that while text entry speed and accuracy are lower in the supine position, subjective comfort levels are comparable. For target selection, head tracking is most efficient when seated, while controller-based input is preferable when lying down. We discuss the implications of these findings for the design of VR interfaces for reclined use and highlight the potential of this approach to improve accessibility and comfort.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; **Text input**; **Pointing**.

KEYWORDS

VR, text entry, pointing

1 INTRODUCTION

The use of Virtual Reality (VR) is rapidly expanding beyond recreational applications to include knowledge work and office-oriented tasks. In these scenarios, users typically wear VR headsets while seated at a desk with a keyboard and a pointing device (mouse, trackball, touchpad on keyboard etc.), much like a traditional work setting, but enhanced with floating virtual displays and customisable virtual office backdrops [2, 32]. One of the inherent advantages of VR is the ability to render virtual screens anywhere in 3D space, which opens up possibilities for supporting different working postures. Recently, there has been an increasing interest in exploring VR usage while lying down, driven by the desire for more relaxed interaction modes and to accommodate users with medical conditions or disabilities [4, 17]. Reflecting the growing importance of VR usage in a supine position, Meta introduced a lying down mode for its Quest headsets in 2024.

Previous research on reclined VR has predominantly focused on adapting high-movement VR applications like games, which were originally designed for upright or seated use. These studies emphasise the challenges involved in adapting such applications to supine postures [15, 16, 35], where remapped interactions often remain physically demanding and less intuitive[20]. In terms of hardware, the company Diver-X launched a Kickstarter project in early 2022 for a VR headset specifically designed for use in bed, but the project was ultimately cancelled [6]. Other efforts have included experimental devices and applications aimed at video watching and relaxation while lying down [18, 29].

Despite these developments, no prior work has explored the feasibility of conducting work-like tasks in VR while lying down. The few prior usability studies hint at the potential for increased comfort and accessibility for leisure applications but lack comprehensive evaluations in productivity contexts. To address this gap, we take a first step towards assessing the suitability of VR for office work in recumbent positions. We focus on two fundamental tasks essential for such scenarios: typing and target selection. Given the efficiency requirements of productivity work, we use a physical keyboard placed on a tilted tray for typing and compare text entry performance between supine and sitting positions. For target selection, we evaluate the performance of a touchpad, a controller, and head orientation, again comparing sitting and supine positions. The results show that text entry is feasible in a supine position, with users achieving 75% of their seated typing performance, while for pointing, head tracking is efficient but can cause fatigue, with controllers and touchpads offering comfortable alternatives.

2 RELATED WORK

We examine the literature on VR use while lying down and briefly review relevant prior work on typing and target selection in VR using standard devices.

2.1 VR in a Supine Position

The exploration of VR experiences in reclined positions is a relatively new area of research.

Kontio et al. explore non-standing VR locomotion techniques, including in supine poses, with techniques involving significant arm and leg movements and therefore with high physical demands [16]. Van Gemert et al. examine the usability of playing popular VR games while lying down, finding that while the position is generally comfortable, it presents difficulties for movement-intensive interactions [35]. Echoing those findings, Koeshandika et al.'s usability study of various VR applications in different positions concludes that a supine posture is more suited to low-movement activities such as watching videos compared to more dynamic and physically demanding games [15].

Marengo et al. [23] and Luo et al.[20] investigate the impact of lying down on simulation sickness. Both studies indicate that

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supine positions can increase the likelihood of simulation sickness, especially with redirected content designed for upright use. To mitigate this, Luo et al. propose VR locomotion methods for users in reclining and swivelling chairs, leveraging chair movements as an input method [19].

These studies highlight the challenges of using VR in supine or reclining positions, especially for applications involving significant movement. Consequently, efforts have also focused on more static and low-movement activities in these contexts. For instance, PillowVR integrates a phone into a cushion for viewing videos in bed, relying on head movements for navigation [18]. Additionally, the similarly named Meta Quest app Pillow offers low-demand mixed reality games and relaxing experiences specifically for use while lying down [29]. The potential of VR for work-focused tasks in such positions, however, remains largely unexplored.

2.2 Typing and Pointing Studies in VR

2.2.1 Typing with Physical Keyboards. Given their efficiency, physical keyboards have also been investigated for text entry in VR. Prior work has focused on identifying effective visual representations to facilitate typing [10, 14] and comparing the performance of hard vs soft keyboards [13]. Additionally, innovative approaches have been explored in mobile contexts, such as keyboards placed on user-worn trays [27], headsets [12], or directly on the user's body [25, 26].

2.2.2 Target Selection Techniques. The standard method for pointing and selecting objects in VR is raycasting with controllers, but many other techniques and input devices have also been explored. Luro and Sundstedt compared gaze and controller-based pointing and found that gaze offered comparable performance while being less physically demanding [22]. On the other hand, Minakata et al. reported that gaze input was outperformed by mouse and head-based pointing [24]. Thanks to hand tracking, bare hand-based selection methods are also possible, but they often lack precision and can cause fatigue [21]. Pens have also been considered as pointing devices and found to be precise and efficient but are not commonly used in standard VR settings [28].

2.3 Summary and Research Gap

Prior research underscores the challenges and potential of VR in reclined positions, mainly emphasising low-movement applications. Studies on typing and pointing with standard devices mostly consider seated or upright contexts. Notably, apart from a limited gaze study with just four participants [1], there has been no substantial examination of keyboard typing and pointing performance in VR while lying down. Our work aims to fill this gap with a view to providing insights into the potential for office work in such contexts.

3 STUDY

3.1 Study Design

Working on desktop computers with keyboard and mouse involves a variety of interactions depending on the application and work context, but two fundamental tasks of typical office work on a PC are entering text and selecting items on the screen. Instead of choosing tasks directly mimicking professional work settings and applications for our experiment (e.g. writing a report, editing a spreadsheet or creating a presentation), we designed a within-subjects study with generic typing and pointing tasks that have been widely used in prior work for more generalisability and to facilitate comparisons.

3.1.1 Apparatus. Our experiments utilised a Meta Quest 3 VR headset. For the seated position, participants used a conventional desk and chair setup. For the supine position, participants lay on a yoga mat with a pillow, and the keyboard was placed on a tiltable stand, as shown in Figure 1b. We used a Logitech MX Keys Mini keyboard for the typing task and an Ashata wireless keyboard with integrated touchpad for the pointing task. To provide visual feedback of the keyboard and the user's hands in VR during text entry, a downward-facing web camera was attached to a pole affixed to the keyboard.

3.1.2 Task 1: Text Entry. We used a physical keyboard as our primary text input device, given its prevalence in office contexts and its superior efficiency compared to virtual keyboards [3, 5, 7, 8, 11].

For the text entry task, we adapted TextTest++ [37], a text input evaluation tool that presents a series of random English sentences for participants to type as quickly and accurately as possible. In our VR adaptation, participants viewed a compact floating window displaying the prompt sentence above a text field for typing (Figure 1). Below this window, we displayed the live feed from the webcam capturing the keyboard and the user's hands. These windows were positioned at a virtual distance of 2m from the participant.

The study was conducted in a laboratory setting. To minimise the impact of learning effects on the results, we rotated the order of the conditions between participants. At the beginning of the experiment, participants set up the Quest headset, adjusted the interpupillary distance and straps, and positioned the text input window in front of them. Additionally, they adjusted the stand, desk, chair and mat to ensure comfortable conditions.

Before starting the main task, participants engaged in three practice trials with further practice sessions available upon request. Participants then performed the main text input tasks, consisting of ten randomly selected phrases, in both postures. After completing the tasks in each posture, participants were requested to evaluate the usability, efficiency, eye fatigue, body fatigue, and satisfaction associated with that posture on a continuous scale from 0 to 100. To ensure that the relative differences in scores accurately reflected their experiences, participants were given the possibility to adjust their scores for the first posture after rating the second. Furthermore, they were invited to provide comments to justify their choices. After completing all tasks with both postures, participants reviewed their scores one final time and responded to follow-up questions if clarification regarding any ratings or comments was needed.

3.1.3 Task 2: Pointing. In 2D VR interfaces, such as the windows that appear in the Quest's home environment, item selection is typically achieved by raycasting with controllers, hands, the headset, or, if available, with a pointing device such as a mouse or a trackpad. We use these methods for our pointing study. We did not consider gaze input evaluated in some previous work [1], as eye tracking is not a standard feature of consumer VR headsets (and

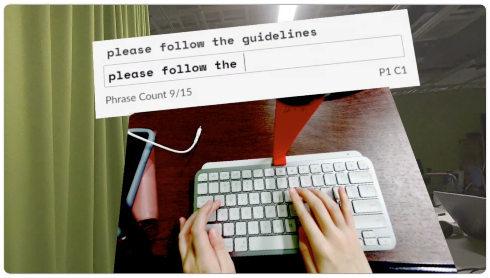
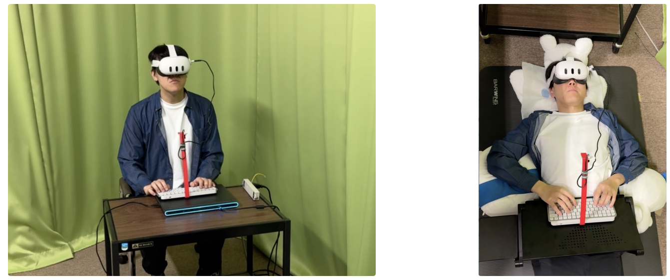


Figure 1: Text entry task with external view of the keyboard shown in VR



Sitting **Supine**

Figure 2: The two conditions of the typing study

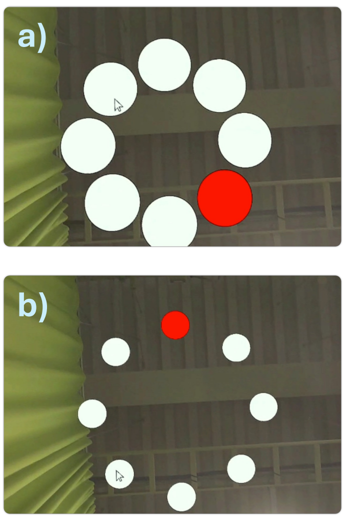


Figure 3: The two target sizes for the pointing task

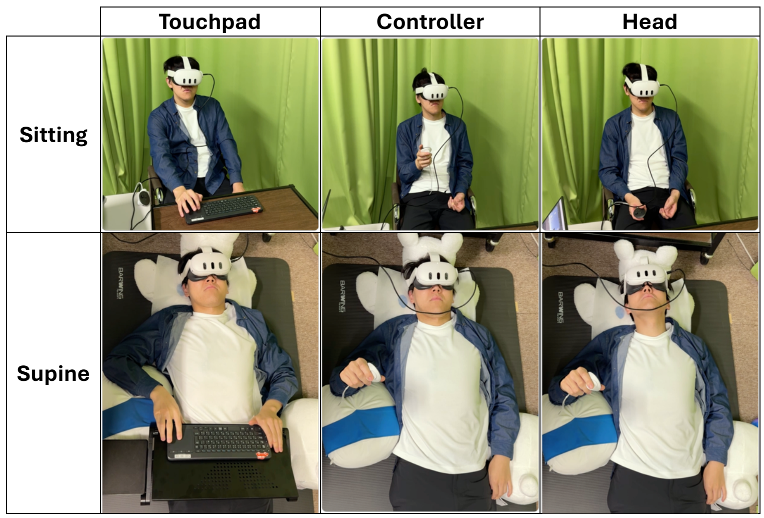


Figure 4: The six conditions of the pointing study using touchpad, controller and head pointing methods in sitting and supine postures

is not supported by the Quest 3). This experiment was conducted immediately after the text entry task with the same participants.

The pointing task was based on the FittsStudy tool [36], which we adapted for VR. The experiment consisted in showing targets in a circular layout that participants had to select one after the other, as fast and accurately as possible. Successive targets appeared on opposite sides of the circle, requiring the participant to move across the diameter for each selection.

Our conditions combined two postures (Sitting and Supine) and three pointing techniques (Touchpad, Controller and Head), i.e. participants experienced six conditions. Specifically, the pointing techniques were:

1. Touchpad: using the touchpad on the keyboard for cursor movement and selection confirmation.
2. Controller: using the controller's joystick for cursor control and trigger button for selection confirmation.
3. Head: using head movement to control the cursor and the controller's trigger button for selection confirmation.

To minimise the impact of learning effects on the results, participants were randomly assigned to one of three different sequences of input methods. The experimental setup mirrored that of the text input task, and participants were allowed to readjust the equipment, stand, desk, and chair to achieve maximum comfort.

Prior to starting the main task for each posture and technique, participants completed a round of practice trials, involving eight target selections for each of the three methods; additional practice sessions were permitted upon request. Each task included high-difficulty targets (large circle diameter of 1 meter, small circle diameter of 0.03 meters) and low-difficulty targets (large circle diameter of 0.8 meters, small circle diameter of 0.05 meters) (Figure 3, with participants completing 24 trials for each target type.

Following the completion of the tasks for each condition, participants were asked to evaluate the usability, efficiency, eye fatigue, body fatigue, and satisfaction associated with that posture on a continuous rating scale from 0 to 100. To ensure that their scores accurately reflected their experiences, participants were encouraged to adjust their ratings for prior conditions as necessary. They were also invited to provide comments to further elaborate on their ratings. Once all tasks in all conditions were completed, participants reviewed their scores one final time and responded to follow-up questions.

3.1.4 Participants. Our study involved 12 participants recruited from our institute, with one participant excluded due to incomplete data, resulting in a final sample of 11 participants (7 male, 4 female) with an average age of 26.73 years (*SD* = 5.55). Participants had varying levels of prior VR experience: 6 reported having never used VR, 4 reported occasional use, and 1 reported frequent use. Their ability to type on a physical keyboard without looking also varied: 7 reported some proficiency, 3 claimed they could do it well, and 1 stated they could not. Each participant who completed the experiment received 1000 Yen as compensation. The study session lasted approximately 1 hour.

3.2 Results

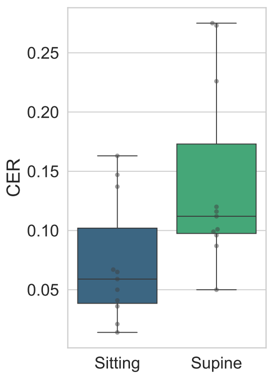


Figure 5: CER

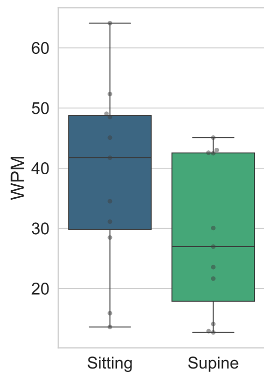


Figure 6: WPM

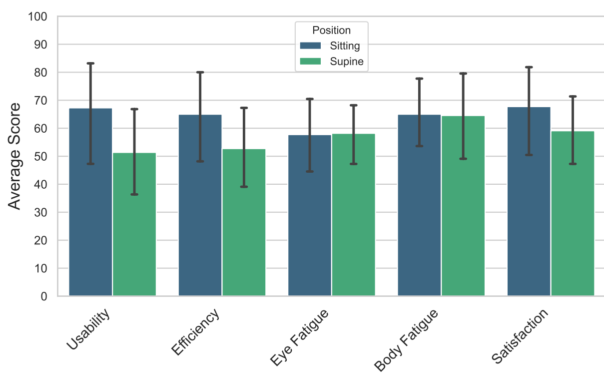


Figure 7: Participant ratings for the typing task

3.2.1 Text Entry. We analysed participants' text input speed, measured in Words Per Minute (WPM), and their Corrected Error Rate (CER, proportion of incorrectly typed characters relative to the total number of characters entered).

Shapiro-Wilk tests indicated that WPM data were normally distributed for both sitting ($p = 0.821$) and supine positions ($p = 0.082$), as well as for the difference scores ($p = 0.137$). For CER data, while the sitting position and difference scores were normally distributed ($p = 0.062$ and $p = 0.422$ respectively), the supine position data deviated from normality ($p = 0.009$). However, given the robustness of paired t-tests to minor violations of normality, the absence of extreme outliers in our data, and the normal distribution of the difference scores, we proceeded with parametric analyses.

As shown in Figure 6, participants achieved an average speed of 38.59 WPM ($SD = 15.53$), while seated, which decreased to 28.65 WPM ($SD = 12.86$) when lying down. A paired t-test confirmed that this difference was statistically significant ($t = -4.207, p < .01$). The CER nearly doubled in the supine position, increasing from 7.3% ($SD = 5.3\%$) while seated to 14.1% ($SD = 7.8\%$) while lying down. This difference was also statistically significant ($t = 6.810, p < .001$). These results suggest that maintaining typing accuracy is more challenging when lying down.

To assess the subjective impact of different usage postures on the user experience of text input, we conducted independent t-tests on five subjective indicators: usability, efficiency, satisfaction, eye fatigue, and body fatigue. For usability, participants gave higher ratings for Sitting ($M = 67.27, SD = 31.25$) than Supine ($M = 51.36, SD = 28.12$), though this difference was not statistically significant ($p = 0.224$). Regarding efficiency, Sitting ($M = 65.00, SD = 29.58$) similarly showed numerically higher scores compared to Supine ($M = 52.73, SD = 24.53$), but this difference was also not statistically significant ($p = 0.302$). In the satisfaction evaluations, Sitting ($M = 67.73, SD = 27.69$) received higher ratings than Supine ($M = 59.09, SD = 23.11$), though again, this difference was not statistically significant ($p = 0.436$). The fatigue-related indicators showed particularly consistent patterns between postures, with eye fatigue scores for Sitting ($M = 57.73, SD = 23.60$) and Supine ($M = 58.18, SD = 19.91$) nearly identical ($p = 0.962$), and body fatigue showing similarly negligible differences between Sitting ($M = 65.00, SD = 21.56$) and Supine ($M = 64.55, SD = 27.43$) conditions ($p = 0.966$).

Qualitative feedback from participants shed light on these findings. Although 4 participants found the supine position more comfortable, 7 reported that restricted head movement made it difficult to switch their gaze between the keyboard and the virtual text input window. This difficulty may explain the decreased typing performance despite the perceived comfort. Furthermore, all participants agreed that typing while seated resulted in greater focus and efficiency, which aligns with the quantitative performance results.

3.2.2 Pointing. To assess pointing performance, we calculated throughput (bits/s) using Wobbrock et al.'s methodology [36]. This metric combines speed and accuracy to provide a single measure of pointing efficiency.

Shapiro-Wilk tests indicated that throughput values were normally distributed across all conditions ($W = 0.991, p = 0.5661$). However, Levene's test revealed significant heterogeneity of variances ($F = 4.19, p = 0.0026$), so we used Welch's ANOVA, which is more robust to variance heterogeneity while maintaining good control of Type I error rates.

Welch's ANOVA revealed significant main effects for Technique ($F(2, 82.51) = 39.79, p < .001, \eta_p^2 = 0.41$) and Task Difficulty ($F(1, 128.89) = 4.34, p < .05, \eta_p^2 = 0.03$), while the main effect of Posture was not significant ($F(1, 129.51) = 1.51, p = .222, \eta_p^2 = 0.01$). Games-Howell post-hoc analyses indicated that Head ($M = 3.067, SD = 0.847$ bits/s) significantly outperformed both Touchpad ($M = 2.207, SD = 0.601$ bits/s, $p < .001$) and Controller ($M = 1.800, SD = 0.457$ bits/s, $p < .001$). Touchpad also significantly outperformed Controller ($p < .01$). Task Difficulty showed a consistent impact with Low difficulty tasks yielding higher throughput than High difficulty tasks. Notably, Posture did not have a significant main effect on throughput, with Sitting ($M = 2.447, SD = 0.812$ bits/s) being comparable to Supine ($M = 2.269, SD = 0.775$ bits/s). This indicates that pointing

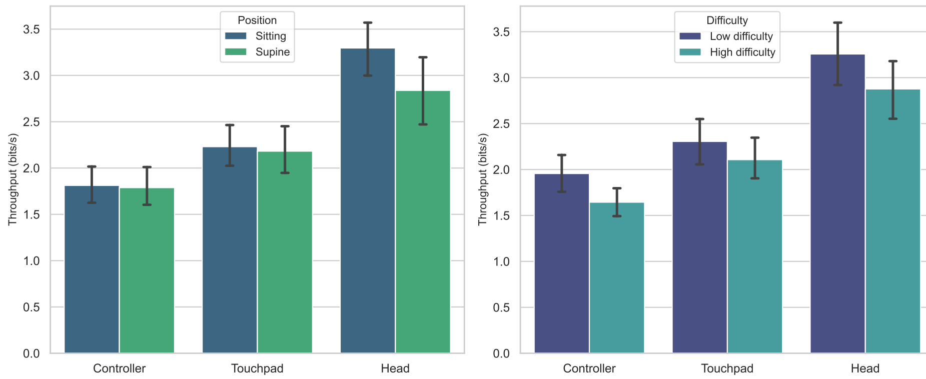


Figure 8: Throughput of the pointing task under the different conditions

performance was potentially comparable between the two positions, regardless of the input method. Head maintained superior performance across all conditions (Hedges' g = 1.20 compared to Touchpad, and g = 1.89 compared to Controller), with throughput values ranging from 2.891 to 3.420 bits/s (*SD* range: 0.779-0.892 bits/s), while Touchpad demonstrated moderate throughput values (2.102-2.359 bits/s) with stable performance (g = 0.75 compared to Controller), and Controller showed the lowest but most consistent performance (*SD*s ranging from 0.389 to 0.537 bits/s). These findings indicate that while Head may be the most efficient pointing method overall, Controller offers the most stable performance, and Touchpad represents a balanced middle ground. These results suggest pointing interactions can be performed effectively in VR while lying down.

To analyse participants' subjective ratings of Technique and Posture on their experience, we first conducted normality tests (Shapiro-Wilk) and homogeneity tests (Levene) for the five primary metrics. We used two-way repeated measures ANOVA for metrics meeting parametric assumptions, and non-parametric Friedman tests otherwise.

The analysis of body fatigue, which violated normality assumptions, a Friedman test revealed significant differences for Technique ($W = 0.55$, $Q = 12.05$, $p = 0.002$). Regarding efficiency, we obtained a significant main effect of Posture ($F(1, 9) = 11.89$, $p = 0.007$, $\eta^2 = 0.028$) and a significant interaction between Technique and Posture ($F(2, 18) = 13.42$, $p < 0.001$, $\eta^2 = 0.122$). Notably, for Head, the efficiency of Sitting ($M = 80.75$, $SD = 19.78$) was significantly higher than Supine ($M = 50.00$, $SD = 24.39$). In contrast, for Touchpad, Supine exhibited slightly higher efficiency than Sitting. For eye fatigue, there were no significant main effects of Technique ($F(2, 18) = 0.75$, $p = 0.48$) or Posture ($F(1, 9) = 2.13$, $p = 0.18$), nor any significant interaction ($F(2, 18) = 1.17$, $p = 0.32$), suggesting similar visual demands across conditions. Satisfaction assessments indicated a significant interaction between Technique and Posture ($F(2, 18) = 16.31$, $p < 0.001$, $\eta^2 = 0.154$). For Head, Sitting ($M = 74.17$, $SD = 17.82$) received significantly higher satisfaction ratings compared to Supine ($M = 38.27$, $SD = 28.17$). The usability ratings also exhibited a significant interaction between Technique and Posture ($F(2, 18) = 11.08$, $p = 0.004$, $\eta^2 = 0.167$). In particular, for Head, Sitting ($M = 81.42$, $SD = 18.24$) demonstrated significantly higher usability than Supine ($M = 45.00$, $SD = 29.58$).

Analysing participant feedback, 9 participants noted that head movement was limited when lying down, resulting in quick fatigue when using Head to control the cursor. Additionally, 6 participants reported experiencing dizziness with this technique. This may explain the lower ratings for head-based interaction in the supine position. In contrast, 9 participants found Controller to be the most effective method, as it allowed them to keep their hands comfortably resting on the yoga mat, increasing comfort and minimising overall body movement. Finally, 3 participants reported hand fatigue with Touchpad.

3.3 Discussion

While our study only included 11 participants, the results suggest that both text entry and pointing tasks can be accomplished in a supine position, albeit with some differences in performance and user experience compared to traditional seated setups. Text entry speed and accuracy were lower in the lying position, potentially due to restricted head movement and other ergonomic factors, but subjective ratings of comfort and satisfaction were generally comparable between postures. In the supine position, participants were able to achieve 75% of their seated typing performance. With practice and further optimisation of the physical setup, including more ergonomic equipment such as trays and keyboards specifically designed for supine use, we believe both performance and comfort can be further improved.

Our study focused on the use of a physical keyboard, as it remains the predominant input device for office-like tasks. Alternative text entry techniques, such as virtual keyboards, tap-based methods, or speech input, present limitations in terms of efficiency, require additional sensors or language-specific models [9, 30, 31, 33, 34], or may not be suitable for the diverse range of keyboard-based work tasks. While our study evaluated text entry using English phrases, keyboard input for computer work covers a variety of other tasks, including command shortcuts, cursor control, text selection, coding, etc. which may influence the suitability of different text entry methods.

For pointing tasks, head tracking emerged as the most efficient input technique, particularly in the seated position. However, it also led to increased fatigue and discomfort when used in the supine position, primarily due to the limited range of head movement. This could potentially be mitigated by adjusting the control-display gain

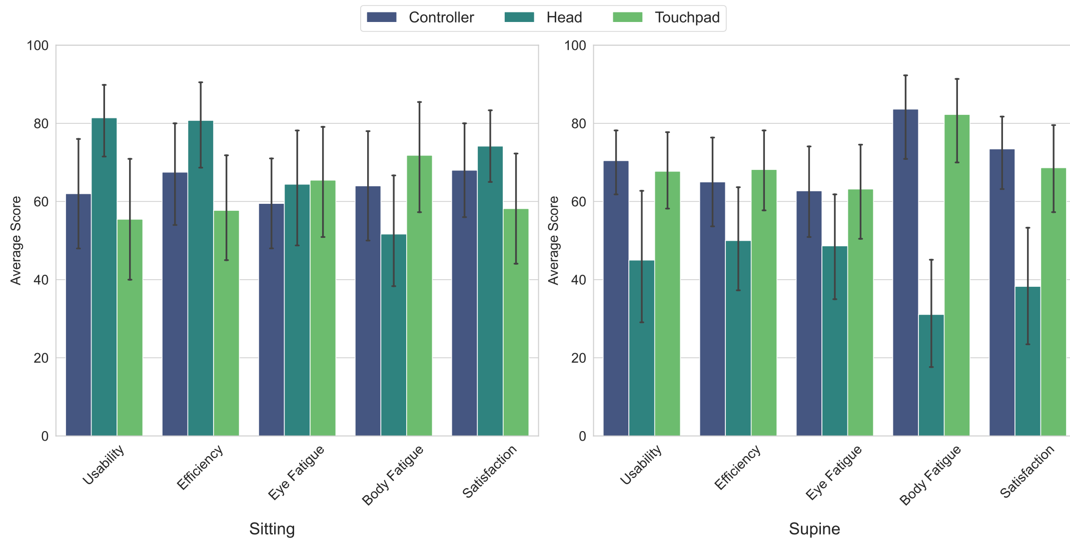


Figure 9: Participant ratings for the pointing task

function to allow smaller head movements to translate into larger pointer movements in VR, or by using lighter headsets with straps that allow comfortable head rolling on a pillow. The controller provided a comfortable and consistent alternative, especially in the supine position, while the touchpad offered a balance of efficiency and comfort across both postures. These findings highlight the importance of considering both performance and ergonomics when designing input methods for VR use while lying down, and suggest that different input methods may be optimal depending on the user's posture and task requirements.

Our results further underscore the potential accessibility benefits of supine VR for users with disabilities or medical conditions that may preclude them from working in a traditional seated position [4, 17]. VR solutions designed specifically for reclined use could enable these individuals to engage in productive computing activities in a comfortable and accessible manner. Compared to alternative solutions for supine computer use, such as reclining stands for laptops and specialised workstations, VR offers a more compact, immersive and adaptable environment, with the ability to customise virtual workspaces and interaction methods to suit individual needs and preferences.

4 CONCLUSION

This work represents a first step towards understanding the potential of VR while lying down for productivity work involving typing and pointing. Our findings suggest that while there are challenges to overcome, supine VR offers a viable alternative for performing work-related tasks, particularly for users who may not be able to work in a seated position. To further assess the potential of this emerging interaction paradigm, we plan to conduct more extensive, longitudinal studies involving a wider range of users, including people with disabilities, using real work applications and tasks. This will allow us to gain a deeper understanding of the long-term impact of working in VR in a reclined posture and evaluate its suitability for various user groups and work scenarios.

As VR technology continues to evolve and adapt to various use cases, we believe that supine VR offers a promising work environment, making productivity tasks more accessible, comfortable, and inclusive.

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