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Auditory and Visual Feedback During Eye Typing

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experiment, a special "ready" key was added. Activating this key cleared the typed text field and loaded a new source sentence.

We collected three types of data: fixation data, raw eye data, and event data logged by the experimental software. We also videotaped all trials.

The experiment was a 4 x 4 repeated measures design with 4 feedback modes and 4 blocks of sentences. The order of administering the feedback modes was randomized across blocks and participants to minimize asymmetric learning effects. Each block involved the entry of the same five short phrases of text. The user was instructed to memorize the source sentence and then eye type it as fast and accurately as possible. There was a short pause after each block. Each participant came to the test four times. In the last visit we interviewed the user and gave a questionnaire. The total number of phrases was 1040 (13 participants x 4 feedback modes x 4 blocks x 5 sentences).

RESULTS AND DISCUSSION

The grand mean for entry speed was 6.97 words per minute. This is typical for eye typing [1, 2], but it is still too low for fluent text entry. As evident in Figure 3, participants improved with practice, as a significant main effect for block was found ($F_{3,36} = 10.92$, $p < .0001$).

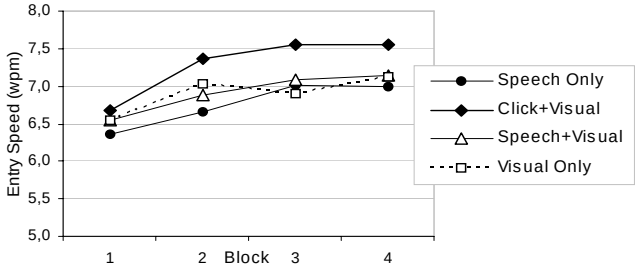

Figure 3. Entry speed (wpm) by feedback mode and block

The main effect for feedback mode was also significant ($F_{3,36} = 8.77$, $p < .0005$). Overall, the combined use of Click plus visual feedback yielded the fastest entry rate, with participants achieving a fourth block mean of 7.55 wpm. The other fourth-block means were 7.14 wpm (Speech plus visual), 7.12 wpm (Visual only), and 7.00 wpm (Speech only). The dwell time was constant for all feedback modes. The entry rate will naturally speed up with a shorter dwell duration. This may be possible as a user develops proficiency with the apparatus.

Participants' accuracy also improved significantly with practice ($F_{3,36} = .09$, $p = .005$), as seen in Figure 4. Character-level error rates were quite low overall with a grand mean of 0.54%. Participants proceeded quite cautiously to avoid a loss of calibration, which occurred occasionally and necessitated re-typing a phrase. There were significant main effects for feedback mode ($F_{3.36} = 5.01$, $p = .005$). Eye typing with Speech only feedback was the most accurate technique throughout the experiment with error rates under 0.8% on all four blocks.

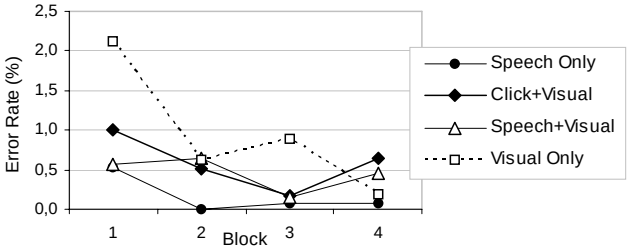

Figure 4. Error rate (%) by feedback mode and block

Our experimental software logged various events of interest. One such event was "read text", referring to a participant switching their point of gaze to the typed text field to review the text typed so far. The values analyzed were the mean number of such events per phrase of text entered.

The overall mean was 1.63 read text events per phrase. By feedback mode, the means were 1.17 (Speech only), 1.28 (Click plus visual), 1.24 (Speed plus visual), and 2.77 (Visual only). The mean for Visual only feedback mode was significantly higher than for the other modes ($F_{3,36} = 30.06$, $p < .0001$). The users' gaze behavior shows (Figure 5) that auditory feedback (click or spoken) significantly reduces the need to review and verify the typed text.

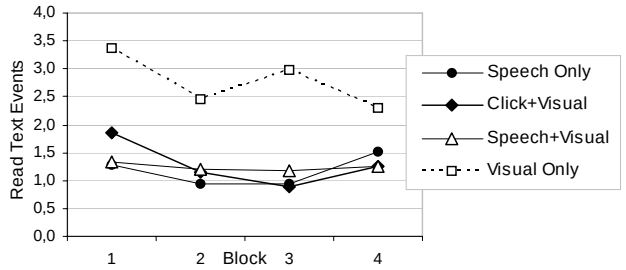

Figure 5. Read text events (mean per phrase) by feedback mode and block

CONCLUSIONS AND FUTURE WORK

Our results show that the feedback mode affects typing speed, error rate, and the user's gaze behavior during eye typing. In particular, proper feedback may dramatically reduce the need to switch gaze between the soft keyboard and the typed text field thus reducing the entry time. The results also suggest that auditory feedback (click or spoken) is a more effective indication of selection than visual feedback alone.

The data analysis is ongoing; there are other interactions to analyze, such as gaze path, the types of errors, and the results of the questionnaire.

REFERENCES

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2. Majaranta, P., and Räihä, K.-J. Twenty years of eye typing: Systems and design issues, *Proceedings of ETRA'02*, New Orleans, LA, ACM Press, 2002, 15-22.