

REPORT

The role of physicality on reproducing a sequence

Experimental hypotheses

Our hypothesis is that subjects will reproduce a sequence of colours, shown on a screen, faster using physical and coloured buttons than using a touch screen with coloured buttons of the same size.

Experimental procedure

Independent variable: Input method and sequence length.

Dependent variable: Time taken to input the sequence.

Experimental design: Within subjects, seven trials with each method per user.

Our experiment was conducted as follows:

- Two subjects sat down, one in front of the physical buttons and the other in front of the tablet. At the end of the table was the screen where the sequence of colours was displayed. The screen was equidistant from both subjects.
- Each subject was given instructions on how to use their respective input method. All subjects get the same instructions.
- The subject entered seven sequences, all of either 4 or 8 colours, with a short countdown before the next sequence after both participants had input the current sequence. This sequences corresponded to the ones being displayed on the screen at the end of the table. The sequences were generated randomly.
- The time taken to input the sequence, in milliseconds, was recorded. If the sequence was entered incorrectly, that trial was not used in the final analysis.
- After the subjects had completed seven sequences with their respective input methods, the subjects swapped input methods and repeated the experiment. Both subjects would be instructed on the use of their new input method.

Some quick overview on the experiment.

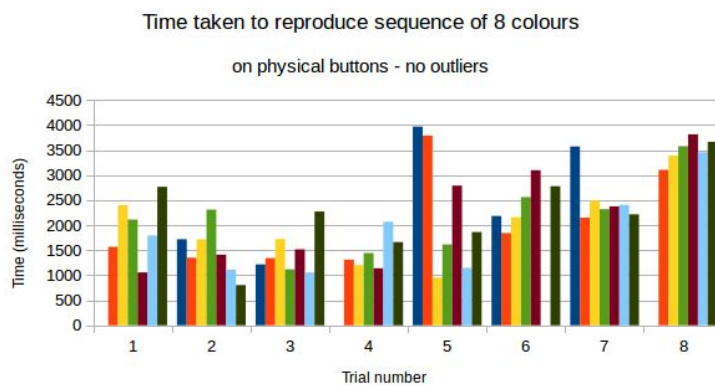
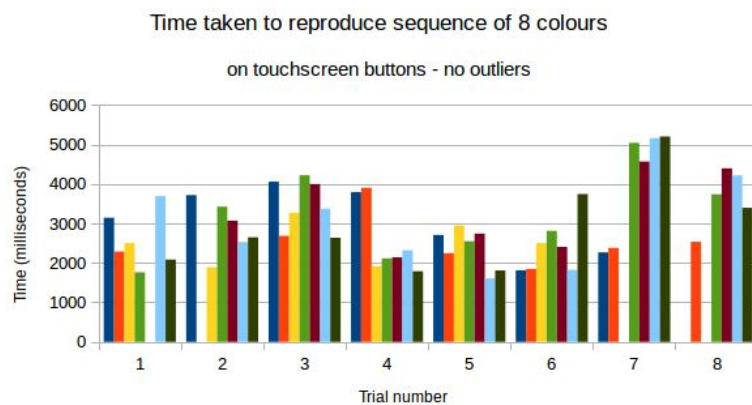
- They had as much time as they needed to look at the sequence before reproducing it, as we were only measuring how long it took for them to actually input the sequence.
 - Sequence of colours is completely random.
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- Buttons on the board and on the tablet were in the same order and of the same size. Buttons were ordered red, yellow, green, as it is the order and colours used in traffic lights and we thought it would make it easier for users to remember the order of the buttons.

Data

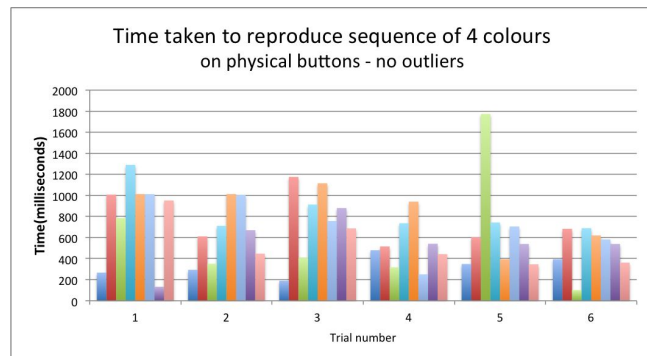
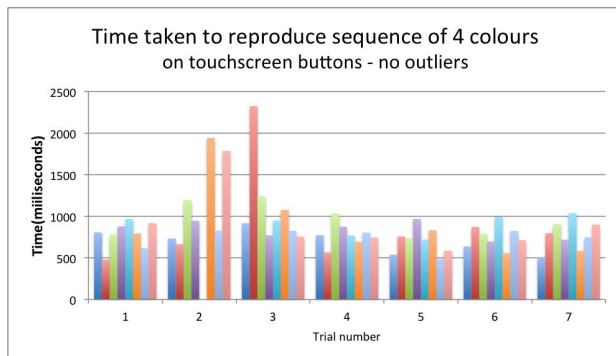
We performed the experiment a total of 16 times, with 8 pairs of participants. The first four pairs reproduced sequences that were formed by 4 coloured circles. The next four pairs reproduced sequences formed by 8 coloured circles.

Data for sequences of eight



The colours on the graphs are to improve readability of the data.

Data for sequences of four



Data analysis

Analysis for sequences of four

Tablet

Mean time : 917 ms

standard deviation: ± 531 ms

Number of errors: 4

Buttons

Mean time : 707 ms

Standard deviation: ± 522 ms

Number of errors: 5

From the data collect for color sequence of 4, the average user reaction time is within 1 seconds. The difference isn't that big between the table and buttons. However, from the graph we can still see the potential short reaction from the Physical buttons. The reason is likely to be the tangible feature. Therefore we conclude that tangible does play a role when dealing with simple and easy reproducing color sequence.

Analysis for sequences of eight

Tablet

Mean time : 2968 ms

standard deviation: ± 969 ms

Number of errors: 4

Buttons

Mean time : 2124 ms

Standard deviation: ± 870 ms

Number of errors: 4

From the data analysis we can see that the difference in the means is not very big ($\frac{8}{10}$ of a second). Also the accuracy seems unaffected by the input method used.

Conclusions

Conclusion for sequences of eight

Doing t test on our data for sequences of eight returns a value of 1.050. This gives us a p-value of 0.2962 which is not significant at $p < 0.05$. This is a very low level of significance, and although our averages may imply that physical buttons are faster to use than touchscreen buttons, ultimately we cannot prove causation. Also we can not say that one input method is more accurate than the other as the amount of errors for both was the same.

Conclusion for sequences of four

From the t test, we get the t-value 0.00345 which corresponds to a p-value of 0.997, which is not significant at $p < 0.05$. Same as the sequences of eight, the significance is not enough to show causation. Overall, our data suggests that tangibility might only has a slight impact in this experiment.

Final conclusion

As both p-values are bigger than 0.05 we can not prove that physical buttons are any better for inputting fast sequences of colours than a smart screen for any sequence of any length. Even though the mean values for the buttons are slightly lower there is not a difference significant enough to prove any relationship between the time taken to input a sequence (of varying length) and the method used to input the sequence (either physical buttons or a touch screen).

Contributions

Henry Boudabbous:	10%	Alex Cotton:	20%
Carlos Gonzalez Betancort:	24%	Senthuran Subramaniam:	16%
Thomas Jennings:	10%	Ruichao Zhang:	20%