Show or Tell? Visual and Verbal Representations Bias Position Recall

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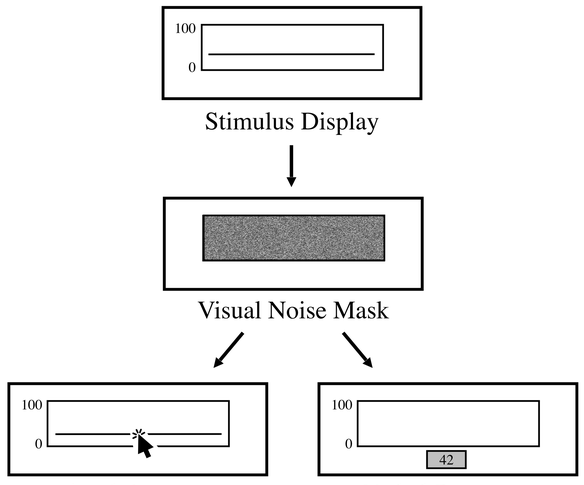
Introduction

Recent work has shown that visual representations of data can be biased, such that the position of a line in a graph will be consistently underestimated [1]. But when we view visualizations, we not only have a visual representation of the data (e.g., the estimated position of the data), but also a verbal one which may convey semantic information (e.g., 50, or the estimated y-axis value of the data).

Are verbal representations of position encodings biased in the same manner as visual representations?
This bias may only exist on a visual level, with the additional context provided with a verbal representation mitigating this bias. But it could also be possible that our representation of data in a visualization is biased regardless of whether it was verbally and/or visually encoded, as memory is often an imperfect process.

Design and Procedure



Participants saw a stimulus display containing flat lines in a random vertical position on a chart with a y-axis labeled 0 to 100 *(Stimulus Display)*.

This was followed by a moving noise mask to reduce any visual afterimages *(Visual Noise Mask)*.

Participants then estimated the vertical position of the line by either dragging a response probe in the form of a horizontal line *(Visual Response)* or typing a number between 0 and 100 to represent the vertical position of the line *(Verbal Response)*.

References

[1] C. Xiong, C. R. Ceja, C. Ludwig, and S. Franconeri. Biased Average Position Estimates in Line and Bar Graphs: Underestimation, Overestimation, and Perceptual Pull. *IEEE TVCG, InfoVis*, 2020.

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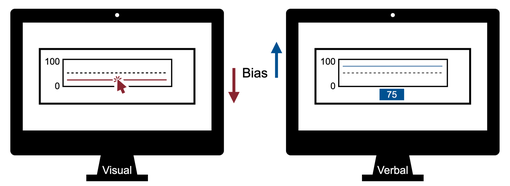
Conclusion

The present experiment shows that different response modalities result in differing biases for the recall of data values. In even simple line charts, both visual and verbal representations (captured by the visual and verbal response modalities, respectively) of data were shown to be biased, with *visual* reproductions showing a position *underestimation* while *verbal* responses showed *overestimation*.



Our representation of data is biased regardless of whether it is visually or verbally encoded, with the direction of the bias dependent on the modality used.

This work could be imperative to not only better understand how different representations can influence the accuracy of data recall for visualizations, but to also inspire future research for designing visualization systems or tools to help mitigate this bias.

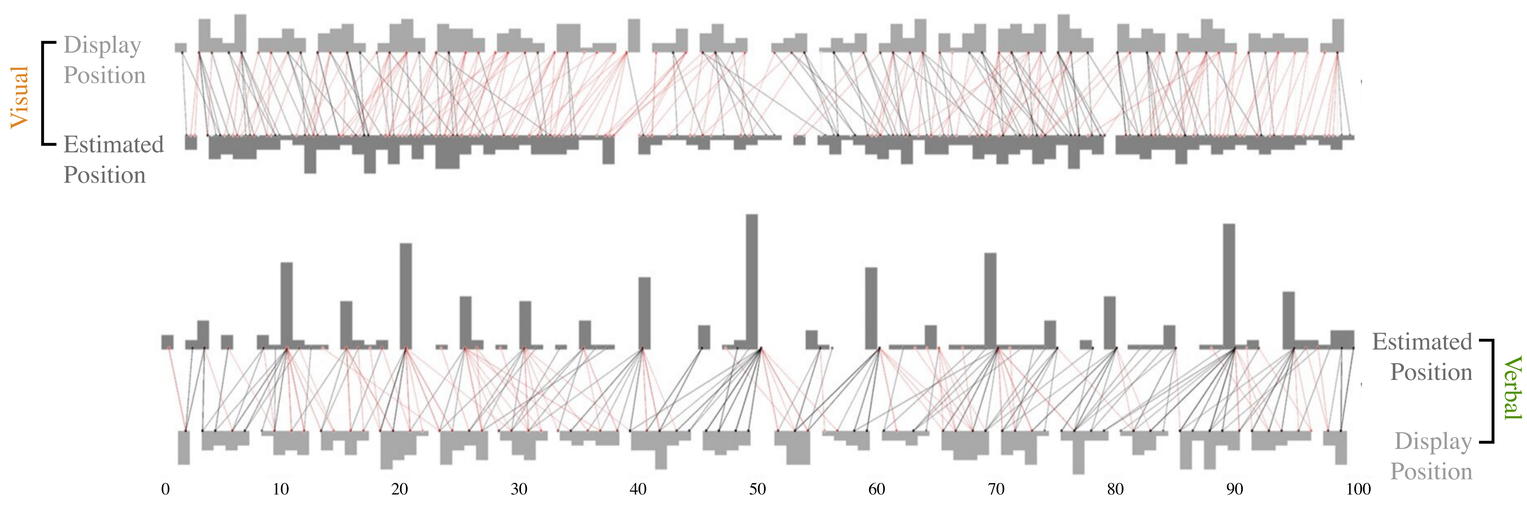
Results

Visual Condition

In the *Visual* condition overall, participants significantly *underestimated* the vertical positions of the lines by dragging a horizontal line, replicating findings from Xiong, Ceja et al., 2020.

Estimates in the *Visual* condition also showed a more uniform distribution for line position estimates compared to the *Verbal* condition.

The light gray histograms represent the distributions for the displayed vertical positions of the lines, and the dark gray histograms represent the distributions for their estimated vertical position responses. Each line connects a trial's displayed line position to the participant's estimated position for that line, with red lines indicating underestimated responses and gray lines indicating overestimated responses.



Verbal Condition

In the *Verbal* condition overall, participants significantly *overestimated* the vertical positions of the lines when they typed in a number from 0 to 100.

Estimates in the *Verbal* condition also tended to be rounded-numbers, such as “10’s" (57% of responses; e.g., “50"), followed by numbers that ends with “5” (22% of responses; e.g., “15”). This rounding, however, did not explain the overestimation bias.