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Index Terms Visualized decision making, eye tracking, crowdsourcing, quantitative empirical study, limitations, peripheral vision.

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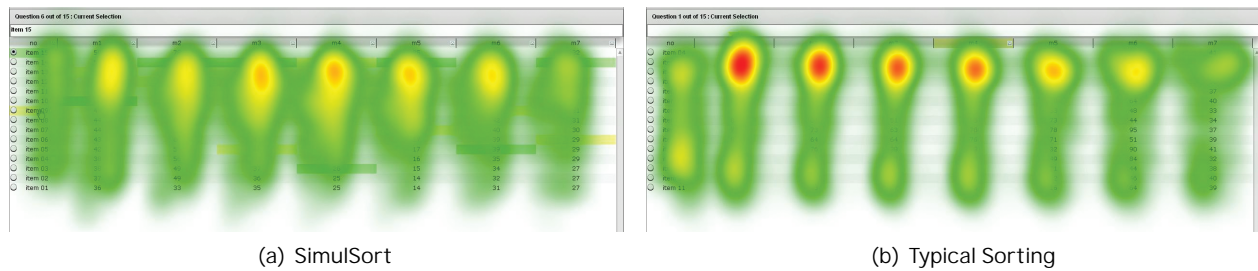


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Does an Eye Tracker Tell the Truth about Visualizations?: Findings while Investigating Visualizations for Decision Making

Sung-Hee Kim, Zihua Dong, Hanjun Xian, Benjavan Upatising, and Ji Soo Yi, IEEE Member



Fig. 1. Comparing two screenshots of the total aggregated fixation duration of 10 participants for 10 trials. The red area indicates longer duration of fixations. The two interfaces compared are (a) SimulSort, a tabular visualization with simultaneously sorted columns, and (b) Typical Sorting, a table with a one-column sorting feature.

Abstract For information visualization researchers, eye tracking has been a useful tool to investigate research participants' underlying cognitive processes by tracking their eye movements while they interact with visual techniques. We used an eye tracker to better understand why participants with a variant of a tabular visualization called 'SimulSort' outperformed ones with a conventional table and typical one-column sorting feature (i.e., Typical Sorting). The collected eye-tracking data certainly shed light on the detailed cognitive processes of the participants; SimulSort helped with decision-making tasks by promoting efficient browsing behavior and compensatory decision-making strategies. However, more interestingly, we also found unexpected eye-tracking patterns with SimulSort. We investigated the cause of the unexpected patterns through a crowdsourcing-based study (i.e., Experiment 2), which elicited an important limitation of the eye tracking method: incapability of capturing peripheral vision. This particular result would be a caveat for other visualization researchers who plan to use an eye tracker in their studies. In addition, the method to use a testing stimulus (i.e., in a central column) in Experiment 2 to verify the existence of such limitations would be useful for researchers who would like to verify their eye tracking results.

Index Terms Visualized decision making, eye tracking, crowdsourcing, quantitative empirical study, limitations, peripheral vision.

1 INTRODUCTION

An eye tracker is a potentially useful tool for information visualization researchers because its basic premise is that it can tell you what a person looks. In addition, as long as the eye-mind hypothesis holds, eye-tracking results can reveal the underlying cognitive processes of a human user. In this case, the eye is literally the window to the mind. For this particular reason, some InfoVis researchers are interested in the cognitive aspects of a visualization user often use eye-tracking methods (e.g., [6, 11, 46, 32]). In addition, visualization tools have been proposed to analyze eye-tracking data (e.g., [48]). We are also researchers who would like to see the person's mind while investigating visualization tools supporting multi-attribute decision making, where one has to choose the best option among candidates after reviewing the multiple attributes of each candidate (e.g., choosing a college or a nursing home). Since such multi-attribute decision making often involves overwhelming information and various cognitive processes, various visualization techniques have been proposed (refer to [25] for reviews). Some recent empirical studies demonstrated that such techniques lead to better decision quality and satisfaction [1, 35, 38, 40, 15]; however, the gap in the literature is that there is no empirical explanation of how these visualization techniques have helped with decision making beyond a simple confirmation of their effects. For example, studies using a visualization tool called SimulSort (or SS) [16, 15] empirically showed that the participants who used SS made higher-quality decisions in a shorter amount of time than made the participants who used a regular (or TS) with a typical single-column sorting technique: Typical Sorting (or TS). However, these empirical studies cannot clearly explain why this gap, in this paper, we conducted an eye-tracking study to investigate how visual aids influenced the participants' browsing behavior and decision-making strategies that eventually influence decision quality [10, 29]. The eye-tracking study partially showed that the decision quality difference actually came from the changes in the decision strategies that the participants employed. Though this finding is only meaningful to a relatively small number of researchers who would like to combine InfoVis and decision science, such a finding is one of the first pieces of empirical evidence showing that and also one of major contributions of this paper.

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