Getting more out of Area of Interest (AOI) analysis with SPLOT

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Background

- To analyze eye-tracking data the viewed image is often divided into areas of interest (AOI)
- Per AOI, summary statistics (e.g., proportion of fixations or dwell time) is often computed
- Temporal dynamics is either entirely lost or significantly reduced by "binning" the data
- Here I introduce SPLOT (smoothed proportion of looks over time) method for analyzing the eye movement dynamics across AOIs

With SPLOT you can

- Visualize AIO time-course without loosing temporal resolution
- Perform statistical analysis using cluster-based permutation and without loosing statistical power

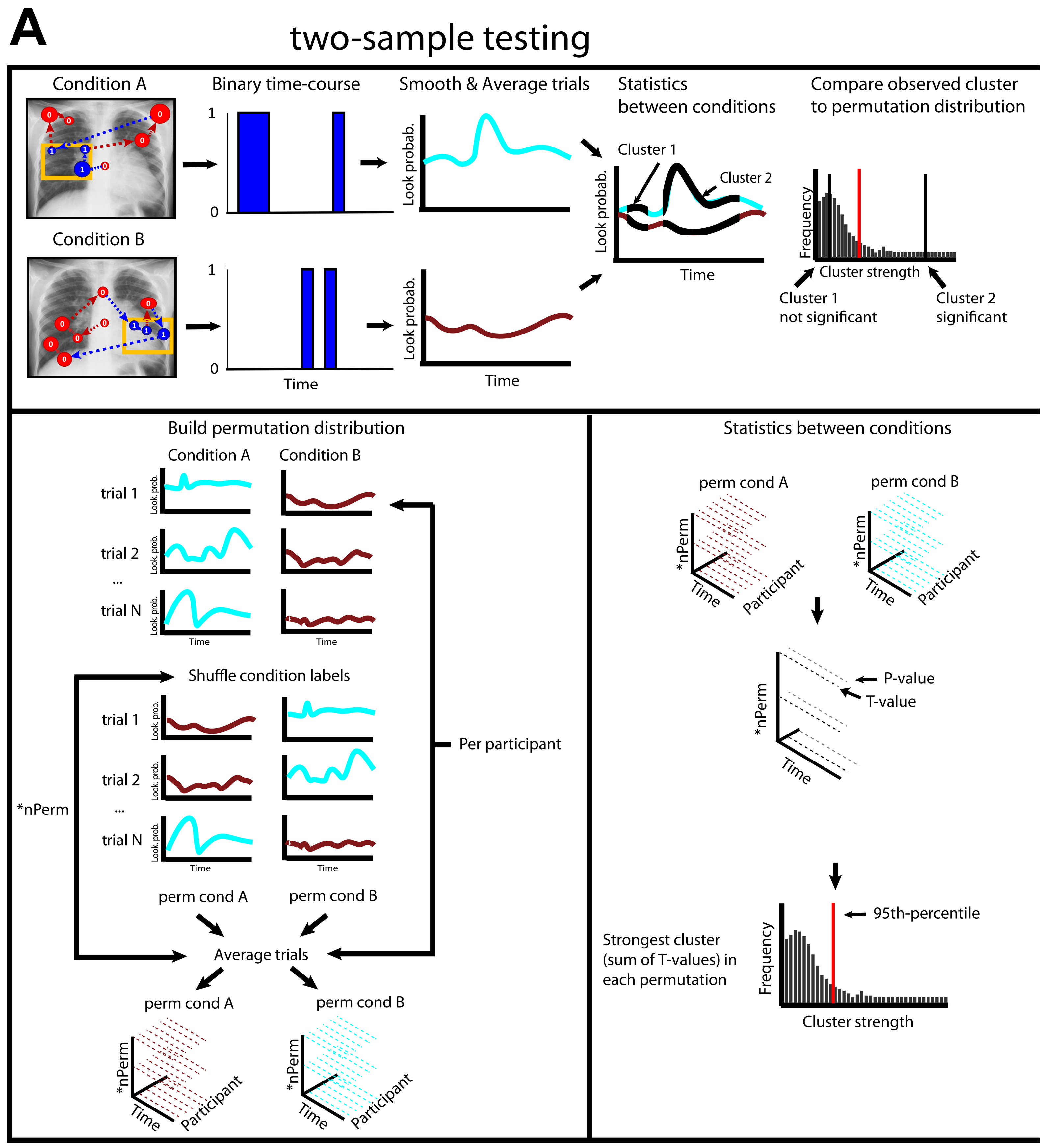
Step 1: generating binary time-course

- The eye movement sequence is transformed into a sequence of fixations and their corresponding durations using any event-detection algorithm
- Then, fixations are transformed into "looks". The looks are coded as a binary variable, with '1' assigned to each time point that belongs to a fixation falling inside the AOI and '0' assigned to all other time points in the trial.
- The total number of time points in a trial is determined by the sampling rate of the eye-tracker.

Step 2: temporal smoothing and averaging across trials

- To reduce the noise present on individual trials and to convert a discreet signal into a continuous one, the square wave sequences are convolved with Gaussian kernel of a chosen size
- Trials can be averaged, producing an average time-course of proportion of looks at AOI for each participant (or image)

The SPLOT method



Step 3: cluster-based permutation testing

- When performing a statistical test on each individual time point, clusters of significant points will emerge, since the time points are not independent of each other. Significance should be tested on the level of clusters
- Cluster-based permutation testing involves building a distribution of the cluster-based test statistic under the null hypothesis and comparing the observed cluster-based statistic to it. Any cluster in the observed data, whose test statistic exceeds the 95th percentile (which corresponds to a p-value of 0.05) is considered significant
- Building a permutation distribution is different depending on whether two conditions are compared to each other or a single condition is compared to a baseline (see article for details)

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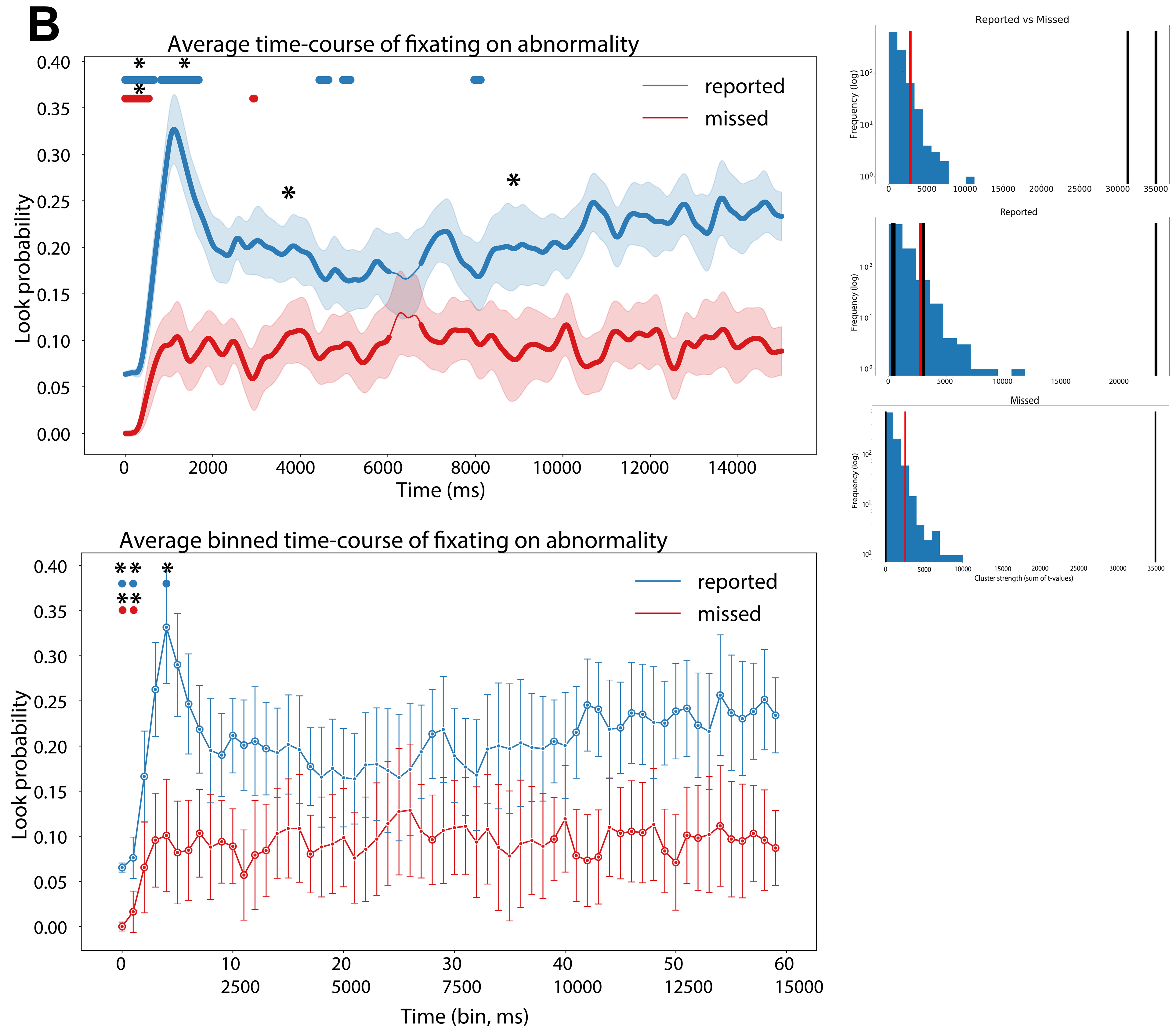
Application to real data



TOP: SPLOT applied to eye-tracking data of radiologists diagnosing chest X-rays

- The average time-courses of looking at the abnormality were different, depending on whether the image was diagnosed correctly or not. Participants looked at the abnormality significantly more often when it was reported. There were two large significant clusters (0-6 seconds and 7 - 15 sec)
- To analyze whether there were peaks in the looks at abnormality, the time-courses for each condition were compared to their respective average time-courses. This analysis showed 5 clusters for the reported condition, in which only the first two (0-1.8 sec) reached significance . For the missed condition, there were 2 clusters and only the first one (0-1 sec) was statistically significant

BOTTOM: Momentous proportion over time, 60 bins of 250 ms

- Same analyses were performed but t-tests with Bonferroni correction were used instead of permutations tests.
- Although the overall results were similar, many time points did not reach significance. Adding more bins or extending the epoch would render even the strongest effects not significant.

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