A Metric to Quantify Shared Visual Attention in Two-Person Teams

Patrick Gontar, Jeffrey B. Mulligan

1 Introduction

Critical tasks in high-risk environments are often performed by teams, the members of which must work together efficiently. In some situations, the team members may have to work together to solve a particular problem, while in others it may be better for them to divide the work into separate tasks that can be completed in parallel. We hypothesize that these two team strategies can be differentiated on the basis of shared visual attention, measured by gaze tracking.

2 Method

Gaze recordings were obtained for two-person flight crews flying a high-fidelity simulator (Gontar & Hoermann, 2014). Inherent for those teams is that they normally do not face each other while working in time-critical situations (in contrast to infant-parents' shared attention research, such as Redcay, Kleiner, and Saxe, 2012). Gaze was categorized with respect to 12 areas of interest (AOIs). We used these data to construct time series of 12 dimensional vectors, with each vector component representing one of the AOIs. At each time step, each vector component was set to 0, except for the one corresponding to the currently fixated AOI, which was set to 1. This time series could then be averaged in time, with the averaging window time (Δt) as a variable parameter. For example, when we average with a Δt of one minute, each vector component represents the proportion of time that the corresponding AOI was fixated within the corresponding one minute interval. We then computed the Pearson product-moment correlation coefficient between the gaze proportion vectors for each of the two crew members, at each point in time, resulting in a signal representing the time-varying correlation between gaze behaviors. We determined criteria for concluding correlated gaze behavior using two methods: first, a permutation test was applied to the subjects' data. When one crew member's gaze proportion vector is correlated with a random time sample from the other crew member's data, a distribution of correlation values is obtained that differs markedly from the distribution obtained from temporally aligned samples. In addition to validating that the gaze tracker was functioning reasonably well, this also allows us to compute probabilities of coordinated behavior for each value of the correlation. As an alternative, we also tabulated distribu-

Published at SAGA Workshop 2015, proceedings archived under DOI: 10.2390/biecoll-saga2015_0.
Individual article archived under DOI: 10.2390/biecoll-saga2015_20

tions of correlation coefficients for synthetic data sets, in which the behavior was modeled as a first-order Markov process, and compared correlation distributions for identical processes with those for disparate processes, allowing us to choose criteria and estimate error rates.

3 Discussion

Our method of gaze correlation is able to measure shared visual attention, and can distinguish between activities involving different instruments. We plan to analyze whether pilots' strategies of sharing visual attention can predict performance. Possible measurements of performance include expert ratings from instructors, fuel consumption, total task time, and failure rate. While developed for two-person crews, our approach can be applied to larger groups, using intra-class correlation coefficients instead of the Pearson product-moment correlation.

ACKNOWLEDGMENTS: This work was supported by the TUM Graduate School and a LuFo IV-2 grant (PG), and NASA's Airspace Operations and Safety Program (JBM). The authors are grateful to Immanuel Barshi for his help and support.

References

1. Gontar, P., & Hoermann, H.-J. (2014). Flight Crew Performance and CRM Ratings Based on Three Different Perceptions. In A. Droog (Ed.), *Aviation Psychology: facilitating change(s): Proceedings of the 31st EAAP Conference* (pp. 310–316). Malta.
2. Redcay, E., Kleiner, M., & Saxe, R. (2012). Look at this: the neural correlates of initiating and responding to bids for joint attention. *Frontiers in human neuroscience*, 6, 169.

Published at SAGA Workshop 2015, proceedings archived under DOI: 10.2390/biecoll-saga2015_0.
Individual article archived under DOI: 10.2390/biecoll-saga2015_20