Trust Impacts Driver Glance Strategy in Multitasking

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Extended Abstract

Growing evidence supports the idea that patterns of gaze are important to human-machine trust, as they are to human-to-human trust (LaFrance & Mayo, 1976; Kendon, 1967), and indeed potentially all primate social dynamics (Emery, 2000). A growing literature explores trust and gaze toward anthropomorphic robots (Mutlu et al., 2009; Stanton & Stevens, 2014; Van de Brule et al., 2014, Hancock et al., 2011). Less work has investigated far-more-common non-anthropomorphic systems, despite evidence suggesting that operators deploy the same trust patterns toward such interface that they might toward fellow humans (Nass, 1996; Fogg & Nass, 1997), and that they change patterns of visual allocation based upon that trust (Hergeth et al., 2016; Geitner at al., 2017). In critical operational settings, such as driving while multitasking, maximum safety and stability is associated with maximum visual attention devoted to the road (Hancock & Warm, 1989; Strayer, Drews & Johnston, 2003; Sawyer et al., 2014). Social gaze strategies deployed toward an interface suggest competition for these resources, and so applied consequences in terms of adopting appropriate information gathering strategies.

The present work re-analyzed data from three on-road driving studies of drivers interacting with in-vehicle voice navigation in a 2014 Chevrolet Impala (Mehler et al., 2014), a 2014 Mercedes CLA (Mehler et al., 2015a), and a 2015 Toyota Corolla (Mehler et al. 2015b). Drivers were and were analyzed in terms of glance behavior (Angell et al., 2006; ISO 15007-1, 2002; ISO 15007-2, 2001) with a glance to a region of interest defined to include transition time. Gaze transitions away from the road per second (TrAp/s) and average seconds of dwell time away per transition (Sap/T) were calculated to understand gaze strategy. TrAp/s = $\frac{\sum Transition\ count\ away\ from\ roadway}{\sum \mu Total\ Duration}$ while Sap/T = $\frac{\sum Dwell\ Time\ off-road}{\sum Transition\ count\ away\ from\ roadway}$. Using the antiphony framework (Sawyer, Reimer & Mehler, 2017), both DVs were calculated separately for epochs in which driver or system was actively engaged and communication occurred (active), and the silent waiting that could proceed communication (latency). Pre-experiment reported level of trust in technology, on a 1-10 Likert scale, were strongly positively skewed. After considering alternatives, we ultimately decided to divide the scale into three parts: regrouped scores of three through five to produce a low trust group, scores of six through seven to produce a medium trust group, and scores of eight through 10 to produce a high trust group. The study was analyzed as a 3 trust level (low, medium, high) MANOVA, with "study" entered as a covariate to account for differences in protocol and vehicle interface.

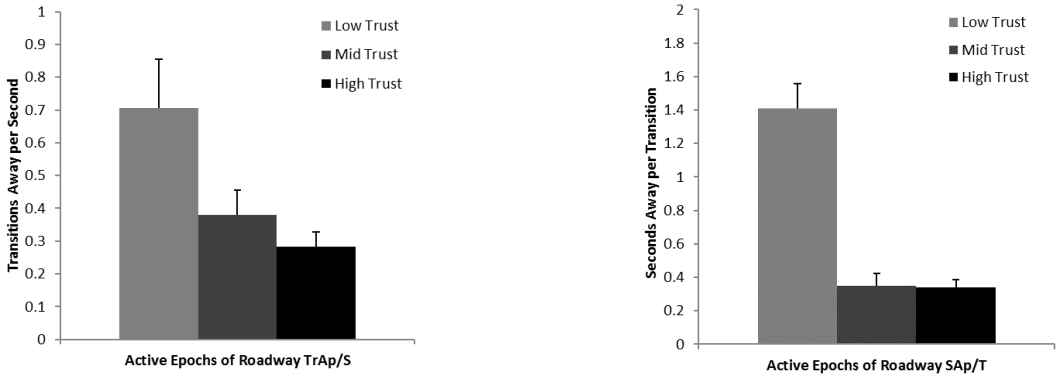

Figure 1. (Left) Three groups differentiated by self-reported trust are shown in terms of their transitions per second away from the roadway toward an in vehicle navigation system. Individuals reporting lower trust transitioned away more often. (Right) In terms of seconds away from the roadway per transition toward an in vehicle navigation system, individuals reporting lower trust spend more time away with each transition.

Results revealed that the lowest trust groups both transitioned more often, and spent more time off-road per transition than the highest trust groups, both in terms of transition (TrAp/s) and dwell (Sap/T) behavior. The pattern was only significant under the active epochs, not the latency epochs, suggesting that social gaze to interface is restricted to periods of active engagement. Low and medium trust users in the present analysis adopted a visual attention strategy results in more time with eyes off road than high-trust users. There is, in the opinion of the authors, a strong possibility that this attentional strategy is maladaptive, given the imperative to maintain attention on the forward roadway. These results suggest both import for training and design, as trust in an interface can here be linked directly to patterns of attention associated with danger to the operator. This effect joins other described dangers of miscalibrated trust in human-machine interaction (notably Parasuraman & Riley, 1997). Substantial understanding yet needed regarding gaze to non-anthropomorphic agents, both in terms of data and the necessary coming formation of underlying theory, is discussed.

ACKNOWLEDGEMENTS

Support for this work was provided in part the US DOT's Region I New England University Transportation Center at MIT, the Toyota Class Action Settlement Safety Research and Education Program, Toyota's Collaborative Safety Research Center (CSRC) and the Santos Family Foundation. The views and conclusions being expressed are those of the authors, and have not been sponsored, approved, or endorsed by Toyota or plaintiffs' class counsel.

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