CONVERSATION EFFECTS ON DRIVING: NEURAL MECHANISMS UNDERLYING REACTION TIMES TO VISUAL EVENTS

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ABSTRACT

OBJECTIVES

The purpose of this study was to determine the behavioral and neural correlates of conversation effects on driving using the same visual event detection paradigm in brain imaging, behavioral testing, and closed-road driving experiments.

METHODS

The “load” paradigm (Young et al., 2005b) assessed the effects of conversation on visual event detection during simulated driving in behavioral labs, fMRI and MEG imaging centers, and actual driving on a closed road. Behavioral and imaging data were collected. The primary task was to depress a foot pedal in response to a small red light presented to the left or below the driving scene at unpredictable times. The secondary task was to engage in a conversation. The participant pressed a button to answer a ring tone, and then answered simple auditory questions such as “What is your birthdate?” fMRI and MEG data were analyzed to examine the neural substrates of driving with and without conversation. The correlation, reliability and repeatability across experimental settings were analyzed using statistical procedures such as random effect ANOVA and multivariate regression models with repeated measure adjustment.

RESULTS

The behavioral results from all sites demonstrated that conversation had a small but consistent increase in reaction time (about 70-200 ms) with no effect on miss rates compared to the “no conversation” baseline. The random effect ANOVA and adjusted regression models confirmed the conversation effect in all settings, with good reliability and repeatability. The fMRI results showed that conversation activated not only language-specific areas as expected, but also increased activation in fronto-parietal pathways engaged in sensory-motor integration, attention modulation, and decision execution (Young et al., 2005a). Results of MEG imaging showed that in the “no conversation” baseline, behavioral RT was inversely related to changes in MEG brain activity in the right superior parietal lobe: more modulation in brain activity in the 200-300 ms range after light onset resulted in shorter RTs, and less modulation in longer RTs. A similar

relation to RT was also seen in brain activity in the visual cortex in the 85-90 ms interval after red light onset. Conversation again activated language-specific areas in the MEG study, and resulted in less modulation in the right parietal and visual regions (Bowyer et al., 2006). Accordingly, conversation tended to increase mean behavioral RT slightly (no conversation 926 ms; conversation 993 ms). Further experiments are required to determine if the reduction in modulation due to conversation arises from inhibition, interference, or a removal of facilitation from top-down attentional processes.

CONCLUSIONS

Conversation slightly increases visual event reaction times in laboratory and closed-road driving experiments compared to a no-conversation baseline, with little or no effect on miss rates. Common fMRI and MEG imaging findings revealed fronto-parietal and visual-auditory-motor networks associated with sensory-motor integration, decision-making, and attention modulation during a driving-like scenario. Conversation appears to contribute to increased reaction times by reducing brain modulation to visual events in the right superior parietal region and visual cortices. These experimental findings should not be interpreted as if conversation increases the rate of crashes in real-world driving when compared to baseline driving without real-world validation and comparison of reaction time effects from other in-vehicle tasks.

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