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Motor Output Variability Impairs Driving Ability in Older Adults: Reply to Stinchcombe, Dickerson, Weaver, and Bedard

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Driving is a complex skill, as indicated by Stinchcombe and colleagues in their letter. It requires the integration of sensory inputs, cognitive processing, and motor execution. Although our title is broad, we clearly indicate that our findings only address a single component of driving, namely reactive driving. We also indicate that these findings are based on a simulated task and recommend that future studies should examine the contribution of motor output variability to on-road driving performance (see Considerations in the Discussion section). Thus, we share the consideration of Stinchcombe and colleagues that the current results only address a small portion of the driving complexity. Stinchcombe and colleagues (1) also raised the following concerns, which we address below:

Surrogate Measure of Driving

We chose reactive driving as our model functional task (clearly indicated in the Introduction section) because it is performed daily during car following (8). During this part of driving, the driver must respond to unexpected visual stimuli with accurate and consistent movements. Our goal was to decompose the contribution of sensory, cognitive, and motor components, to the age-related impairments in reactive driving. To accomplish this, it was essential that we use a simulated task so we could control for extraneous variables (eg, number of stimuli presented, driving conditions, distractors unrelated to the task) that could influence our results.

Our goal was not to predict crash risk or on-road driving performance. Rather, we sought to determine if motor output variability, a factor that has been ignored in the driving literature, is important for a simulated driving task that requires the integration of visual inputs, cognitive processing, and motor execution. The main point of our study is that in older adults, the motor control deficit, as quantified by motor output variability, predicts their impaired ability to react in a simulated driving task, whereas strength does not. Throughout the article, we do not make any claims that motor control deficit in older adults is a predictor of on-road driving performance. Rather, we provide evidence to driving researchers, such as Stinchcombe and colleagues, that an interesting variable to consider in aging-related reactive driving impairments, is motor output variability.

Behavioral Adaptation

We appreciate the fact that humans adapt their behavior in response to their limitations. This is not unique to aging and driving. It occurs for walking or postural control. For example, individuals with impaired leg muscle control may hold on the stair handle rail while ascending and descending stairs, whereas healthy individuals will not. However, to understand the underlying mechanisms that could contribute to the age-related impairments, young and older adults need to perform the task under identical situations. Using a well-controlled laboratory task that simulates reactive driving allows us to perform such comparisons and better understand the underlying mechanisms with minimal danger to the participants.

Methodological Issues

Stinchcombe and colleagues were concerned with the cognitive health of older drivers. We would like to assure them, as well as the readers, that the older adults we tested in this project were all cognitively healthy. We have been testing older adults for the last 20 years and we routinely use questionnaires (e.g., Mini Mental) to exclude older adults with cognitive deficits. The older participants in this study were cognitively healthy, self-dwelling, and current drivers. The results presented in Figure 2B provide evidence for the cognitive health of older adults. Figure 2B shows the premotor response time for each participant in this study, which is a measure that quantifies cognitive processing. Only five of the older adults were slower than the young adults. If we corrected for a family-wise error (see comments below), then the reported differences for premotor response time will not be significant. This will argue that older adults were as cognitively fast in processing the visual information as young adults.

An additional concern was part of the statistics used. Specifically, they were concerned that we didn't use a correction for multiple comparisons for the results presented in Figure 1. The possible family-wise error would have happened for the results presented for Figure 1B and C, because the task was similar for those two variables. This will bring the alpha level to $p = .025$, which would have made only the results in Figure 1B, borderline insignificant ($p = .03$). Independent of whether gas pedal variability was statistically significant or not in Figure 1B, the point remains the same, which is evident in Figure 4A–D. Motor output variability is associated with reactive driving impairments and not strength. Similarly, we would like to acknowledge that we haven't corrected for multiple comparisons for the Results presented in Figure 2A–D. Again, this has no effect to the findings of the study, because the main variable of the study was the composite value from all the variables presented in Figure 2A–D. Therefore, the main point of the article remains valid. Increased motor output variability and not strength deficits predict the age-related impairments observed during a simulated reactive driving task.

In summary, we do not argue that these findings will translate to on-road driving. That remains to be tested. We do however argue that variability is an important and understudied component of reactive driving. Future studies should examine whether motor output variability is a predictor of on-road driving performance in older adults.