ARTICLE

The Reliability of a VISION COACH Task as a Measure of Psychomotor Skills

Yubin Xi1, Patrick J. Rosopa2, Mary Mossey2, Matthew C. Crisler1, Nathalie Drouin3, Kevin Koper3, & Johnell O. Brooks1

1Clemson University International Center for Automotive Research, 4 Research Drive, Greenville, South Carolina, USA, 2Department of Psychology, Clemson University, 418 Brackett Hall, Clemson, South Carolina, USA, 3Roger C. Peace Rehabilitation Hospital, Greenville, South Carolina, USA

ABSTRACT. The VISION COACHTM interactive light board is designed to test and enhance participants’ psychomotor skills. The primary goal of this study was to examine the test–retest reliability of the Full Field 120 VISION COACH task. One hundred eleven male and 131 female adult participants completed six trials where they responded to 120 randomly distributed lights displayed on the VISION COACH interactive light board. The mean time required for a participant to complete a trial was 101 seconds. Intra-class correlation coefficients, ranging from 0.962 to 0.987 suggest the VISION COACH Full Field 120 task was a reliable task. Cohen’s d’s of adjacent pairs of trials suggest learning effects did not negatively affect reliability after the third trial.

KEYWORDS. Interactive light board, Psychomotor skills, Test–retest reliability, VISION COACH, Visual rehabilitation

The coordination between visual perception and limb movement is a component of psychomotor skills. Psychomotor skills refer to the skills relating to movement or muscular activity associated with mental processes (American Heritage, 2002), and therefore, they are required to successfully complete many activities of daily living, including functional mobility. The VISION COACH interactive light board has been developed as a tool to assess as well as enhance psychomotor skill and better fulfill a patient’s rehabilitative needs. The VISION COACH was developed in 2009 by an optometric vision therapist who found existing units to be lacking key features (R. Donley, personal communication, February 3, 2014).

Pilot studies using the VISION COACH have been initiated in a variety of institutions, including rehabilitation hospitals, sports training centers, and military...
settings (Perceptual Testing, Inc., 2012). In order to establish the ability of the VISION COACH to reliably index psychomotor skills, the test–retest reliability of the VISION COACH should be established. Since no published research has presented data on the reliability of the VISION COACH, this present study fills this research gap.

VISION COACH (see Figure 1) is a dynamic and interactive wall-mounted light board where the user responds to illuminated lights by pressing on the board with a finger as quickly as possible when the light is seen. The VISION COACH was designed to work on the visual functions, muscular coordination, and psychomotor skills (Perceptual Testing, Inc., 2012).

There are several clinical tools available to evaluate and enhance psychomotor skills. Among them, the Dynavision™, which shares some operational characteristics with the VISION COACH, has also been used by rehabilitation and human performance centers for occupational therapy and sport-related training (Klavora et al., 1994). In contrast to the VISION COACH, the main performance metric of Dynavision is the number of “hits” a participant can achieve on various Dynavision tasks (Klavora et al., 1995). Research has examined the test–retest reliability of the Dynavision tasks (Klavora et al., 1994, 1995) and investigated the relationship between Dynavision performance and various conventional psychomotor tests, such as the simple response time test (Vesia et al., 2008).

The Dynavision provides individuals a variety of tasks, several of which can include unpredictable displays with potential target locations to attend to with raised targets. Research on visual search suggests prior knowledge of target locations may serve as a cue and may affect task performance (Geng & Behrmann, 2005). Given that many important visual scanning tasks have unpredictable target locations, the
VISION COACH, which does not indicate the location of potential targets, may offer an alternative representation of psychomotor skills for these tasks.

The main purpose of the current study is to examine the test–retest reliability of a VISION COACH task and investigate the relationship between participants’ performance and demographic and anthropometric characteristics.

**METHODS**

**Participants**

Only healthy able-bodied individuals were recruited for this study with participant recruitment targeting four age/gender combinations: older female, older male, younger female, and younger male. To recruit participants, flyers and posters were posted at a university as well as community senior centers in the area. There were 246 participants in the present study in the four groups (see Table 1). Participants were first provided with information about the study, and then they provided informed consent. Upon completing the study, participants were compensated $10 for their participation. Note that this study was approved by the Clemson University Institutional Review Board.

Data from four participants were excluded from our analyses. One participant from the younger female group was excluded due to a data entry error, and two participants from the younger female group and one from the younger male group were excluded as outliers, due to performance in at least one trial that exceeded three standard deviations from the mean performance.

**Apparatus**

The VISION COACH is a 50″ × 34″ black, non-glare board attached to a wall-mounted counter weight slider, which accommodates variations in participant height as well as a range of physical limitations (see Figure 1). The surface houses 120 target light dots. With no lights illuminated, the board appears as a flat, matte black surface with no visual cues regarding potential target locations provided to participants. Some dots have built-in letters or numbers. A typical VISION COACH task is accomplished by the participant facing the VISION COACH board and responding to each illuminated light by pressing with a finger as quickly as possible when the light is seen. A fixator light, which is a single white dot located in the center of the board, can be incorporated into a variety of different tasks for various purposes, but in the current study, it was used to align the board for each participant. The LED window in the upper right corner provides program options (e.g., task names, speed, etc.)

**TABLE 1. Participant Demographics and Anthropometric Measurements**

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Age</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
<th>Height (cm)</th>
<th>Mean</th>
<th>SD</th>
<th>Wingspan (cm)</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older female</td>
<td>30</td>
<td>67</td>
<td>5.5</td>
<td>55–77</td>
<td>163.3</td>
<td>7.2</td>
<td>161.2</td>
<td>8.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Older male</td>
<td>17</td>
<td>64</td>
<td>7.5</td>
<td>50–74</td>
<td>179.6</td>
<td>7.8</td>
<td>179.6</td>
<td>9.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Younger female</td>
<td>101</td>
<td>20</td>
<td>1.6</td>
<td>18–25</td>
<td>166.9</td>
<td>6.9</td>
<td>164.7</td>
<td>8.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Younger male</td>
<td>94</td>
<td>20</td>
<td>2.1</td>
<td>18–32</td>
<td>180.9</td>
<td>7.9</td>
<td>180.9</td>
<td>8.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
and performance data after each vision coach task is completed. The control panel in the lower-right corner allows operators to select, configure, and initiate tasks. A variety of task options are provided, including different visual fields, 12 device-paced speeds of light, number of lights displayed, and color of lights displayed. The time it takes a participant to successfully respond to a specified number of lights is presented on the top right corner of the board and serves as a common metric to describe performance on vision coach tasks (Perceptual Testing, Inc., 2012).

The Full Field 120 vision coach task was identified as relevant to general assessment and training, and chosen as the focus of the current investigation. The task consists of presenting dots one at a time, at random locations across the entire surface of the board until all 120 dots have been presented and responded to. When a dot illuminates, the participant depresses the dot with a finger or thumb and the light turns off. The next dot illuminates immediately after a response is received. The Full Field 120 task is not paced, so each dot remains displayed until a response is received. It was suggested by the Vision Therapist that the red lights be used for this investigation.

Procedure
Thirteen university students and research staff members were trained to collect data. After participants provided informed consent, data collectors recorded demographic and anthropometric data, including age, gender, height, wingspan, and self-reports of visual or physical problems. The height and wingspan were measured by having the participants stand against a wall with arms also against the wall, but horizontal to the ground. Then, data collectors marked the position of the tips of both middle fingers. The distance between both marks was the wingspan. To measure height, data collectors used a square ruler, with one side of the ruler against the wall and the other side against the top of the participant’s head. All participants completed the procedure individually.

To prepare for the vision coach task, the fixator light was toggled on, and the board was adjusted vertically, such that the fixator light was level with the participant’s eye height as he or she stood straight and looked forward toward the display. A data collector then confirmed that while standing the participant could reach the top of the board, and then the fixator light was turned off for the remainder of the procedure.

After the display height was adjusted, the data collector provided the participants with a short demonstration. Participants briefly practiced the task to minimize the effect of learning. The demonstration and practice consisted of responding to the first 10 dots in the Full Field 120 task. Then, the data collector instructed all participants that they were allowed to move their head and eyes to scan the board, and they should respond to the dots as quickly as possible. The data collector also emphasized to participants that they were to use the pad of one finger or thumb of either hand for each depression, and they were allowed to switch between hands and/or digits, if desired. Prior to data collection, participants confirmed that they understood the task, and they were given a final opportunity to ask questions to clarify the procedure. In a standing position, the participants then completed six
TABLE 2. Percentiles of Time to Complete the Full Field 120 Task for Older Female (N = 30)

<table>
<thead>
<tr>
<th>Trial (sec)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>95th percentile</td>
<td>168</td>
<td>165</td>
<td>158</td>
<td>159</td>
<td>157</td>
<td>151</td>
</tr>
<tr>
<td>75th percentile</td>
<td>159</td>
<td>146</td>
<td>141</td>
<td>142</td>
<td>140</td>
<td>138</td>
</tr>
<tr>
<td>Median</td>
<td>144</td>
<td>137</td>
<td>133</td>
<td>129</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>25th percentile</td>
<td>125</td>
<td>122</td>
<td>119</td>
<td>117</td>
<td>116</td>
<td>115</td>
</tr>
<tr>
<td>5th percentile</td>
<td>116</td>
<td>111</td>
<td>105</td>
<td>106</td>
<td>105</td>
<td>105</td>
</tr>
</tbody>
</table>

trials of the Full Field 120 task. The dependent variable, time to complete each trial, was recorded by the VISION COACH.

While this study included healthy, community dwelling participants, the opportunity for participants to take breaks was required by the IRB. Therefore, all participants were given an opportunity to sit, drink, or use the restroom if needed between completing each trial of the Full Field 120 task. Very few participants requested a break. If breaks were requested, they were very short (typically less than 1 minute).

Data Analysis

Various statistical procedures were used to analyze our data and examine relationships. To estimate reliability with repeated measurements, we calculated intraclass reliability coefficients (Baumgartner, 1989). Then, to examine linear relationships between variables, Pearson correlation coefficients were calculated. Next, to index the change in performance between adjacent trials, we estimated Cohen’s effect size (d) (King et al., 2010).

To examine whether the effect of trial differed depending on age or gender, we conducted a mixed-model analysis of variance (King et al., 2010), using time to complete a trial as the dependent variable, trial as a within-subjects factor, gender as a between-subjects factor, and age (younger and older) as a dichotomous between-subjects factor. Because time to complete a trial was not normally distributed, a logarithmic transformation (using 10 as the base) was applied to the dependent variable (Kirk, 1995). Based on the results of Q-Q plots and the Shapiro–Wilk test, the normality assumption was restored, thus, bolstering the validity of statistical tests. Because Mauchly’s test indicated the sphericity assumption was not satisfied, the Greenhouse-Geisser adjusted procedure was used (Kirk, 1995).

TABLE 3. Percentiles of Time to Complete the Full Field 120 Task for Older Male (N = 17)

<table>
<thead>
<tr>
<th>Trial (sec)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>95th percentile</td>
<td>156</td>
<td>148</td>
<td>139</td>
<td>139</td>
<td>139</td>
<td>145</td>
</tr>
<tr>
<td>75th percentile</td>
<td>133</td>
<td>128</td>
<td>125</td>
<td>129</td>
<td>130</td>
<td>121</td>
</tr>
<tr>
<td>Median</td>
<td>127</td>
<td>117</td>
<td>115</td>
<td>115</td>
<td>111</td>
<td>115</td>
</tr>
<tr>
<td>25th percentile</td>
<td>114</td>
<td>110</td>
<td>105</td>
<td>102</td>
<td>103</td>
<td>99</td>
</tr>
<tr>
<td>5th percentile</td>
<td>104</td>
<td>98</td>
<td>95</td>
<td>94</td>
<td>94</td>
<td>93</td>
</tr>
</tbody>
</table>
TABLE 4. Percentiles of Time to Complete the Full Field 120 Task for Younger Female (N = 101)

<table>
<thead>
<tr>
<th>Trial (sec)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>95th percentile</td>
<td>121</td>
<td>119</td>
<td>119</td>
<td>114</td>
<td>115</td>
<td>115</td>
</tr>
<tr>
<td>75th percentile</td>
<td>110</td>
<td>109</td>
<td>107</td>
<td>106</td>
<td>105</td>
<td>103</td>
</tr>
<tr>
<td>Median</td>
<td>105</td>
<td>102</td>
<td>100</td>
<td>99</td>
<td>99</td>
<td>98</td>
</tr>
<tr>
<td>25th percentile</td>
<td>99</td>
<td>97</td>
<td>95</td>
<td>95</td>
<td>94</td>
<td>93</td>
</tr>
<tr>
<td>5th percentile</td>
<td>91</td>
<td>91</td>
<td>87</td>
<td>87</td>
<td>87</td>
<td>86</td>
</tr>
</tbody>
</table>

RESULTS

The 95th, 75th, 50th, 25th, and 5th percentiles of time to complete the Full Field 120 task for each of the six trials is summarized in Tables 2–5 for the four age and gender groups. The median completion time for each of the four groups is shown on a single graph in Figure 2. The error bars represent the 95% confidence interval of the median times.

As noted above, intraclass reliability coefficients (Baumgartner, 1989) are a reliability estimate for repeated measurements. Table 6 shows the intraclass reliability coefficients for the vision coach Full Field 120 task for each of the demographic groups included in this investigation.

As can be seen from Table 6, the test–retest reliability of the vision coach task was the highest for the older female participants and was the lowest for the younger male participants. The intraclass reliability coefficients for all participant groups were greater than 0.9.

The results of the mixed-model analysis of variance are summarized in Table 7. The effect of trial, age, gender, as well as the effect of interactions between trial and age and between trial and gender, were all significant, which indicated that the effect of trial was different between younger and older participants and between females and males, respectively, and that the effect of age was not significantly different between genders.

To investigate how learning effects (see also testing effects; Shadish et al., 2002) may have affected reliability, the relationship between performances on adjacent trials was examined. Cohen’s $d$ was calculated for each of the five pairs of adjacent trials (1–2, 2–3, 3–4, 4–5, and 5–6), regardless of gender and age. They were 0.22, 0.13, 0.05, 0.05, and 0.07, respectively. An evident decrease in Cohen’s $d$ occurred

TABLE 5. Percentiles of Time to Complete the Full Field 120 Task for Younger Male (N = 94)

<table>
<thead>
<tr>
<th>Trial (sec)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>95th percentile</td>
<td>118</td>
<td>111</td>
<td>109</td>
<td>110</td>
<td>108</td>
<td>106</td>
</tr>
<tr>
<td>75th percentile</td>
<td>107</td>
<td>102</td>
<td>103</td>
<td>101</td>
<td>100</td>
<td>99</td>
</tr>
<tr>
<td>Median</td>
<td>100</td>
<td>96</td>
<td>95</td>
<td>95</td>
<td>95</td>
<td>94</td>
</tr>
<tr>
<td>25th percentile</td>
<td>94</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>89</td>
<td>87</td>
</tr>
<tr>
<td>5th percentile</td>
<td>84</td>
<td>82</td>
<td>82</td>
<td>83</td>
<td>81</td>
<td>81</td>
</tr>
</tbody>
</table>
between pair 2–3 and pair 3–4, suggesting the relatively stable performance from the third trial.¹

Pearson correlations were also calculated to assess the relationship between wingspan, age, and task performance. Based on the previous analysis suggesting the learning effect stabilizes after trial 3, task performance was defined as the mean time across trials 4–6 for this analysis. Correlations between wingspan and task performance were conducted within gender groups, given the gender effect and the likely correlation between gender and wingspan. There was no significant correlation between wingspan and task performance for older females ($r = 0.118, N = 30, p = 0.536$), older males ($r = -0.335, N = 17, p = 0.188$), younger females ($r = -0.145, N = 101, p = 0.147$), or younger males ($r = -0.051, N = 94, p = 0.623$). A significant positive correlation between age and task performance (i.e., as age increased, task completion time increased) was found among older participants ($r = 0.618, N = 47, p < 0.01$), but not younger participants ($r = -0.052, N = 195, p = 0.472$).

**DISCUSSION**

The data presented in this study provide occupational therapists an initial set of comparison data of an active, healthy sample. This study demonstrated that because the task is reliable and only minimal training is needed, the *VISION COACH* is likely useful for occupational therapists.

The reliability of the selected *VISION COACH* task ranged from 0.962 to 0.987 across four groups (Table 6). Among various Dynavision tasks examined in existing studies, the Self-paced Simple Task, in which participants were required to respond to

¹The Cohen’s $d$ was also calculated for the four age-gender groups. There was no substantive change in our interpretations. To simplify our results section, we used Cohen’s $d$, regardless of age and gender.
TABLE 6. Intraclass Reliability Coefficients for Full Field 120 Task for Four Groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Intraclass reliability coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older female</td>
<td>0.987</td>
</tr>
<tr>
<td>Older male</td>
<td>0.985</td>
</tr>
<tr>
<td>Younger female</td>
<td>0.970</td>
</tr>
<tr>
<td>Younger male</td>
<td>0.962</td>
</tr>
</tbody>
</table>

as many illuminated buttons as possible, was the most comparable to Full Field 120 task using vision coach. The reliability of the Self-paced Simple Task was 0.88 and lower than that of the Full Field 120 task (Klavora et al., 1995). This difference of the test–retest reliabilities between the selected vision coach task and the cited Dynavision task may be due to the longer trial-to-trial intervals (2 weeks) used in the Dynavision studies by Klavora et al. (1994, 1995).

The decrease in Cohen’s d noted above indicates the learning effect could negatively affect reliability and may reduce the validity of the psychomotor skills testing results obtained in the first two trials of the task. Completing at least two warm up trials before completing a test trial is suggested and may be warranted as part of a clinical assessment procedure. Our data suggest that conducting a third practice trial may have a positive effect on reliability; however, reliability and task performance are acceptably stable after two practice trials.

Limitations and Future Research

In this vision coach study, the six trials were carried out consecutively in a single visit. To better compare the reliability of the vision coach with the Dynavision, the trials should be separated by longer periods in order to allow direct comparisons to the existing Dynavision studies (Klavora et al., 1994, 1995). In addition, more vision coach tasks with a variety of difficulty levels should be investigated. It is important to note the results of this investigation pertain only to the reliability of the Full Field 120 vision coach task. Generalization to other tasks will require further investigation. In future research, children and adult participants with short stature should be included, as there is some indication among shorter female participants that task performance decreased. However, our sample did not include enough small-statured individuals to thoroughly investigate this issue. Future research should examine the impact of a variety of different treatment protocols on patients’ performance using

TABLE 7. Mix-Model Analysis of Variance for Effects of Trial, Age, Gender and their Interactions

<table>
<thead>
<tr>
<th>Factor</th>
<th>$df_{between}$</th>
<th>$df_{within}$</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial</td>
<td>2.991</td>
<td>711.834</td>
<td>126.344</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Trial × age</td>
<td>2.991</td>
<td>711.834</td>
<td>7.882</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Trial × gender</td>
<td>2.991</td>
<td>711.834</td>
<td>3.355</td>
<td>0.019</td>
</tr>
<tr>
<td>Trial × age × gender</td>
<td>2.991</td>
<td>711.834</td>
<td>0.946</td>
<td>0.418</td>
</tr>
<tr>
<td>Age</td>
<td>1</td>
<td>238</td>
<td>218.117</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Gender</td>
<td>1</td>
<td>238</td>
<td>33.719</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Age × gender</td>
<td>1</td>
<td>238</td>
<td>3.334</td>
<td>0.069</td>
</tr>
</tbody>
</table>
the \textit{VISION COACH}. Future studies should also compare the \textit{VISION COACH}'s performance with other methods of measuring psychomotor skills in a clinical setting.

The current results reveal an expected trend toward poorer performance on the \textit{VISION COACH} task with increasing age. Data were not collected from participants 25 to 50 years old. Future research should further examine task performance with respect to age. However, we should note that difference in sample sizes has no systematic effect on differences in performance between age groups. The sample-based mean difference is an unbiased estimate of the population mean difference, regardless of the difference in sample sizes (Kirk, 1995). Although differences in sample sizes can have a deleterious effect on Type I error rates and power when the homogeneity of variance assumption is violated (Rosopa et al., 2013), because this assumption was not violated, inflated Type I error rates and low statistical power are not likely to be threats to statistical conclusion validity (Shadish et al., 2002). Future studies should investigate the effect of age with a sample that includes participants within the missing age range. Performance of a large sample of older adults, as well as a broad range of clinical populations, should also be investigated. This would provide a richer understanding of the effects of age on task performance, as well as the relationship between \textit{VISION COACH} task performance and the ability to successfully complete Instrumental Activities of Daily Living tasks.

\textbf{Application to Practice}

It is beneficial for occupational therapy practitioners to have a variety of tools at their disposal to meet the needs of individual patients. Both the Dynavision and the \textit{VISION COACH} have the ability to provide practitioners with objective information regarding their patients’ capabilities and limitations and offer the opportunity for therapists to choose which tool is more appropriate for their patients. Future research should assess the utility of specific features of the \textit{VISION COACH}, including the lack of glare, range of vertical motion, lack of visual cues, and the lifespan, as well as durability of the system.

The \textit{VISION COACH} is now in use by occupational therapists at Roger C. Peace Rehabilitation Hospital of the Greenville Health System throughout the continuum of occupational therapy services. Data are currently being collected using a broad patient population to provide norms on a clinical sample and will hopefully provide further assessment and intervention data.

\textbf{CONCLUSION}

The Full Field 120 \textit{VISION COACH} task demonstrates the reliability to be used for measuring perceptual scanning task. Utilizing two practice trials prior to completing the test trial minimizes learning effects and increases reliability to an acceptable level. Our results suggest that using the result from the third trial in clinical assessment can produce sufficiently reliable results. Further research is warranted with regard to the clinical applications of various \textit{VISION COACH}-based tasks because it is not known whether these results will generalize to other \textit{VISION COACH} tasks.
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ABOUT THE AUTHORS

Yubin Xi, MS, Graduate Research Assistant, Clemson University International Center for Automotive Research, Clemson University, Clemson, South Carolina, USA. Mary Mossey, MS, Graduate Research Assistant, Department of Psychology, Clemson University, Clemson, South Carolina, USA. Matthew C. Crisler, PhD, Research Specialist, Clemson University International Center for Automotive Research, Clemson University, Clemson, South Carolina, USA. Nathalie Drouin, OTR/L, CDI, CDRS, Occupational Therapist, Roger C. Peace Rehabilitation Hospital, Greenville, South Carolina, USA. Patrick J. Rosopa, PhD, Associate Professor, Department of Psychology, Clemson University, Clemson, South Carolina, USA. Kevin Kopera, MD, Medical Director, Roger C. Peace Rehabilitation Hospital, Greenville Health System, Greenville, South Carolina, USA. Johnell O. Brooks, PhD, Associate Professor, Clemson University International Center for Automotive Research, Clemson University, Clemson, South Carolina, USA; Clinical Research Faculty, Department of Medicine, Greenville Health System, Greenville, South Carolina, USA.

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