

An Item Response Theory-Based Classification of Hazards in a Driving Risk Assessment Test

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Drivers' hazard perception skills and related training are crucial for safe driving, and active efforts have been made to measure and develop these skills. One such tool is the driving risk assessment test. In this test, participants observe animations from a driver's perspective on a touchscreen display and sequentially tap hazards that require attention or confirmation to ensure safe driving. The hazards included in this test comprise "other vehicles", "pedestrians and bicycles", "traffic signals and signs", and "blind spots". Understanding the internal hazard detection characteristics of respondents is significant for properly evaluating their hazard perception abilities. Furthermore, it is useful to evaluate *a priori* the difficulty of identifying each hazard and the extent to which responses to individual hazards contribute to discriminating respondents' hazard detection characteristics.

The present study aimed to elucidate the structure of respondents' latent hazard detection characteristics and to assess the psychometric properties of individual hazards by analyzing the factor structure underlying responses in this test. Factor analysis and Item Response Theory (IRT) were applied to analyze respondents' hazard detection performance.

First, a new dataset ($n = 823$) was compiled by merging data obtained from an experiment designed to develop an evaluation method for executive function with data collected in previous studies. Responses to each hazard were converted into binary data based on the presence (1) or absence (0) of a response. Subsequently, tetrachoric correlation coefficients among the hazards were calculated, and exploratory factor analysis was iteratively performed on the correlation matrix. As a result, 34 hazards were ultimately retained. The first factor comprised signs as well as moving pedestrians and bicycles, and was designated as "Overt Hazards." The second factor included elements such as intersections with poor visibility, and was therefore termed "Covert Hazards." The third factor consisted primarily of responses to pedestrian crossings and was thus named "Pedestrian Crossings." The validity of this factor structure was confirmed through various reliability indices and independent confirmatory factor analyses for each factor.

Following this, an IRT-based analysis using a two-parameter logistic (2PL) model was conducted on the hazards loading onto each factor to estimate the item parameters. Additionally, Item Characteristic Curves (ICCs) and Test Information Curves (TICs) were plotted for each factor (Fig. 1). The results indicated that "overt hazards" and "pedestrian crossings" exhibited a wide range of difficulty parameters, demonstrating that the constituent hazards are suitable for evaluating respondents across various levels of hazard detection capability. Conversely, for "covert hazards," the findings suggested that the included items are more appropriate for assessing respondents with high hazard detection capabilities.

The analysis conducted in the present study clarified the structure of respondents' internal hazard detection characteristics, which underlie their hazard detection responses, and enabled the evaluation of the properties of the individual hazards included in the driving risk assessment test. These findings will contribute to the more effective utilization of the driving risk assessment test as an improved evaluation and educational tool for hazard perception skills.

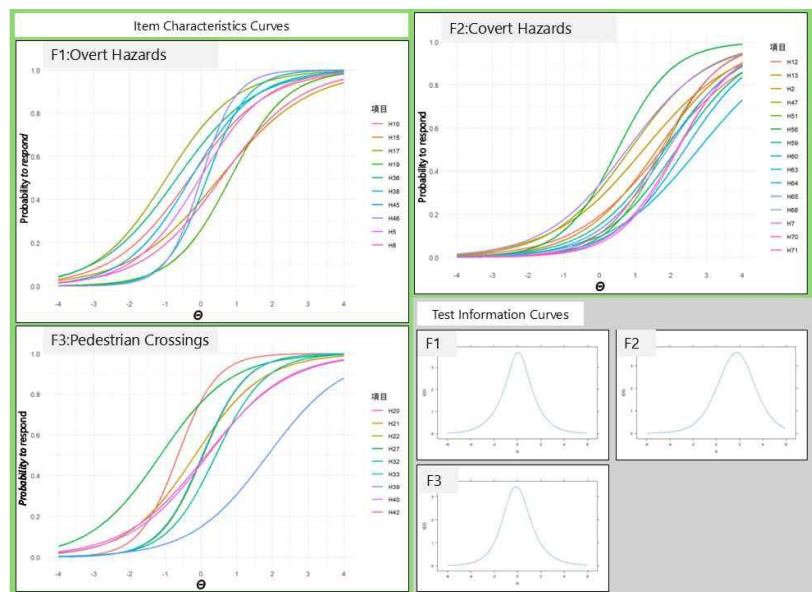


Fig. 1 Item Characteristic Curves and Test Information Curves