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An analysis on level of stress for bicycle facilities by using vital reactions according to driving tasks

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There are various types of bicycle infrastructure, including separated and shared paths on sidewalks or roadways alongside other transportation modes. Although each type of bicycle path requires different skills and confidence for cyclists, interactions between user response and path conditions have not been captured well.

Previous studies have shown that safety, stress, and comfort levels of cyclists affect route or path choice behaviors. In terms of the stress response, researchers have developed evaluations of road conditions by measuring vital reactions using heart rate interval (RRI), Galvanic skin response (GSR), Electroencephalography (EEG), and Electromyography (EMG). While riding a bicycle in various conditions affects user response through vital reactions, few studies have considered the comprehensive relationship between stress response and the task intensity, as cycling requires physical activity under complex task conditions.

Therefore, in order to obtain some basic insights on vital reactions associated with road conditions during bicycle use, experimental observations of vital reactions using RRI, EMG, and GSR in two different designated courses that required different driving tasks considering individual riding experience was conducted. Subjects were fifteen students with different frequencies of bicycle usage on a daily basis. The driving experiments were conducted in the campus course that combined simple driving tasks for approximately 1 minute and in the road course that combined actual complex driving tasks for approximately 30 minutes. Since the vital reaction was measured at 0.5 seconds for RRI and at 0.001 seconds for EMG and GSR, some statistical analyses were made for each stress factor in the analysis. Driving Tasks were scored by a modified mental workload measurement with NASA-TLX in order to scale workload for different conditions.

Results indicated that driving tasks in each bicycle lanes affected users' vital reactions. Furthermore, it was found that the vital reactions of daily users tended to be larger in any type of bicycle path if compared to the reactions of occasional users. In addition, as a reaction characteristic of each vital reaction index, both physical and mental loads can be measured in all vital reaction indices, in particular, it clarified that GSR was easy to respond to stress factors caused by mental loads while RRI and EMG were easy to respond to stress factors caused by physical loads.