ORIGINAL ARTICLE

ASSESSING THE RELIABILITY OF SUBJECTIVE EVALUATION FOR COMFORTABLE DRIVING POSTURES

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ABSTRACT

Drivers' posture is one of the factors that can contribute to driving discomfort. Subjective evaluation is needed in determining the driving discomfort problem. The purpose of this study is to examine the reliability of different driving postures that may lead to drivers' discomfort. A total of thirty-four healthy Malaysian drivers were involved in this study. Respondents were required to sit on the driver's seat with the required adjustments of three different postures and fill-in the given subjective evaluation form. The same procedure was repeated for each respondent after three days for purpose of conducting test retest evaluation. The reliability statistical analysis result shows the study was reliable and valid with a Cronbach's alpha coefficient equal to 0.827. The comparison means that ANOVA analysis also shows significance difference between these three groups of postures for all measured parameters. In conclusion, the result from this study shows the subjective evaluation conducted is reliable and can be used for drivers' posture discomfort study.

***Keywords**: ergonomic, comfort, driving posture, reliability, subjective evaluation*

INTRODUCTION

Driving posture is an important issue that need to be taken into account during vehicle design process[1]. This is in addition to consumer concerns on the vehicle design[2,3]. Every car driver had his/her own preferred driving position and posture, which may vary with each other. The different preferences are due to their comfort level and the driver's own physical built and gender. Comfort is one of the criteria considered by the consumer in choosing the best vehicle in term of driving quality and performance[4].

Research conducted by MacLean et al.[5] shows that 20% of road accidentswere due to driver's fatigue. As a result, drivers' fatigue factor has been considered as one of the market study objectives and in academic research paper presentations[4,6].

Past researchers have used many methods for determining the fatigue issue, such as: subjective evaluation, physical measurement and observation of drivers' movements[4]. Subjective evaluation is commonly used in car's driver interior design and optimum drivers' posture research[7]. There are also other researchers that studied and measured the relationship between comfort level and musculoskeletal injuries subjectively[6,8]. Rating-scale technique is a natural and convenient approach and it has been widely used for intensity and comfort or discomfort assessment[9].

Driving posture angle is one of the critical factors that had to be considered closely and thoroughly in design and development of driver's car seat. Table 1 shows the value of comfortable angle postures published by several past researchers.

Table 1 - Comfortable driving posture angle by past researchers (unit in deg.)

Researchers / Posture Angles	Mohamad et al.[10] n=45	Hanson et al.[11]	Park et al.[12] n=43	Porter& Gyi[13] n=14	Grandjean[14]	Rebiffe[15]
Neck	22-48	NA	NA	NA	NA	NA
Elbow	100-188	NA	86-144	86-164	NA	80-120
Shoulder	16-61	NA	7-37	NA	NA	NA
Trunk-Thigh	96-123	NA	103-131	90-115	100-120	95-120
Elbow	102-143	109-157	120-152	99-138	110-130	95-135
Foot	69-116	NA	82-124	80-113	90-110	90-110

The parameters for driver seating posture used in this subjective evaluation were taken from Mohamad et al.[10]. This parameterswere chosen because they arerelevant to the research purpose to assess the comfort level for drivers among the Malaysian population. This is consistent with Rashid et al.[16]findings, which shows there is significance different in driving posture between Malaysian and other countries population.

An instrument's inter-class and intra-class coefficient reliability can be examined by using test-retest statistical method. Test-retest method involves multiple administrations of an instrument to the same people at two different times. This method usually used in physical fitness and motor acting skills measurement[17,18]. Researchers had been using the test-retest method in order to evaluate or determine the reliability of certain method or parameter. Graham et al.[19] have been using this method to assess the between-day reproducibility of each dependent measure, by testing the operators at the same time on the following workday. On the other hand, Miyake et al.[20]and Ikula et al.[21] had also applied the test-retest method in their study to evaluate the user physiological response in performing a worktask.

The two main objectives of this study are to assess the reliability of the subjective evaluation rating used in examining the comfortable driving posture and to determine the significance difference between the postures measured.

METHODS

1) Participants

Thirty-four healthy Malaysian car drivers involved in the test-retest evaluation. All participants were experienced drivers with at least one year driving experience.

2) Experimental Procedure

First, each participant was briefed in details on the objectives and procedures of the experiment. Participants will be then required to sit on the driver's seat with the required adjustments of three different postures and fill-in the given subjective evaluation form. The subjective evaluation form comprise of three sections: personal information, drivers' seat information and driving posture information. For the first section on personal information, it includes the information on drivers' personal data and driving frequency. For the second section, the questions were focused on the feedback of the car seat involved. The third section is on the driver's posture evaluation on the three different positions as shown in Figure 1.

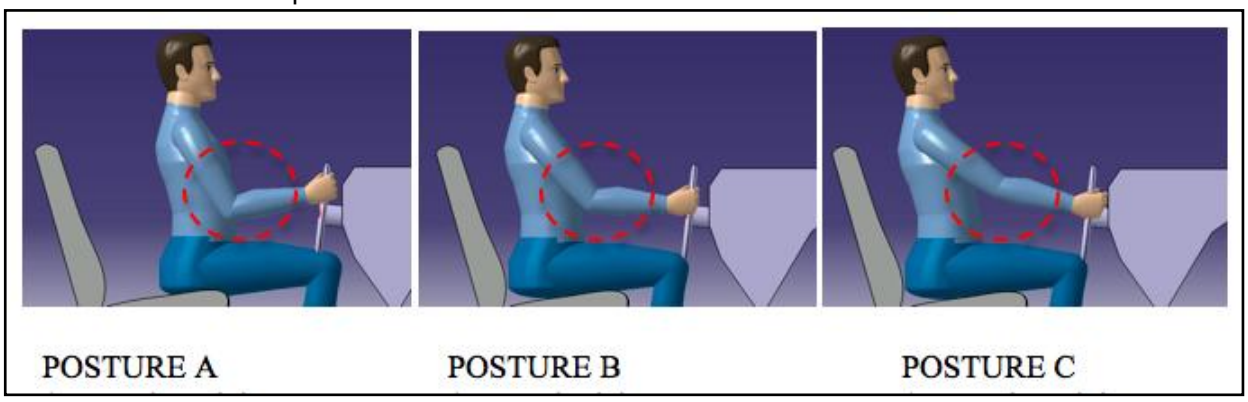

Figure 1 -Three different postures for subjective evaluation

The three driving posture positions are taken from Mohamad et al.[10]. Two angles were used to differentiate between the three driving postures involved, they are the shoulder and elbow angles. The value for every angles involved in this study are depicted in Table 2.

Table 2 - Shoulder and elbow angles for driving postures

	Shoulder angle	Elbow angle
Posture A	Less than 36 %	Less than 134 %
Posture B	Around 36 %	Around 134 %
Posture C	More than 36 %	More than 134 %

For each participant, the same procedure was repeated after three days for conducting test retest evaluation purpose. A retest evaluation within 2 to 4 days is acceptable for muscle related experiment[18]. As a token, the participants were given some form of incentives

for their contribution. Figure 2 show an example of participant in the posture adjusted for the experiment.

Figure 2 - Participant's driving posture during the evaluation

3) Statistical Analysis

The data collected from participants were analysed using SPSS statistical software version 22. Test-retest reliability was used to collect the value of Cronbach's alpha. Besides that One-Way ANOVA analysis was also conducted to compare the significance difference of comfort rating between the three postures involved in the study.

RESULTS

All participants involved in this study had given a complete feedback of the evaluation and able to retake the retest evaluation three days later. From this study, 64.7% of the participants are males and 35.3% are females.

1) Test-Retest

The data collected from the subjective evaluation form feedback were then analysed using the SPSS statistical software version 22.

Later, reliability statistics was done using the Cronbach's alpha coefficient. Cronbach's alpha coefficient were calculated for the perceived usefulness and perceived ease of use subscales for both administrations of the instrument[17]. These alpha coefficients are extremely good indicators of the instrument's reliability[22]. From the SPSS statistical analysis the Cronbach's alpha coefficient was found to be equal to 0.827 as depicted in Table 3.

Table 3 - Cronbach's alpha coefficient result

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items (N)
0.827	0.853	40

George & Mallery[23] and Nunnally[24] mentioned that if the value of the Cronbach's alpha coefficient is 0.7 and above, then the data are considered reliable. Therefore, based on this study results, the instrument used for conducting the subjective evaluation is reliable.

2) Means Comparison

One-Way ANOVA analysis was conducted to compare if there is any significance difference of comfort rating among all three postures tested in this study. Table 4 shows the One-Way ANOVA analysis results conducted in SPSS software.

Table 4 - One-Way ANOVA Analysis

		Sum of Squares	df	Mean Square	F	Sig.
Neck Comfort	Between Groups	54.725	2	27.363	25.380	0.000
	Within Groups	106.735	99	1.078		
	Total	161.461	101	/		
Hand Placement Comfort	Between Groups	65.314	2	32.657	28.731	0.000
	Within Groups	112.529	99	1.137		
	Total	177.843	101			
Steering Grip Comfort	Between Groups	33.078	2	16.539	14.080	0.000
	Within Groups	116.294	99	1.175		
	Total	149.373	101			
Lumbar Comfort	Between Groups	64.549	2	32.275	30.278	0.000
	Within Groups	105.529	99	1.066		
	Total	170.078	101			
Whole Body Comfort	Between Groups	66.020	2	33.010	33.742	0.000
	Within Groups	96.853	99	0.978		
	Total	162.873	101			

The Null hypothesis H_0 is rejected if the significance value is smaller than significant level appointed (α value = 0.05). In this study, the Null hypothesis H_0show that there is no significant differences among three groups of data. The Alternative hypothesis H_1 is accepted if one or more group data is differ from the others. As shown in Table 4, all 5 parameters measured shows significance value lower than the significant level appointed α value of 0.05. This means that there is significant difference of rating value for all the three group of data (postures). An elaborate post hoc comparison that is called the Tukey's test was done to determine which level means are different between the three sets of data. Table 5 shows the result from the Tukey's test.

Table 5 - Tukey's Test

Dependent Variable	(I) posture	(J) posture	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Neck Comfort	Posture A	Posture B	-1.79412*	0.252	0.000	-2.393	-1.195
		Posture C	-.88235*	0.252	0.002	-1.482	-0.283
	Posture B	Posture A	1.79412*	0.252	0.000	1.195	2.393
		Posture C	.91176*	0.252	0.001	0.313	1.511
	Posture C	Posture A	.88235*	0.252	0.002	0.283	1.482
		Posture B	-.91176*	0.252	0.001	-1.511	-0.313
Hand Placement Comfort	Posture A	Posture B	-1.94118*	0.259	0.000	-2.557	-1.326
		Posture C	-.73529*	0.259	0.015	-1.351	-0.120
	Posture B	Posture A	1.94118*	0.259	0.000	1.326	2.557
		Posture C	1.20588*	0.259	0.000	0.591	1.821
	Posture C	Posture A	.73529*	0.259	0.015	0.120	1.351
		Posture B	-1.20588*	0.259	0.000	-1.821	-0.591
Steering Grip Comfort	Posture A	Posture B	-1.35294*	0.263	0.000	-1.978	-0.728
		Posture C	-0.382	0.263	**0.317**	-1.008	0.243
	Posture B	Posture A	1.35294*	0.263	0.000	0.728	1.978
		Posture C	.97059*	0.263	0.001	0.345	1.596
	Posture C	Posture A	0.382	0.263	**0.317**	-0.243	1.008
		Posture B	-.97059*	0.263	0.001	-1.596	-0.345
Lumbar Comfort	Posture A	Posture B	-1.94118*	0.250	0.000	-2.537	-1.345
		Posture C	-1.11765*	0.250	0.000	-1.714	-0.522
	Posture B	Posture A	1.94118*	0.250	0.000	1.345	2.537
		Posture C	.82353*	0.250	0.004	0.228	1.419
	Posture C	Posture A	1.11765*	0.250	0.000	0.522	1.714
		Posture B	-.82353*	0.250	0.004	-1.419	-0.228
Whole Body Comfort	Posture A	Posture B	-1.97059*	0.240	0.000	-2.541	-1.400
		Posture C	-.97059*	0.240	0.000	-1.541	-0.400
	Posture B	Posture A	1.97059*	0.240	0.000	1.400	2.541
		Posture C	1.00000*	0.240	0.000	0.429	1.571
	Posture C	Posture A	.97059*	0.240	0.000	0.400	1.541
		Posture B	-1.00000*	0.240	0.000	-1.571	-0.429

From the Tukey's test results shown in Table 5, all parameters measured shows significance value lower than 0.05 except for steering grip comfort between Posture A and Posture C (sig. 0.317). TheseTukey's test results explains that all parameters are showing significance difference between all three postures measured except for the steering grip comfort. These Tukey's test results shows that the comfort rating for the three postures experienced by the participants are showing major difference in term of values and scores. Thus, this is a strong justification that a further study needs to be performed to evaluate the differences between these three types of driving postures.

CONCLUSIONS

The results of this study showed the instrument developed for conducting subjective evaluation was reliable. Comparisons and analysis of means also shows they are significance difference between all three postures involved. In short, the two main objectives of this study, which

aimed to assess the reliability of the subjective evaluation rating used in examining the comfortable driving posture and to determine the significance difference between the postures measured have been achieved successfully. This subjective evaluation had proven to be reliable and can be used for future study in determining car driver's comfortable driving postures for the Malaysian population.

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COMPETING INTERESTS

There is no conflict of interest.

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