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Development Of Framework For In-Vehicle Rear-End Collision Warning System Considering Driver Characteristics

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DEVELOPMENT OF FRAMEWORK FOR IN-VEHICLE REAR-END COLLISION WARNING SYSTEM CONSIDERING DRIVER CHARACTERISTICS

by

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A dissertation
presented to Ryerson University
in partial fulfillment of the requirements for the Degree of

Doctor of Philosophy (Ph.D.)

In the Program of
Civil Engineering

Department of Civil Engineering
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Toronto, Ontario, Canada, 2010

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ABSTRACT

Rear-end collisions are one of the serious traffic safety problems. These collisions occur when the following vehicle driver is inattentive or could not judge a potential rear-end collision situation. The use of rear-end collision warning systems (RECWS) may help drivers to avoid rear-end collisions. The existing systems assumed constant driver reaction time for all driver population in their design and evaluation. They also ignore variations in driver characteristics, such as age and gender.

The objectives of this thesis research are: (1) to develop reaction-time models that incorporate driver characteristics, (2) to develop a car-following simulation model that represents driver behaviour, and (3) to develop a rear-end collision warning system that accounts for driver characteristics and produces reliable collision warnings. In the human-factors study, four driver reaction-time models are developed for four different car-following scenarios: lead vehicle decelerating with normal deceleration rate, lead vehicle decelerating with emergency deceleration rate, lead vehicle stationary, and car-following acceleration regime. These models describe how the driver and situational factors affect reaction-time. The driver factors include age and gender, and the situational factors include speed and spacing between the following and lead vehicles.

The developed car-following model assumes that drivers adjust their speeds based on information of both the lead and the back vehicles. The model also assumes that the driver reaction-time varies based on driver characteristics and kinematics. The proposed model represents driver behaviour in acceleration, deceleration, and steady state regimes of the car-following scenarios. Another unique feature of the model is that it explicitly considers information on the back vehicle. The model is calibrated and validated using vehicle tracking database. The driver reaction-time models and other kinematics constraints were integrated to develop a driver-sensitive rear-end collision warning algorithm (RECWA).

The developed car-following model is used to evaluate and validate the performance of the proposed RECWA. The results show that the proposed

RECWA is functioning properly and producing reliable results. With further research and development, the proposed algorithm can be integrated into driving simulators or real vehicles to further evaluate and examine its benefits.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

A rear-end collision occurs when a following vehicle collides with a leading vehicle travelling in the same lane. In 2007, rear-end collisions accounted for approximately 30% of all reported collisions in the US (NHTSA 2007). Safe driving requires a careful scanning of the environment and responding properly to the actions of the lead vehicle. Driving errors contribute to the collisions that result in the loss of precious human lives and costly property damage to society. Several driver performance factors may contribute to rear-end collisions, such as inappropriate driver reaction time, following too closely, and driver inattention (Brown et al. 2001). Roadway safety can be enhanced by overcoming drivers' errors with the aid of rear-end collision warning systems (RECWSs). Based on the nature of their design, these systems can be classified as kinematics-based and perceptual-based RECWSs. The kinematics-based RECWSs use the basic laws of motion and assumed driver reaction time to trigger the warnings. These systems trigger the warnings when the following vehicle is within the specified minimum stopping distance. The perceptual-based RECWSs trigger the warnings using an assumed driver reaction time and a time-to-collision (*TTC*) threshold.

The warning algorithm is an important component of these systems. A poorly designed algorithm initiates the warning either too early or too late, which undermines the reliability of these algorithms. Brown et al. (2001) have identified

that the driver reaction time has important impact on algorithm performance. Driver reaction time can vary with individual driver characteristics such as age and gender and driving situations such as driving speed and spacing between the following and lead vehicles. Based on the assumption of an assumed driver reaction time, the warning initiated by a rear-end collision warning algorithm could be an early or a late warning for different drivers under different driving situations. The warnings should also not be issued if it is determined that the driver is aware of the situation and responding properly to the actions of the lead vehicle. If the warnings are issued regardless of the awareness of the driver then these warnings are called nuisance warnings and undermine the reliability of a collision warning system.

Traffic engineers and transport professionals use microscopic traffic simulation tools to evaluate traffic operational problems and intelligent transportation system (ITS) applications. The ITS systems include collision warning systems, adaptive traffic management, traveler information, and incident management systems. These systems are difficult to evaluate using analytical tools due to the complex system dynamics involved in these applications. In a traffic simulation tool, different scenarios can be generated with varied roadway geometric and different traffic data and traffic problems can be evaluated without disrupting traffic conditions on the road. Traffic simulation tools are composed of several driver behaviour models including car-following, lane changing, and travel route choice. In particular, car-following models have significant impact on the accuracy of the traffic simulation tools in replicating traffic behaviour on the

road (Sakda and Hussein 2005). A car-following model simulates the driver behaviour in a car-following scenario. A rear-end collision also occurs in a car-following situation. Therefore a car-following simulation model is very useful to evaluate a rear-end collision warning algorithm.

Design of a rear-end collision warning algorithm involves several factors that include driver and situational factors such as driver reaction time, speed of the following and lead vehicles, spacing between the following and lead vehicles, and acceleration/deceleration rate of the following vehicle. The warning criterion determines the moment when it is unsafe for a following vehicle driver to continue travelling at the same driving speed. The existing rear-end collision warning algorithms do not consider driver characteristics and also produce early or late warnings which affect their usefulness. The existing car-following simulation models which are used to evaluate the performance of the rear-end collision warning algorithms also do not consider driver characteristics in the modelling of driver behaviour.

1.1.1 Research Summary

A human factors study is conducted to determine the effect of driver and situation factors on driver reaction time in car-following scenarios. The driver factors include age, gender, driving experience, and driving intensity (average driving hours per week). The situational factors include driving speed and spacing between the following and lead vehicles. The car-following scenarios were characterized based on the actions of the lead vehicle such as normal, surprised, and stationary. In these scenarios the following driver follows a lead vehicle

which either decelerates with a normal deceleration rate, or an emergency deceleration rate, or is stationary at some spacing, respectively. These scenarios were tested at different driving speeds (60, 80, and 100 km/h) and spacing (10, 20, 30, and 40 m). Statistical analysis was done to model the driver reaction time in all of the tested car-following scenarios such as normal, surprised, and stationary. These driver reaction-time models include both the driver and situational factors (such age, gender, speed) and the spacing between the following and lead vehicles. The driving experience and driving intensity were not found to be the significant variables. Driver reaction time in an acceleration manoeuvre was also modelled based driver characteristics such as age and gender. A visual signal such as speed limit sign was used to determine the driver reaction time in an acceleration regime.

The developed reaction-time models are used in developing the car-following simulation model and rear-end collision warning algorithm. The driver reaction time used in developing the proposed car-following model and rear-end collision warning algorithm explicitly considers the driver characteristics such as age and gender. The proposed car-following model also addresses some other limitations of the existing car-following models such as consideration of back vehicle and use of different driver reaction times in acceleration and deceleration regimes. The proposed rear-end collision warning algorithm also introduced a risk factor that continuously monitors the actions of the following vehicle driver in response to the actions of the lead vehicle. The risk factor helps to avoid the false alarms which will improve the reliability of the proposed rear-end collision

warning algorithm. The developed car-following simulation model is used to evaluate the performance of the proposed rear-end collision warning algorithm. The results of the application example and sensitivity analysis show that the proposed algorithm is functioning properly.

1.2 Methodology and Scope of the Thesis

The objective of this thesis is to develop a framework for the design of a rear-end collision warning algorithm that incorporates driver characteristics. The framework components include a human factors study to model the driver reaction time in car-following scenarios based on human factors, develop a car-following model and calibrate and validate it with NGSIM individual vehicle tracking data, and develop a rear-end collision warning algorithm and evaluate it with the developed car-following model. A flow chart is developed that describes the overall study methodology and outlines the details of the tasks that were required to conduct this thesis. The flow chart is shown in Fig. 1.1 and the tasks are explained below.

- Development of the methodological framework and identification of the essential framework components: human factors study, car-following model, and rear-end collision warning algorithm.
- Literature review, covering the framework components including human factors study for driver reaction time, car-following logic development, and rear-end collision warning algorithm development. Identifying limitations of

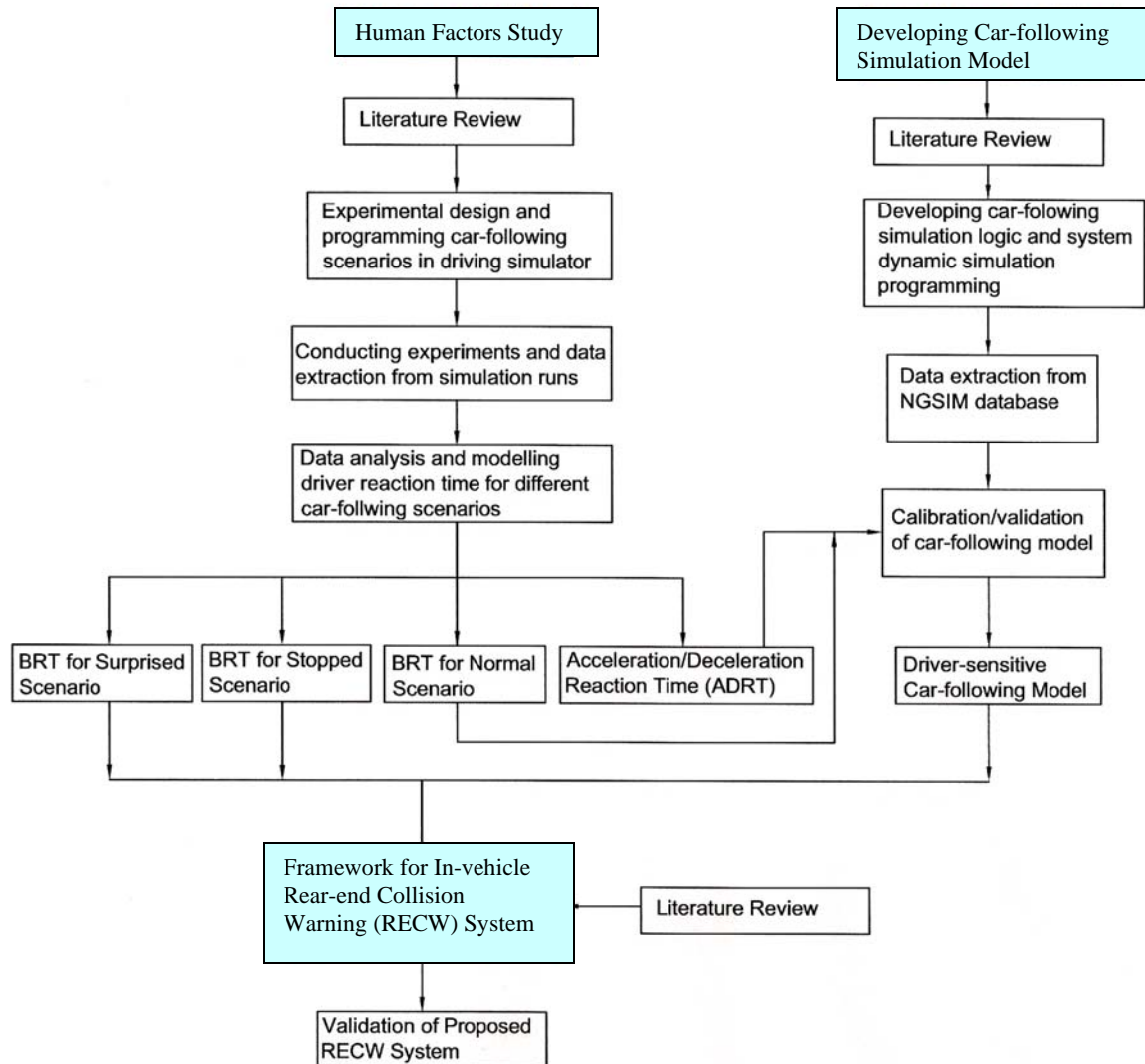


Figure 1.1: Flow chart for thesis methodology

existing driver reaction-time studies, existing car-following models, and existing rear-end collision warning algorithms.

- Design of experiments to study driver reaction time in car-following scenarios.
- Data extraction from the simulator output files, statistical analysis, and modelling of driver reaction time in car-following scenarios.
- Developing a car-following logic for modelling car-following driver behaviour.

- Determination of appropriate variables and data extraction from the NGSIM individual vehicle tracking database to calibrate and validate the proposed car-following model.
- System Dynamics simulation modelling using VENSIM to calibrate the proposed car-following model.
- Calibrate and validate the proposed car-following model with NGSIM individual vehicle tracking data.
- Developing a rear-end collision warning algorithm (logic).
- Integrate the developed car-following model with the proposed rear-end collision warning algorithm to evaluate and validate its performance and present an application example and sensitivity analysis.
- Compilation of the thesis contribution, conclusions, and recommendations.

1.3 Thesis Structure

The thesis structure is organized in the following 8 chapters:

Chapter 1: Introduction

This chapter describes the research background, research summary, research methodology, and scope of the thesis research work.

Chapter 2: Literature Review

This chapter presents the literature review related to framework components: driver reaction time, car-following models, and rear-end collision warning

systems. The limitations identified in the literature review are also discussed for each component of the framework.

Chapter 3: Human Factors and Design of Collision Avoidance Systems

This chapter discusses the fundamental concepts of collision avoidance systems, their types, and the human factors considered in the design of collision warning systems.

Chapter 4: Description of Software

This chapter provides the fundamental concepts and details of the software used in this thesis. This thesis involves the study of human factors and simulation modelling. STISIM, a driving simulator, is used for human factors study. A system analysis method called System Dynamics (SD) is used to develop the car-following model that simulates the individual driver behaviour in a car-following scenario. VENSIM, a System Dynamics computer language, is used to calibrate and validate the proposed car-following model.

Chapter 5: Modelling Driver Reaction Time in Car-following Behaviour Based on Human Factors

This chapter describes the development of driver reaction-time models based on human factors that will be used later for car-following analysis. The reaction time was classified as brake reaction time (BRT) and acceleration/deceleration reaction time (ADRT). The BRT occurs when the lead vehicle is braking and its

brake light is ON, while the ADRT occurs when the driver reacts to adjust his/her speed using the gas pedal only. This chapter evaluates the effect of driver characteristics and traffic kinematic conditions on the driver reaction time in a car-following environment.

Chapter 6: Development of Driver-sensitive Car-following Model

This chapter describes the development of a driver-sensitive car-following model that addresses some limitations of the existing car-following models. The proposed car-following model explicitly considers driver characteristics such as age and gender, and information on the lead and back vehicles in modelling the driver behaviour in a car-following situation. Actual vehicle tracking data obtained from the U.S. Federal Highway Administration were used to calibrate and validate the proposed model.

Chapter 7: Development of In-vehicle Rear-end Collision Warning Algorithm Considering Driver Characteristics

This chapter describes the development of an in-vehicle rear-end collision warning algorithm that considers the driver characteristics and risk factor in the decision rule to initiate the warning to a potential rear-end collision situation. The driver characteristics include age and gender that affect the driver reaction time. The risk factor continuously monitors the driver actions in response to the actions of the lead vehicle. The risk factor is designed to minimize the nuisance

warnings and enhance the reliability of the rear-end collision warning systems (RECWS). The performance of the proposed algorithm is evaluated and validated with the car-following model developed in the previous chapter.

Chapter 8: Conclusions, Contributions, and Future Research

This chapter describes a summary of the thesis contributions, and presents conclusions and suggestions for future research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents the literature review related to framework components: driver reaction time, car-following models, and rear-end collision warning systems. The following sections describe the literature review on each framework component, followed by the description of the limitations identified in the literature review.

2.2 Existing Driver Reaction-time Studies

Before reviewing the literature of driver reaction time it is important to understand the fundamental concepts of driver reaction time. Driver reaction time in response to a sensory signal comprised of two main response components called mental processing time and movement time. *Mental processing time* is the time it takes for the responder to perceive that a signal has occurred and to decide on a response. For example, it is the time required by the driver of the following vehicle to detect that the leading vehicle is decelerating and he/she should apply the brakes at a certain moment. *Movement time* is the time required by the driver of the following vehicle to lift his/her foot from the accelerator and then touch the brake pedal.

The review of existing reaction-time studies were classified based on the factors they have considered while analyzing the driver reaction time. Researchers have identified many factors that influence driver reaction time and divided them into driver and situational factors. The driver factors include driver age, gender, and experience. The situational factors depend on the driving tasks which include expectation, urgency, and cognitive load. Details on driver-specific and situational factors are presented in the following sections.

2.2.1 Driver Factors

Generally, it appears that age slows the driver brake reaction time. Surprisingly, several studies have produced mixed results. Broen and Chiang (1996) found that older drivers react slowly in some cases. But Lerner (1994) found no effect of age on reaction time. Green (2000) identified several reasons for the mixed results: biased sample, old people with better health drive like young people, and experience and more practice which compensate for the slowing of perception or movement time. The perception of urgency may also compensate for the age factor. Young drivers may warrant a low urgency compared to old drivers while facing the same dangerous situation. Aging produces vision loss that results in a slower braking response, particularly at night and in poor weather conditions. Summala and Koivisto (1990) found that older drivers compensate for their poorer braking by driving slower.

The research findings on the effect of gender are also mixed. Some researchers have found faster reaction time for men (Lings 1990) and others found no difference (Hankey 1996). Driving experience has not been explicitly

addressed as a variable in the literature. Summala et al. (1998) measured driving experience by the lifetime mileage driven. The study found no effect of driving experience on the perception of the lead vehicle's braking onset while performing the in-vehicle tasks.

2.2.2 Situational Factors

Expectancy

The terms 'expected' and 'unexpected' are used in the literature to refer, respectively, to drivers alerted and expecting a signal to brake and those that use unexpected signal. Some researchers have used the term 'expected' when drivers are explicitly told that a brake response must be made at a particular stimulus. In a car-following scenario, drivers always expect the normal deceleration rate except when a lead vehicle behaves unexpectedly, such as suddenly braking with a maximum deceleration rate to avoid an unexpected situation ahead. This is also referred to as the expectancy of the car-following driver. The results of the expected reaction time vary significantly in the literature. Some studies reported an expected reaction time in the range of 1.3 to 1.4 s (van Winsum and Brouwer 1997). Other studies reported a range from 1.14 to 1.21 s (Triggs 1987). The third cluster of studies agrees with a value of 0.9 s (Alm and Nilsson 1994). The wide variation in these results is due to the use of different signals and situations for determining the driver reaction time.

Urgency

Urgency is usually defined by the time-to-collision (TTC), where shorter TTC is more urgent and vice versa. The TTC depends on vehicle speed and spacing

(distance headway) and can be manipulated by varying the distance, speed, or both. Chang et al. (1985) found a half-second reduction in the reaction time to a yellow light as speed increased from 25 to 40 mph, but found no further reduction for speeds up to 55 mph. Schweitzer et al. (1995) studied the effect of the speed and following distance on the reaction time and found no effect of speed on the reaction time. However, the authors did not account for the behaviour of the lead vehicle (i.e., expectancy).

Other studies used surprised intrusion paradigms (e.g., intrusion of a policeman) to determine the effect of the TTC on the reaction time. Both studies found totally different results. Summala and Koivisto (1990) concluded that reaction time decreased by almost 1 s as the TTC decreased from 6 s to zero, while Hankey (1996) found that the reaction time increased by 0.4 s as the TTC grew shorter from 4.35 to 2.85 s. Green (2000) stated that these opposing conclusions are likely due to methodological differences. Some studies also found that at very short TTC, drivers prefer the steering manoeuvre rather than braking (Malaterre et al. 1988). Urgency in a car-following scenario cannot be defined by the TTC alone. The behaviour of the lead vehicle is very important, such as braking then accelerating, continuously decelerating, or even becoming stationary.

Cognitive Load

Several researchers found that high cognitive load slows the driver reaction time (Green 2000). Two primary sources of cognitive load are the use of in-vehicle devices and complicated drivers' path such as successive turns in a winding

road. Korteling (1990) and Summala et al. (1998) found slower reaction time when the road has more turns and the drivers viewed in-car displays, respectively. The use of cellular phones also increases the cognitive load. Several studies attempted to determine the effect of cellular phone use on the reaction time. The results showed that cellular phones increased the reaction time by about 0.5 s (Lamble et al. 1999). It is very difficult to calibrate the effect of cognitive load on reaction time since precise tracking of drivers' in-vehicle activities is not possible. For these reasons, the cognitive load is not considered in this study.

2.2.3 Limitation of Existing Reaction-time Studies

1. The existing reaction-time studies were exclusively designed to study the effect of some specific factors alone, such as driver factors (age and gender, etc.) or situation factors (expectancy, urgency, etc.). Some studies ignored the effect of situational factors and some ignored the effect of driver factors.
2. The existing car-following models use the driver reaction time that was based on some previous physiological studies where actual car-following behaviour in different driving situations (lead vehicle stationary or decelerating with normal or emergency deceleration rate) was ignored.
3. The existing reaction-time studies failed to provide reaction-time models that can readily be used in car-following analysis for different driving situations. The studies also failed to identify how various factors affect differently driver reaction time in different driving situations.

4. The existing reaction-time studies assume the same reaction time for both the acceleration and deceleration regimes in a car-following situation.

2.3 Existing Car-following Models

Car-following models describe how two vehicles interact with each other in a traffic stream. Model performance is evaluated based on considering key factors that affect driver behaviour. Researchers have found a number of key factors that influence car-following behaviour. These factors are classified into two categories: individual and situational. The individual factors include age, gender, risk-taking behaviour, vehicle characteristics, and driving skill. The situational factors include time of day, day of week, weather and road conditions, and information of the lead and back vehicles such as speed and spacing.

A number of car-following models have been developed during the past several decades. These models have been grouped into five categories (Brackstone and McDonald 1999): (a) Gazis-Herman-Rothery (GHR) model, (b) collision avoidance (CA) models, (c) linear models, (d) psychophysical models, and (e) fuzzy-logic-based models. Brief descriptions of these categories including the most recent developments are presented here.

The first car-following model was developed at the General Motors Corporation by Gazis et al. (1961) also known as the GM car-following model or the GHR model. This model assumes that the acceleration/deceleration rate of the following vehicle depends on the relative speed and spacing between the

following and leading vehicles, and the speed of the following vehicle at time t , as follows:

$$a_F(t + \Delta t) = \alpha \left[\frac{[V_F(t)]^m}{[X_L(t) - X_F(t)]^l} \right] [V_L(t) - V_F(t)] \quad (2.1)$$

where,

$a_F(t + \Delta t)$ = acceleration/deceleration rate of the following vehicle at time $(t + \Delta t)$,

α , m , and l = calibration parameters,

V_F = velocity of the following vehicle at time t ,

X_F = position of the following vehicle at time t ,

V_L = velocity of the lead vehicle at time t , and

X_L = position of the lead vehicle at time t .

Many studies were conducted for the calibration of the GHR model. Chandler *et al.* (1958) calibrated the parameters using a data sample of 8 drivers who drove a test track for 20-30 minutes. Their initial work was followed by other researchers (Heyes and Ashworth 1972, Aron 1988, Ozaki 1993, Wolshon et al. 2000).

The first collision avoidance (CA) model was developed by Kometani and Sasaki (1959). This model calculates the safe following distance required to avoid the collision with the lead vehicle based on the speeds of the following and leading vehicles and the reaction time of the driver of the following vehicle. The model is expressed as

$$\Delta X(t - \Delta t) = \alpha V_L^2(t - \Delta t) + \beta V_F^2(t) + \beta_1 V_F(t) + b_0 \quad (2.2)$$

In Equation 2.2,

$\Delta X(t - \Delta t)$ = safe following distance for the following vehicle at time $(t - \Delta t)$ (m),

$b_o, \alpha, \beta, \beta_1$ = calibration parameters,

$V_L(t - \Delta t)$ = velocity of the lead vehicle at time $(t - \Delta t)$ (km/h), and

$VF(t)$ = velocity of the following vehicle at time t (km/h).

The model of Eq. 2.2 was improved by Gipps (1981) who introduced the performance limits of the vehicles and drivers for the calculation of the maximum and the minimum acceleration/deceleration rates. These performance limits end up with two constraints: acceleration constraint (assumed to depend on vehicle characteristics and driver comfort) and safety constraint (assumed to depend on the speed of the lead vehicle). Other CA models include the NETSIM and FRESIM models developed by the U.S. Federal Highway Administration (FHWA) and the CARSIM model developed by Benekahal and Treiterer (1988).

The linear model (Helly 1959), which has originated from the GHR model, assumes that the acceleration/deceleration rate of the following vehicle depends on the relative spacing and speed between the following and leading vehicles, desired following distance, speed of the following vehicle, and driver's reaction time. The model is given by

$$a_n(t) = C_1 \Delta v(t - T) + C_2 \{ \Delta x(t - T) - D_n(t) \} \quad (2.3)$$

$$D_n(t) = \alpha + \beta v(t - T) + \gamma a_n(t - T) \quad (2.4)$$

where,

$a_n(t)$ = the acceleration of vehicle n at time t ,

$D_n(t)$ = desired following distance at time t ,

v = speed of vehicle n ,

Δx = relative distance between the vehicles n and $(n-1)$,

Δv = relative speed between the vehicles n and $(n-1)$,

T = driver's reaction time,

$\alpha, \beta, \gamma, C_1$, and C_2 = calibration parameters.

The main difficulty with the linear model is its calibration (Hanken and Rockwell 1967, Roackwell et al. 1968, Aycin and Benekohal 1998). The psychophysical or action-point (AP) models were developed based on the assumption that a driver will perform an action when a threshold of his/her perception-reaction is reached. Michaels (1963) proposed certain thresholds of the relative speed and spacing between the following and the leading vehicles. For example, based on the threshold of the relative speeds, a driver will decelerate until the relative speed between the following and the lead vehicles becomes zero. In a situation when the spacing between the following and leading vehicles is greater than a certain threshold, then the driver of the following vehicle will not react to the actions of the leading vehicle. The first AP model (Wiedemann 1974), incorporated a traffic simulation program, VISSIM, and described the acceleration/deceleration rate of the following vehicle in four different situations: un-influenced driving, closing process, following process, and braking situation. There are certain thresholds and acceleration/deceleration models for each driving situation.

Other examples of action-point models include those developed by Mehmood et al. (2003) and Zhang et al. (1998). Mehmood et al. (2003)

developed the AP model using the System Dynamics approach. The model incorporates the information of the second leading vehicle and has some alertness levels based on the onset of the brake light of the lead vehicle. The thresholds used in AP models vary widely among drivers and hence there is a need to incorporate individual driver characteristics when including driver behaviour in a car-following model.

The first fuzzy-logic model was presented by Kikuchi and Chakroborty (1992). Other models include those by Yikai et al. (1993) and Rekersbrink (1995). The fuzzy-logic-based models were developed based on fuzzy-set theory that describes how adequately a variable fits the description of a term. In these models, driver decisions are determined based on a set of common sense driving rules developed through experience. The driving rules were presented in IF-THEN format and govern the driver's decision for a given driving condition. For example, IF the vehicle separation is 'Close' AND 'Closing' THEN brake.

2.3.1 Limitation of Existing Car-following Models

1. The existing car-following models do not explain the variation of the model parameters in different car-following situations. The model parameters are assumed to represent the driver behaviour of the car-following vehicle in all driving scenarios such as acceleration and deceleration regimes.
2. The existing car-following models assume a driver reaction time that does not consider the driver's individual characteristics such as age and gender.

3. Some existing car-following models assumed shorter reaction time for deceleration regime and others assumed shorter reaction time for acceleration regime. The reaction-time values were just assumed values and had no empirical basis.
4. The fuzzy-logic-based car-following models are difficult to calibrate, which contributes to the lack of their credibility and reliability in practical applications.
5. The existing car-following models assume that the driver of the following vehicle responds only to the actions of the lead vehicle and ignores the actions of the back vehicle.
6. The safety-distance car-following models assume that drivers travel at an assumed safe following distance. For example, the CARSIM car-following model assumes that drivers follow the lead vehicle at a safe distance which is equal to a car length (L) and a buffer space of 10 ft (i.e. $L + 10$). The assumed safe following distance does not represent the following distance that drivers actually maintain in real traffic.

2.4 Existing Rear-end Collision Warning Systems

Earlier rear-end collision warning systems are divided into two types: perceptual-based and kinematics-based systems. A review of these systems is presented next.

2.4.1 Perceptual-based Systems

The success of the perceptual-based systems depends on the right choice of perceptual thresholds used to trigger the warnings. The time-to-collision and time headway are the driver performance measures for which perceptual thresholds are used. The *TTC* is the time a following vehicle would take to collide with the lead vehicle and it is calculated using the relative speed ($V_L - V_F$) and the space headway (Range) between the following and lead vehicles, expressed as a positive value.

$$TTC = \frac{Range}{V_L - V_F} \quad (2.5)$$

When the following and lead vehicles are travelling at similar speeds, time-to-collision approaches infinity, and when the following vehicle is travelling at a slower speed the time-to-collision does not logically exist. Several researchers suggested different *TTC* thresholds for safe and unsafe driving situations. Van der Horst (1991) suggested a time of 4 s to distinguish between the safe and unsafe driving situations. It was also supported by Farber (1991). But Nilsson et al. (1991) suggested that the threshold limit of 4 s is short and not safe. Hogema and Janssen (1996) conducted experiments for vehicles approaching a queue of vehicles and found out the minimum *TTC* of 3.5 s. Hirst and Graham (1997) found that a *TTC* of 3 s could miss the critical situations but this limit reduced the number of false alarms. The deceleration time for the following vehicle might vary at different driving speeds. Therefore, use of a

constant time-to-collision threshold would be inappropriate for unsafe situations at different driving speeds.

Time headway is another perceptual threshold used to trigger the warning. It is defined as the time in seconds and calculated by dividing the space headway, the spacing between the rear bumper of the lead vehicle and the front bumper of the following vehicle, to the velocity of the following vehicle. Wheatley and Hurwitz (2001) used the time headway criterion to trigger the warning in a potential rear-end collision situation.

Time headway (T_H), expressed in seconds, is defined as the spacing between the front bumper of the following vehicle and the rear bumper of the lead vehicle ($Range$), divided by the velocity of the following vehicle (V_H).

$$T_H = \frac{Range}{V_H} \quad (2.6)$$

Time headway is considered to be the available time for the driver of the following vehicle to match the braking profile of the lead vehicle. This algorithm assumes that drivers drive within the constraints of their reaction time. It is also assumed that both the lead and following vehicles are initially travelling at the same speed and, in a braking situation, the following vehicle will perfectly match the braking profile of the lead vehicle.

These assumptions pose limitations for the use of the time headway criterion. It was estimated that in 75% of rear-end collisions, the lead and following vehicles were not travelling in a continuous car-following state before the collision occurred (Horowitz and Dingus 1992). Furthermore, the following

vehicle driver cannot perceive and match perfectly with the braking profile of the lead vehicle. Therefore, the algorithms based on the time headway criterion may not capture all rear-end pre-collision scenarios.

2.4.2 Kinematics-based Systems

The kinematics-based systems trigger the warnings based on kinematic information of the lead and following vehicles, and assumed driver reaction time and maximum deceleration rate for the following vehicle in a potential collision situation. The trigger criterion is the required minimum stopping distance plus a safety margin of 1 or 2 meters.

$$R_w = \frac{V_F^2}{2d_f} + R.T_F V_F + 2 \quad (2.7)$$

where,

R_w = range for the warning,

V_F = speed of the following vehicle,

d_f = deceleration rate of the following vehicle, and

$R.T_F$ = reaction time of the following vehicle driver, and 2 is the safety margin.

These algorithms assume that the deceleration rate of the lead vehicle remains constant until it stops. The most popular kinematics-based RECWS is developed by Burgett et al. (1998). The important parameters associated with the following vehicle are the driver reaction time and the maximum deceleration rate. Richard and Daniel (2001) tested this system and suggested the maximum deceleration rate of 0.75g and the driver reaction time of 1.5 s.

Other kinematics-based systems were developed by Kiefer et al. (1999) and Krishnan et al. (2001). Kiefer et al. (1999) conducted the experiments and developed an algorithm based on the required deceleration rate. In experiments, the drivers were instructed to brake at the last moment in lead vehicle braking or stationary scenarios. It was observed that all drivers responded at relatively same levels of the required deceleration rate. The observed average required deceleration rate was 0.55g. Krishnan et al. (2001) developed a system for the lead vehicle stationary scenario. In case of the warning, it was assumed that the drivers will use the mean deceleration rate of 5.5 m/s^2 . However, vehicle characteristics such as mass of heavy and light vehicles, and driver comfortable deceleration rates were also used to maximize its capability of preventing the collision. The comfortable deceleration rate was modelled based on the current speed of the following vehicle. The mean reaction time was considered as 1.1 s with a standard deviation of 0.305 s, as reported by Olson and Sivak (1986).

Kinematics-based algorithms appear to present a comprehensive approach to trigger the warning by taking into account the dynamics of the lead and following vehicles and an assumed reaction time of the driver of the following vehicle. However, it would be inappropriate to use the same assumed reaction time for different driving situations and drivers of different ages and genders. This may result in an early or late warning that will maximize the number of nuisance alerts and will also undermine the reliability of existing collision warning systems.

2.4.3 Limitation of Existing Rear-end Collision Warning Systems

The limitation of existing rear-end collision warning systems are summarized as:

1. The existing rear-end collision warning systems assume the same driver reaction time for all population of drivers and ignores the individual driver characteristics such as age and gender.
2. The existing rear-end collision warning systems provide early or late warnings that undermine their reliability and credibility.
3. The deceleration for the following vehicle may vary at different speeds. Use of a constant TTC threshold for a collision warning criterion would be inappropriate for unsafe situations at different driving speeds.
4. For the time-headway warning criterion, it is inappropriate to assume that initially both the following and lead vehicles are travelling at the same speed and the following vehicle will perfectly match the braking profile of the lead vehicle.

2.5 Summary

This chapter has presented the literature review related to framework components: driver reaction time, car-following models, and rear-end collision warning systems. Based on the literature review, the limitations related to each framework component are also summarized. The identified limitations will be addressed in the subsequent chapter.

CHAPTER 3

HUMAN FACTORS AND DESIGN OF COLLISION AVOIDANCE SYSTEMS

This chapter discusses the fundamental concepts of collision avoidance systems and human factors consideration in the design of collision warning systems. The first section describes the type of collision avoidance systems and driving errors involved in roadway collisions. The last section describes the human factors and their fundamental requirements in the design of collision warning systems.

3.1 Collision Avoidance Systems

Recent advances in sensor, computer, and digital processing technologies have led to the development of low-cost collision avoidance systems (CAS) that can be used on vehicles to aid the drivers in potential unsafe driving situations. Based on their mechanisms of intervention, CASs can be categorized into three categories. These categories are illustrated in Fig. 2.1. The first category represents the *advisory systems* that apply to potential collision situations, where urgent collision avoidance action is not necessary. The second category represents the *warning systems* that apply to imminent collision situations, where immediate driver action is needed. The third category represents the *automatic control intervention systems* that apply to imminent collision situations, where driver intervention alone is not sufficient (e.g., automatic soft braking, emergency braking, and automatic steering).

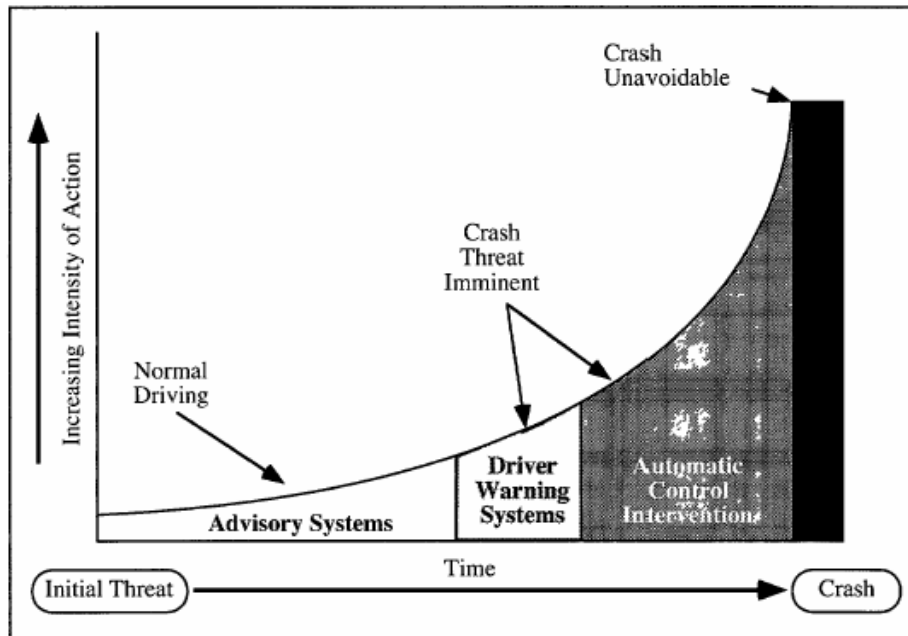


Figure 3.1: Crash Avoidance System Categories (Burgett 1994)

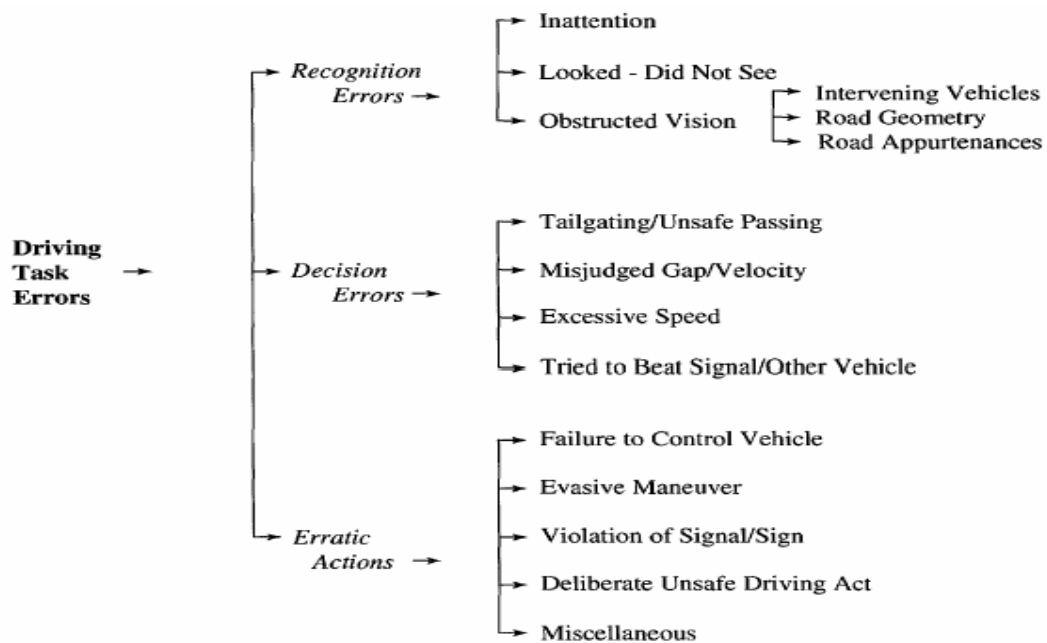


Figure 3.2: Driving Task Errors (Wassim et al. 1995)

It is being identified that driver errors contribute to 93% of all accidents (Treat et al. 1977). The above mentioned different categories of systems are designed to tackle different types of driver errors (Fig. 2.2). It is assumed that driver recognition errors might be remedied by in-vehicle advisory systems which simply indicate the presence of potential hazards via proximal-traffic situation or traffic control advisory displays. Driver warning concepts would incorporate a decision-making capability to compensate for driver decision errors and warn drivers of immediate hazardous situations. Erratic actions might be addressed by control intervention systems that would augment the capabilities of driver warning systems. For instance, crashes caused by unlawful drivers or attributed to unsafe driving acts or vehicle control failure might be mitigated by fully automatic control systems. These three categories of collision avoidance systems, in relation to a rear-end collision avoidance system, are discussed in the following sections.

3.1.1 Driver Advisory Systems

In-vehicle driver advisory systems face design challenges in terms of their effectiveness. These systems must inform the driver of crucial information at critical times without creating a nuisance that result in an in-vehicle distraction. Presence indicators and situation displays are two kinds of advisory systems used in the car-following scenario. Presence indicators would inform drivers of the presence of proximal vehicles in the same lane within a specified range by means of a simple visual or auditory display. Situation displays are more sophisticated than presence indicators, which would render the driver's own vehicle as well as surrounding vehicles within a range. Such displays would

provide drivers with situation awareness information to guide judgments about when to and how to engage in various manoeuvres. Situation displays must not impose *undue workload* on the driver, must be readily available to the driver and be easily checked prior to initiating new vehicle manoeuvres.

3.1.2 Driver Warning Systems

The design of driver warning systems accounts for decision-making algorithms that imply some threshold conditions for a warning. Fixing warning thresholds are problematic and may require driver behaviour studies and driver models to tailor warnings to individual types of drivers (Tijerina et al. 1994). The warning systems will be ineffective if the warnings are delivered too late or too early to the driver. For car-following manoeuvre, the warning systems warn the subject vehicle (SV) drivers via overt/intrusive display warning when it is unsafe to drive at the same kinematics. They also warn the SV drivers to reduce speed if it is excessive. Drivers might react in several ways in response to a warning. Driver warning systems might issue directive warnings so as to tell drivers how to react. Warnings should not induce drivers to make manoeuvres that prompt another crash with a third vehicle. The collision avoidance system might first offer nondirective alarms, followed by directive warnings if time is too short.

3.1.3 Control Intervention Systems

Control intervention systems, either partial or fully automatic, are an alternative or possibly a supplement to collision warning systems and would be activated beyond the point where driver warning alone is likely to be ineffective. Partial

control intervention systems provide some vehicle deceleration or variable resistance to a heading change in the face of a crash hazard, provide additional cues to the driver for crash avoidance, and allow the driver to play a part in the crash avoidance manoeuvre. Examples of such systems might be soft braking or variable resistance steering. Fully automatic control systems are applicable if the time available to avoid a crash dictates that driver time delay is near zero. Concepts of these would involve full automatic braking, automatic steering, and perhaps automatic throttle control. For rear-end crashes, an augment warning is triggered with soft, moderate, or hard braking to stop without driver intervention.

3.2 Human Factors and Design of Collision Warning Systems

During the design process of advanced technologies ranging from advanced collision warning systems (CWS) to comprehensive driver information systems, a careful thought must be given as to how these systems interact with the human driver. Some research work is done in this area but still a lot of work remains to be accomplished. Campbell et al. (1998) identified the human factors research that might be needed to ensure the safe and useful development of collision warning systems. These human factors research needs were developed through a process involving analysis of existing human factors research and system design data sources for ITS devices, and reviews of the research statements developed during the 2-day IVI Human Factors Workshop (ITS America 1997). These human factors research needs are summarized in the following sections.

3.2.1 Baseline Driver Behaviour

During the 2-day IVI Human Factors Workshop (ITS America 1997), a number of research statements focused on the need to characterize baseline driver behaviour and develop driver models for intelligent vehicle initiative (IVI). Currently-available driver models are generally limited to simplistic representations of driver steering and speed control. They do not take into account the probabilistic or variable nature of driving performance and do not include perception and decision-making. Thus, a key need is to develop computational theories and models of driver behaviour and to use these tools to support collision warning system development.

3.2.2 System Standardization and Guidelines

The Human Factors Workshop (ITS America 1997) stated that a successful IVI prototype would require the development of system standards and design guidelines. IVI system designers need assistance and direction in creating complex in-vehicle displays to ensure that the systems are intuitive, useful, and acceptable to drivers. The standards should also ensure that in-vehicle systems are universal across vehicles. Without system uniformity, problems with driver confusion and negative transfer may occur, causing higher accident and fatality rates. The development of standards in other disciplines caused great concern, with some researchers arguing that standards may be developed prematurely, resulting in a poor design. Parkes (1997) argued that standards do not mean mandatory compliance and need to remain specific enough to be useful, but general enough to apply across many systems without restricting design.

3.2.3 Warning Message Modality and Design

Driver messages for a collision warning device may be auditory, visual, tactile, or some combination of these three modalities. Within the driving environment, each of these three modalities is associated with some advantages and disadvantages. The auditory channel can have an advantage over the visual channel due to its attention-getting qualities (McCormick and Sanders 1982). In particular, auditory alerts reduce the visual load on the driver (Wolf 1987) and are well-suited to a collision warning situation in which immediate action is required. However, their attention-getting abilities can become annoying to a driver if the alerts occur frequently or are associated with a high false alarm rate. The auditory displays are frequently disabled by users, apparently because of increase in subjective workload (King and Corso 1993).

Visual alerts are generally less intrusive than auditory alerts and the location of the display in a vehicle can be used as a cue to the direction of the impending collision (e.g., co-located with a side-view mirror). Nonetheless, the visual channel is the more traditional mode for presentation of driving information, and is associated with relatively higher information rates than the auditory channel (Sorkin 1987). Using a visual display to present collision avoidance alerts introduces yet another visual task at precisely the same time that drivers' attention should be external to the vehicle.

Table 3.1: General guidelines for the selection of auditory vs. visual forms of information presentation (Deatherage 1972)

Use auditory presentation if:	Use visual presentation if:
1. The message is simple.	1. The message is complex.
2. The message is short.	2. The message is long.
3. The message will not be referred to later.	3. The message will be referred to later.
4. The message deals with events in time.	4. The message deals with location in space.
5. The message calls for immediate action.	5. The message does not call for immediate action.
6. The visual system of the person is overburdened.	6. The auditory system of the person is overburdened.
7. The receiving location is too bright or dark. Adaptation integrity is necessary.	7. The receiving location is too noisy.
8. The person's job requires him to move about continually.	8. The person's job allows him to remain in one position.

The selection of auditory vs. visual forms of information display should depend on a number of situation-specific variables. Deatherage (1972) developed general guidelines for selecting auditory vs. visual display modalities. These guidelines are presented in Table 3.1. Tactile displays typically provide stimuli in the form of mechanical vibration or electrical impulses (McCormick and Sanders 1982).

Tactile alerts might be transmitted through the seat back, the steering wheel, or even the accelerator pedal. For example, Janssen and Nilsson (1990) conducted a simulator study using an "intelligent gas pedal" that applied a counterforce to the driver's foot as a collision alert. They found that the alert was associated with a reduction in headway on the part of their subject.

3.2.4 Warning Message Timing

Another common issue is the timing of messages, including alerts and warnings. Aside from nuisance alarms, timing of system messages can significantly

contribute to the efficacy of a system. For example, in the case of a rear-end CWS, the driver must confirm with their own eyes that there is a hazard ahead before reacting, so alerts presented very early may go unheeded or cause a distraction at the last moment. All CWSs alerting may share this same trend. Drivers, for the most part, avoid most crashes and do so daily not necessarily in an extreme manner, but in the normal context of traffic interaction.

3.2.5 False Alarms

In collision warning systems two types of false alarms are present. First, a "real" false alarm occurs when a collision alert is presented to the driver in the absence of any crash-relevant obstacle or event. Second, a "nuisance" false alarm occurs under circumstances in which the driver feels that the alert itself, or the urgency associated with the alert, is incorrect or inappropriate. False alarms will reduce the trust and confidence that the driver places in the system, thus reducing system effectiveness. Lee and Moray (1992) identified that users are most reluctant to rely on equipment they do not trust. When trust in the device is too low and an alarm is presented, drivers may spend additional time verifying the problem, thus slowing appropriate collision avoidance actions. Alternatively, they may choose to ignore the alarm, thus completely defeating the purpose of the system.

3.2.6 Driver Reaction Time

A key issue in the development and design of collision warning devices is the perception-reaction times of drivers to warnings and alerts. In the past, several

research studies have been conducted to study this key issue and have reported a wide range of findings. Wortman and Matthias (1983) measured the nighttime braking response times of the drivers to the onset of an amber signal at an intersection and reported mean values ranging from 1.09 to 1.55 s. Chang et al. (1985) conducted a similar study, but in daytime as well and on both dry and wet roadways, and reported mean response times of 1.3 s. Lerner (1993) measured the perception-response times of both younger and older drivers to a simulated on-the-road emergency and reported a mean reaction time of 1.5 s. AASHTO (2004) uses a design reaction time of 2.5 s to determine stopping distance when designing roadway elements such as signs, road curvatures, and traffic signal visibility and timing. Fundamentally, warnings and alerts must be presented early enough in the total time frame of the potential collision event for the driver to perceive and understand the message and to take appropriate action. Therefore, assumptions made about driver capabilities to perceive and to respond to collision alerts affect virtually every design parameter of a collision warning system.

3.2.7 Driver Control Requirements

It is not clear which alert and warning parameters should be adjustable by the driver. Options for driver control include turning the system on and off, switching between alert modalities (e.g., auditory vs. visual presentation of alerts), modifying the intensity of the alert (e.g., loudness or brightness), and adjusting the sensitivity of the system and timing of alerts. For example, in order to better reflect their own driving styles and prevailing driving conditions, drivers may want

to adjust the distance setting or time-to-collision parameter of a collision warning system. Such an adjustment would have the practical consequence of allowing drivers to select either a more or less conservative timing logic for the system, thus changing the timing of alert presentation in response to a potentially unsafe driving condition. Such a control function might increase user acceptance of the system and reduce "nuisance" alarms. However, it also increases the likelihood that the alerts will be presented too late for the driver to make an appropriate response within a given collision scenario unless other measures are built into the system.

3.2.8 Older Drivers

Older drivers present a unique problem to the overall development and deployment of a collision warning system. Dingus et al. (1998) cited several sources of literature outlining empirical evidence that older drivers have longer glance times at in-vehicle displays, drive more slowly with more lateral error, have longer reaction times, veer into different lanes when making turns, and were more likely to make navigation errors than younger drivers. Warnes et al. (1993) reported that cognitive and motor impairments characteristic of the older driver population increased during cognitively complex situations. The collision warning systems must be designed to accommodate older driver limitations and needs.

3.2.9 Driver Performance

A successful design of a collision warning system should enhance the drivers' strengths and support their weaknesses in performing the tasks of safe driving. Drivers' situational awareness, workload, attention, and decision-making have all been defined as important to understanding driver performance. Situational awareness has been defined as an awareness of environmental information relevant to successful task performance, the meaning and context of that information, and the predictive future state of these conditions (Ward 1996).

Driver workload is defined as the extent of the resources required for the driving task (Dingus et al. 1998). Measuring driver workload will assist designers in determining what tasks will require excessive attentional resources, resulting in unsafe driving behaviour. The ability to assess driver workload and safe driving vs. driver overload (i.e., too much information) and unsafe driving will be critical to the overall success of collision warning systems. As situational awareness and attention decreases and workload increases, a speed/accuracy trade-off occurs where bad decisions will be made quickly and good decisions will be acted on too late (Campbell et al. 1998). Much more research is needed on these issues in order to create an efficient collision warning system.

CHAPTER 4

DESCRIPTION OF SOFTWARE

This chapter provides the fundamental concepts and details of the software used in this thesis. This thesis involves the study of human factors and simulation modelling. STISIM, a driving simulator, is used for human factors study. A system analysis method called System Dynamics (SD) is used to develop the car-following model that simulates the individual driver behaviour in a car-following scenario. VENSIM, a System Dynamics computer language, is used to calibrate and validate the proposed car-following model.

4.1 STISIM Driving Simulator

STISIM Drive is an interactive driving simulator developed by Systems Technology Inc. It allows the drivers to control all aspects of driving including the steering and vehicle speed. A real car has been integrated to the simulator that includes a steering wheel and brake and gas pedals. The roadway scene is projected on to the wall in front of the driver using a projector. The arrangement of the real car integration with the simulator and the roadway scene projection provides a real-world driving feeling. The arrangement of driving simulator is shown in Fig. 4.1.



Figure 4.1: Driving simulator at Ryerson University

There are four basic components of the STISIM Drive: the graphics environment, the driver controls, the scenario definition language (SDL), and the STISIM Drive software. The graphics environment is comprised of graphics card that generates the images, the display system that displays the images, and the graphic models that are used so that the images can be displayed. The driver controls such as lateral vehicle position, maximum speed, sound effects, etc. can be set using the configuration file of the STISIM Drive software which is installed on a desktop computer. The SDL is used to program the event file which is used to display the roadway features and various events for the driver's view. The event files also define the required output variables that can be collected in an

output file. The details of the event, configuration, and data output files are described in the next sections.

4.1.1 Event File

The event file is used to program the events that need to be displayed in the simulation scenarios. The events are displayed based on the elapsed longitudinal distance travelled along the road. The general format of the event description in the event file is as follows:

ON DISTANCE, EVENT SPACIFIER, PARAMETER 1, PARAMETER 2,...,
PARAMETER N

The *ON DISTANCE* parameter specifies the location of the start of the event based on the elapsed longitudinal distance travelled since the start of the simulation. The *EVENT SPACIFIER* parameter specifies the type of event that need to be displayed such as a tree, building, vertical curve, horizontal curve, same lane or opposing lane vehicles, pedestrian, etc. The PARAMETER 1 ...PARAMETER N parameters are associated with each types of events. For example, the event V will display a vehicle travelling in the same direction of the subject vehicle with PARAMETER 1 =speed of the appearing vehicle, PARAMETER 2 =longitudinal position of the appearing vehicle with respect to the subject vehicle, and PARAMETER 3 =later position of the appearing vehicle with respect to the centre line of the displayed roadway. The total number of individual events that can be displayed in any simulation scenario is limited to 10,000.

4.1.2 Configuration File

The configuration file allows the users to modify and set the simulation properties such as the vehicle properties, maximum speed limit, sound effects, brake control, driving side of the road, and daytime and nighttime driving environment. STISIM Drive has a default configuration file named STISIM.CFG that can be modified based on the user requirements to run the specific simulation scenarios such as the daytime or nighttime simulation scenarios. The configuration file has numerous tabs that can be modified to adjust the simulator characteristics based on the desired driving conditions. For this research experiments, the brake and steering wheel setups were changed by consulting the subject drivers to have a better real-world normal driving feeling. STISIM Drive also has an option of autopilot mode that can be used to drive the simulation scenario without a driver. This option was used to check the program events and adjust their parameters before the commencement of the actual experiments.

4.1.3 Output Data File

The simulation run creates an output file that contains the output data associated with the required output variables. The output data file is stored in the subdirectory specified in the STISIM drive configuration. The output data can be saved in various options depending upon the required output variable. These options include BSAV/ESAV Data Block, Time to Collision, RMSB/RMSE Data Block, Divided Attention Data, Tailgating, Driver Mistakes, etc. Most of the output variables are saved with the BSAV command option. The same command was used to collect the output data in this research study. The ESAV command is

used to tell the program to stop collecting the data. Following is an example of BSAV/ESAV commands.

```
1200,BSAV,1,0.049,REACTION TIME DATA,PARAMETER 1,...,PARAMETER N  
1350, ESAV
```

The above commands tell the program to start collecting the output data at a travel distance of 1200 meters since the start of the simulation, stop collecting the data at the travel distance of 1350 meters and store the data in the output file under the output data block of REACTION TIME DATA. The numbers 1 and 0.049 tell the program that the data should be collected with respect to the elapsed simulation time (seconds) and at an interval of 0.049 s. The *PARAMETER 1* is the type of variable for which the output data will be collected. STISIM Drive has a list of variables with a specific number assigned to each variable. The variable number is used for the PARAMETER 1 in the event file of the simulation program. STISIM Drive automatically formats the output data file into evenly collimated. This helps to import the variables data into other programs such as MS Excel spreadsheets. Once the output data is formatted into spreadsheets it is ready for the analysis. The driver characteristics data of each participant such as age, gender, driving experience, and driving intensity were collected in a questionnaire before the start of the experiments. The same approach was adopted in this research study.

4.2 System Dynamics

System Dynamics (SD) is a computer-based simulation methodology that was invented in the early 1960s at Massachusetts Institute of Technology (MIT). It was invented by combining the ideas from three fields:

- Control engineering, the concepts of feedback and system self-regulation
- Cybernetics, the nature of information and its role in control systems
- Organizational theory, the structure of human organizations and the forms of human decision-making

Based on the above-mentioned ideas, a guiding philosophy and a set of representational techniques were developed that can be used to simulate the complex, nonlinear, multi-loop feedback systems (Meadows 1980). Initially, SD was applied to analyze industrial and management problems, but gradually its application has been broadened to assess the behavioural characteristics of a number of complex systems including social, economic, engineering, physical, biological, and ecological (Drew 1995). In SD there are three fundamental principles which are used to organize the available information into computer simulation models. These principles are:

- Cause-effect relationships
- Feedback loops
- Delay

4.2.1 Cause-effect Relationships

Cause-effect relationships represent the interaction of variables that drive the behaviour of a system. For example, a cause-effect relationship between the two variables (A and B) represents how a change in variable A will affect the variable B . A change in variable A may cause a positive or negative impact on variable B such as increase in price will reduce the sale of a product or increase in age of a driver will increase his/her reaction time. The description of many underlying factors and their interrelationships forms a System Dynamics model. A few examples of cause-effect relationships are shown in Fig. 4.2.

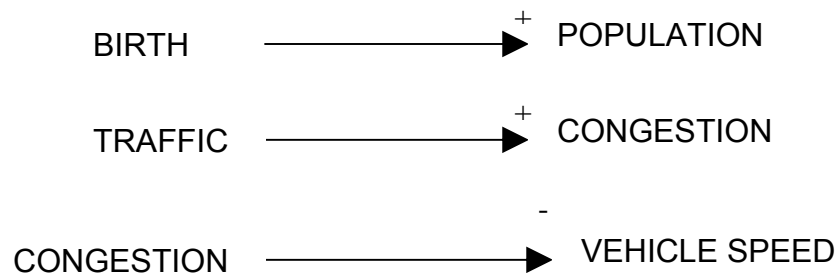


Figure 4.2: Cause-effect relationships

4.2.2 Feedback Loops

Many of the cause-effect relationships feed back upon themselves and form a closed feedback loop. Feedback refers to a situation of a variable A affecting a variable B and variable B in turn affecting A either directly or through a chain of causes and effects. A feedback can be a positive or negative feedback. Feedback is positive if an increase in a variable leads to a further increase in the same variable. Feedback is negative if an increase in a variable leads to a decrease in the same variable.

4.2.3 Delay

System Dynamics modelling also incorporates the time delay for the action of some variables. Sometimes the consequences of an action or decision-making time delay the action of an event. For example, construction of a new road or increasing the capacity of a road will take some time to attract more traffic. On the other hand, the capacity cannot be increased instantaneously since it requires a planning and construction time.

4.2.4 System Dynamics Modelling Variables

The variables in the simulation model are expressed by stocks or levels, flows or rates, and converters or auxiliaries. All variables in the model are connected by the connectors, an arrow that carries information from one variable to another. Levels or stocks are used to represent anything that accumulates over time and flows or rates are used to represent any activity or action. For example, one can consider the level as a bathtub and the rate as the pipe that fills or drains the bathtub. The bathtub holds the water but the pipe either fills or drains the bathtub at a specific rate or volume of water per unit of time. In a car-following model, spacing between the following and lead vehicles is a level that depends on the change in spacing (rate) due to the following and lead vehicle speeds. The input variables can be expressed by auxiliaries that remain constant during the simulation time.

4.2.5 Vensim Functions

Vensim provides an interactive graphical environment that enables modelling, simulating, and analyzing dynamic problems. It allows continuous interactions among many variables and numerous cause-and-effect relationships involved in the simulation model. The simulation blocks consist of a set of equations and functions that define a relationship between the input and output variables that vary over simulation time. The simulation model output is obtained over the simulation time and at each simulation time step. The time step and simulation start and end times are defined by the users at the start of the simulation run (Fig. 4.3).

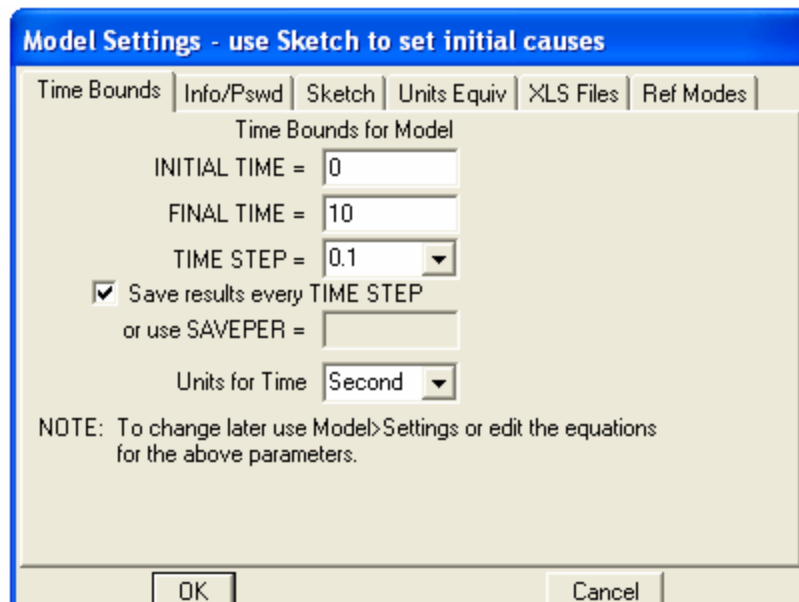


Figure 4.3 Simulation time setting

There are several functions available in the simulation environment that facilitate the development of the simulation logic (Fig. 4.4). A few functions such as “IF THEN ELSE” and “Lookup” are described as follows:

IF THEN ELSE (cond, tval, fval), returns first value (tval) if condition (cond) is true or second value (fval) if condition is false.

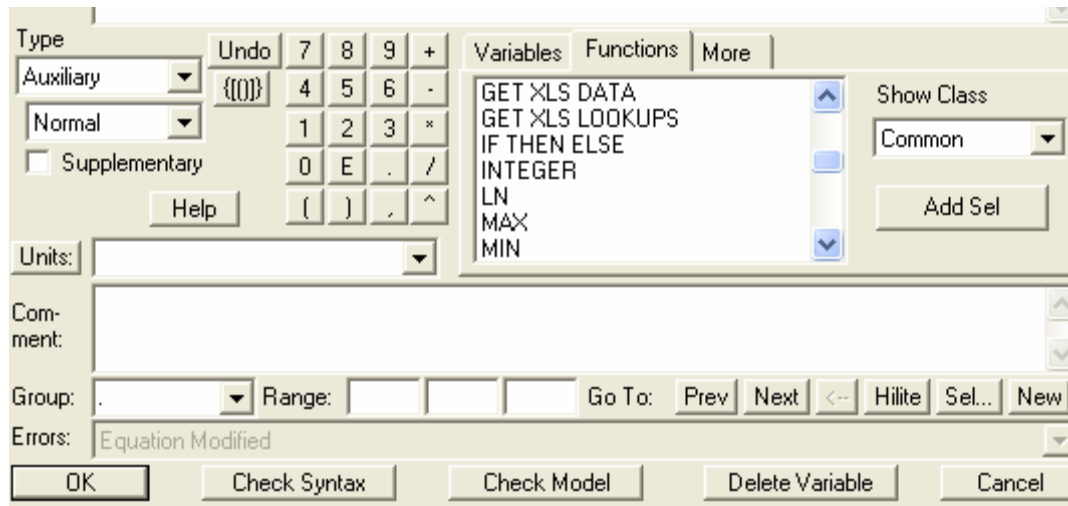


Figure 4.4 Vensim simulation functions

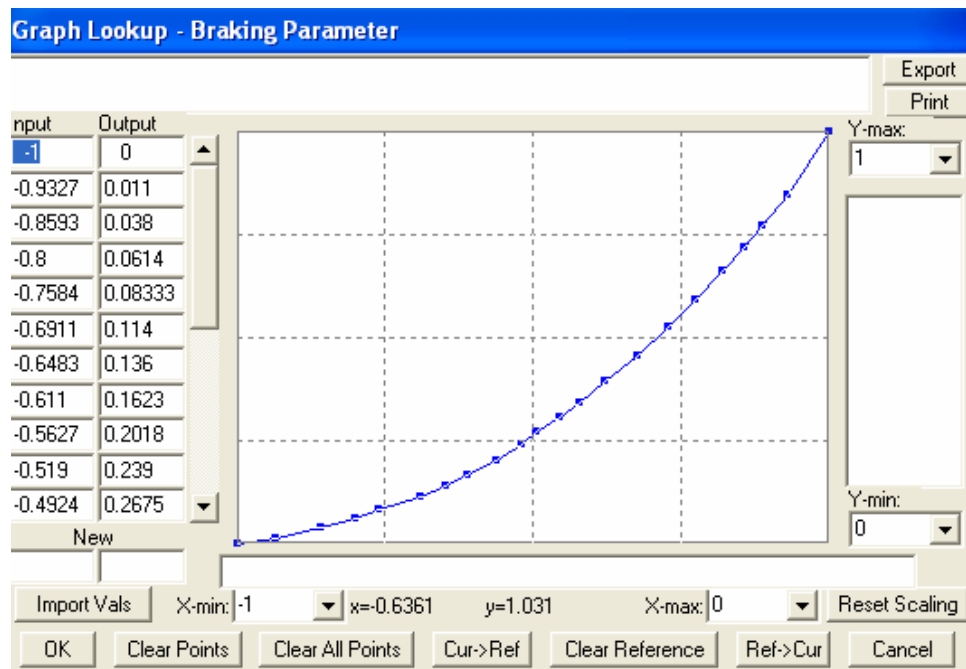


Figure 4.5 Vensim lookup function

In addition to the predefined functions, one can specify an arbitrary linear or nonlinear relationship with a “Lookup” function. A “Lookup” function can be defined with a list of numbers representing an x axis and a y axis (Fig. 4.5). The inputs to the “Lookup” are positioned relative to the x axis, and the output is read from the y axis. The specialized functions created by the “Lookups” are very useful to test the behaviour of a model via simulation runs.

4.2.6 Rationale for Using System Dynamics

There are numerous reasons that provide the rationale why System Dynamics (SD) was chosen to model the driver behaviour in this thesis.

1. Modelling driver behaviour is a complex problem which involves numerous cause-effect relationships that change over time. Analyzing such a complex problem requires a modelling approach that can understand the cause-effect relationships involving many variables that change over time.
2. SD simulation is a computational platform which is flexible, robust, and transparent and has been successfully used in the past to describe and analyze complex interrelated systems or processes, including those involving human behaviour (Sterman 2000).
3. SD simulation describes the structure of a model that helps to identify the key factors and improves the understanding of how a system changes over time (Saeed 1994).
4. SD has a broad database containing both qualitative and quantitative information that can easily be used in determining the structure and parameter values of a model (Graham 1980). The qualitative information

refers to the descriptive information (graphical), while the quantitative information refers to the numerical observed field data.

5. The computer languages used to implement System Dynamic models are STELLA/IThink, DYNAMO, POWERSIM, and VENSIM. These computer languages provide a graphical modelling environment and have user-friendly tools that allow detailed examination of complex models and their outputs. These computer languages simulate the equations and variables of a model and produce the output tables and plots (Roberts 1996). In this thesis, VENSIM was used in the modelling of the driver behaviour in a car-following scenario.

CHAPTER 5

MODELLING DRIVER REACTION TIME IN CAR-FOLLOWING BEHAVIOUR BASED ON HUMAN FACTORS

This chapter describes the development of driver reaction-time models based on human factors that will be used later for car-following analysis. The reaction time was classified as brake reaction time (BRT) and acceleration/deceleration reaction time (ADRT). The BRT occurs when the lead vehicle is braking and its brake light is ON, while the ADRT occurs when the driver reacts to adjust his/her speed using the gas pedal only. This chapter evaluates the effect of driver characteristics and traffic kinematic conditions on the driver reaction time in a car-following environment.

5.1 Introduction

Car-following behaviour is an essential component of rear-end collision avoidance algorithms and microscopic traffic simulation models. The most important parameter used in the calibration of car-following models is driver brake reaction time (BRT) which has been examined in a number of studies. The brake reaction time in response to braking of the lead vehicle definitively differs from the reaction to an obstacle on the road or from the reaction to a crossing vehicle at an intersection (Summala 2000, Ma and Andréasson 2006). In psychological studies, the driver's reaction process is further represented in three states: mental processing, movement, and device response. Driver reaction time is defined in earlier car-following research as the sum of the perception time and

the foot movement time (Ma and Andréasson 2006). The reaction time depends on the driving task and individual driver characteristics. The driving tasks include car-following, lane-change, left-turn, and right-turn tasks.

The reaction time during the car-following task is the time lag that the follower uses to react to the change in the leader's driving behaviour. The driver reaction time in a car-following scenario can also be defined as the reaction time during the acceleration and deceleration manoeuvres. In the case of acceleration/deceleration manoeuvres, the car-following driver will accelerate or decelerate to sustain the desired speed for the given kinematic conditions. The desired speed is defined as the maximum speed at which the following vehicle driver would travel based on the given kinematic conditions. This speed can also be influenced by the speed limit and other factors such as weather conditions and visibility. The car-following driver reacts to adjust his/her speed by using the gas pedal only or by using the brake pedal in the case when the lead vehicle is braking and its brake light is on.

The term acceleration/deceleration reaction time (ADRT) is used when the driver reacts to adjust his/her speed by only using the gas pedal. In this study, the ADRT is defined as the time difference between the moment the driver receives the visual signal to adjust his/her speed and the moment he/she starts to adjust the gas input. The term brake reaction time (BRT) is used when the driver reacts to brake in response to the lead vehicle's braking. The BRT is defined as the time difference between the moment the driver receives the lead vehicle brake light signal and the moment he/she touches the brake pedal.

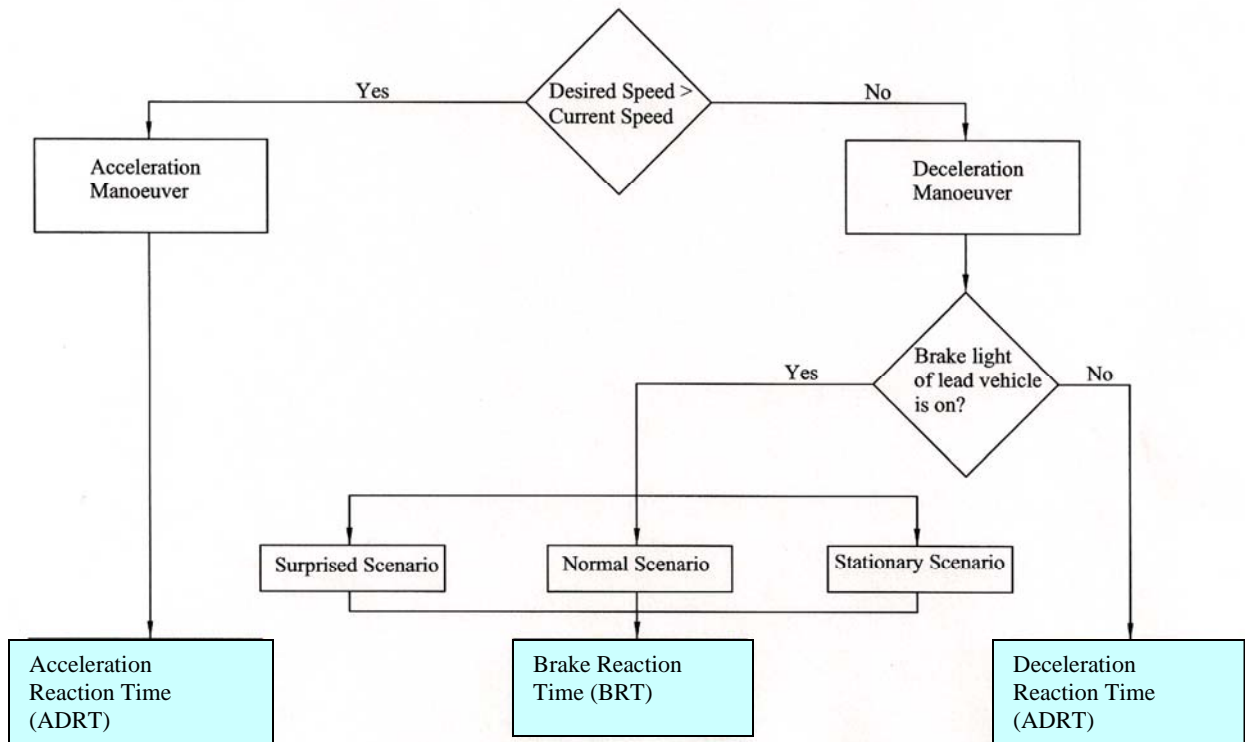


Figure 5.1: Logic of car-following manoeuvres and reaction times

The following vehicle driver can also face a forward collision situation because of a surprised behaviour of the lead vehicle such as when it applies emergency braking or stops at short distance headway. Fig. 5.1 illustrates the car-following logic that includes the different manoeuvres and the respective reaction times. As noted, the BRT and ADRT are essential components of this logic.

Various organizations have established some standards for BRT such as 2.5 s in the United States and 2 s in Europe, but these values have been criticized by many researchers (Green 2000). The author also stated that several studies have recommended BRT values that differ by a factor of almost 4. The variation of the results is due to the use of different signals, responses, and testing situations. Therefore, the use of these values for modelling car-following

behaviour is questionable. Previous studies have focused only on specific factors, but a reaction time study should examine all the factors including driver-specific and situational factors. However, placing drivers in surprised (emergency) or even urgent situations and measuring the perception and movement times is not easy in real road experiments. It is also very challenging to design a scenario that can account for all the factors at the same time.

This chapter overcomes these challenges by modelling such car-following scenarios based on data obtained from a driving simulator. The objective of the study is to determine typical reaction times under car-following environment for different driving conditions and driver characteristics. The main tasks of this chapter are: (1) to design car-following scenarios for different driving conditions at different speeds and spacing, (2) to conduct driving simulator experiments, and (3) to analyze the variables to obtain some insight into their effects on the driver reaction time, and (4) to develop analytical models for the BRT and ADRT. Before describing these tasks, it is useful to present first the mathematical car-following model that will be used later for calibration and validation using real-world vehicle tracking data.

5.2 Mathematical Car-following Model

Various theories have been developed to express the traffic flow process. These theories model the driver behaviour in different traffic flow situations. One class of such theories that attempt to describe the car-following behaviour is called car-following theories. The car-following theories are based on the follow-the-leader

concept and the rules of how a driver follows his/her immediate leading vehicle are established based on both experimental observations and theoretical concepts such as psychological considerations. Background of such theories can be found in detail in Brackstone and McDonald (1999) and elsewhere in the literature. Based on these theories, researchers developed many car-following models that represent the driver's car-following behaviour. These models predict the speed or acceleration/deceleration rate of the following vehicle at each time step during a continuous traffic flow. The simplified formulation of the car-following model (Mehmood et al. 2003) is as follows:

$$a^F(t) = \left[\frac{VD^F(t) - V^F(t)}{T^F(t)} \right] \times 0.278 \quad (5.1)$$

where,

$a^F(t)$ = acceleration/deceleration rate of the following vehicle at time t (m/s^2),

$VD^F(t)$ = desired speed of the following vehicle at time t in both steady and non-steady state conditions (km/h),

$V^F(t)$ = current speed of the following vehicle at time t (km/h),

$T^F(t)$ = reaction time of the following vehicle driver at time t (s), and

0.278 = unit conversion factor, for converting speed in km/h to m/s .

The following vehicle drivers drive in three regimes: coasting, accelerating, and decelerating. The following driver responds to the lead vehicle's deceleration

and acceleration manoeuvres. It is assumed that the decelerating regime is divided into two scenarios: when the brake light of the lead vehicle is ON, the following vehicle driver will apply brakes, otherwise he/she will adjust the speed using only the gas pedal by decreasing the gas or throttle input. It is also assumed that while coasting, if the following vehicle driver wishes to accelerate (the accelerating regime), he/she will increase the speed by increasing the gas or throttle input. In this experimental study, the following vehicle driver's reaction time is modelled during the accelerating and decelerating regimes. As mentioned previously, the reaction times in accelerating and decelerating regimes were further classified as the reaction time (ADRT) in accelerating or decelerating regimes using only the gas pedal and the reaction time (BRT) in decelerating regime using the brake pedal. Using these reaction times in Eq. (5.1) modifies the equation as follows:

$$a^F(t) = \left[\frac{VD^F(t) - V^F(t)}{ADRT(t)} \right] \times 0.278 \quad (5.2)$$

$$a^{Fd}(t) = \left[\frac{VD^F(t) - V^F(t)}{BRT(t)} \right] \times 0.278 \quad (5.3)$$

where,

$a^{Fd}(t)$ = deceleration rate of the following vehicle at time t in decelerating regime using only the brake pedal (m/s^2),

$ADRT(t)$ = reaction time of the following vehicle driver at time t in accelerating or decelerating regimes using only the gas pedal (s),

BRT(t) = reaction time of the following vehicle driver at time t in decelerating regime using only the brake pedal (s) and

0.278 = unit conversion factor, for converting speed in km/h to m/s.

5.3 Experimental Program

5.3.1 Participants and Apparatus

Sixty subjects participated in the experiment (31 males and 29 females), aged 18-70 years. To account for the variability among the driver population, the distribution of age and gender in the selected sample of the tested drivers was selected to be the same distribution of the driver population in Canada (Transport Canada 2006). The drivers were distributed in three age groups, 18-24, 25-54, and 55+ years, where the number of drivers was 8, 35, and 17, respectively. The sample breakdown is given in Table 5.1.

Table 5.1: Sample breakdown of participants

Gender	Age Group and Number of Drivers					
	18-24 years		25-54 years		55+ years	
	Number	%	Number	%	Number	%
Female	4	12.8	17	59.9	8	27.3
Male	4	13.0	18	57.9	9	29.1

The participants were tested using STISIM: a high fidelity, interactive driving simulator that offered a 45 degree horizontal field of view and integrated in a real car equipped with steering, brake, accelerator, and automatic transmission control. The display system used Epson EMP-S3 LCD projector that focused the moving images on a projection screen. The participants sat in the car which was located in front of the projection screen. The vehicle speed (km/h) was displayed on the front screen. Before the start of the experiment, each participant was given instructions regarding the experiment. The participants also signed the consent agreement and provided the information regarding their age, gender, driving experience, and driving intensity. The copies of consent agreement and driver information sheet are given in Appendix A.

5.3.2 Brake Reaction-time Data

To replicate the driver behaviour in the car-following scenario, three driving conditions were tested at different spacing and driving speeds. These conditions are categorized as normal, surprised, and stationary based on the driving behaviour of the lead vehicle, also called principle other vehicle (POV). The following vehicle is also referred to as the subject vehicle (SV). The maximum comfortable deceleration rate an individual driver is willing to use in non-emergency situations (normal driving) ranges from 2 to 3.45 m/s² (Xin et al. 2008). However, in an emergency situation, drivers are expected to brake at a deceleration rate ranging from 5 to 8.5 m/s² (Krishnan et al. 2001). The higher deceleration rate of 8.5 m/s² was reported for the new light vehicles.

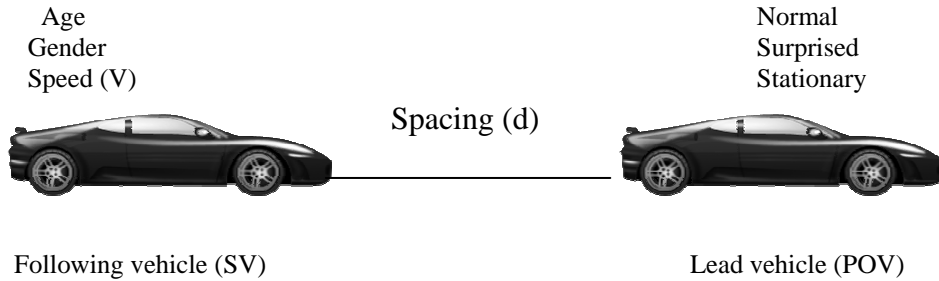


Figure 5.2: Car-following vehicle dynamics

The braking capability of the vehicle decreases with wear and tear. In this study, two deceleration rates of the lead vehicle were selected for normal and surprised situations, as described later. Before the actual experiments, all participants drove a few practice experiments to familiarize themselves with the driving simulator. The simulation runs for normal, surprised, and stationary conditions were chosen at random for each participant. Fig. 5.2 shows the geometry and variables used in the car-following logic.

In all three scenarios, the SV begins to accelerate from the stopped position to the target speed of 60, 80, or 100 km/h. For each run, the drivers are directed to accelerate at the test speed and maintain their speeds until they react in response to the action of the lead vehicle. The SV driver is directed to maintain his/her speed throughout the experiment. At a distance of 1.1 km down the road, the POV appears in the same lane at a certain spacing and speed depending on the type of scenario. In the normal scenario, the POV appears at a spacing of 20, 30, or 40 m and travels at the same speed as the SV. At a distance of 1.2 km the POV decelerates and its brake lights are turned on. The SV driver reacts in response to the braking of the POV. The POV decelerates for a moment and

then starts to travel at the same speed. The average deceleration rate of the POV ranged from 2.5 to 3.5 m/s². This scenario is designed to mimic a normal car-following behaviour at different driving speeds and spacing. The normal car-following behaviour is less likely to contribute to a rear-end collision.

In the surprised scenario, the POV appears at a spacing of 10, 20, or 30 m and travels at the same speed as that of SV. These spacing combinations for the surprised scenario were used since the drivers have difficulty in judging the surprised braking rate at larger spacing. At a distance of 1.2 km the POV decelerates at a very high rate and then stops. This is a surprised driving condition compared to a normal driving behaviour. The average deceleration rate of the POV ranged from 4 to 7.5 m/s². The SV driver reacts by stopping the vehicle to avoid a rear-end collision. In the stationary scenario, the POV is in the stationary condition at different distances from the SV. The POV appears (as stationary vehicle) at a distance of 20, 30, or 40 m. The SV driver brakes to avoid colliding with the stationary vehicle. This scenario also creates a rear-end collision situation at different speeds and spacing. The independent variables included urgency, expectancy, age, gender, and driving experience. Urgency is addressed by varying the speeds of the lead and following vehicles and the spacing between them. The expectancy is addressed by varying the lead vehicle braking behaviour at different traffic kinematic conditions.

5.3.3 Acceleration/Deceleration Reaction-time Data

The urgency and expectancy cannot be used to model the ADRT when the driver wishes to accelerate or decelerate to sustain his/her desired speed. Therefore,

the reaction time was initially collected during the start of the experiment when the driver would accelerate, and represented the acceleration reaction time. The participants were instructed to start the vehicle as soon as they see the start screen. The reaction-time data were collected from the onset of the start of the experiment to the time when the driver presses the gas pedal to start the vehicle. When the driver wants to accelerate while driving at a specific speed he/she will only use the gas pedal. There were 27 runs for each participant for the collection of the BRT data at different speeds, spacing, and situations. In this initial experiment, although the drivers were instructed to start the vehicle immediately when they see the start screen, some drivers had reacted too slowly and some were very fast during the start of the experiment, producing some bias into the data. In addition, the experiment did not provide data related to the deceleration reaction time which the experiment indicated might be different from the acceleration reaction time.

Therefore, another experiment was designed to omit the outliers and check the difference between the reaction times during the acceleration and deceleration tasks, where in the deceleration task the drivers use only the gas pedal. A visual signal was used to instruct the participants that they need to accelerate or decelerate while driving at a specific speed. The speed limit signs were used as a visual signal. These signs appeared at a distance of 40 m from the subject vehicle. Several experiments were run and it was observed that the drivers of each age group can easily read the speed limit signs at a distance of 40 m. The participants were instructed to start the vehicle as soon as they see

the start screen and to accelerate or decelerate at each speed limit sign to follow the displayed speed. The reaction-time data were collected from the onset of visual signal to when the driver uses his/her gas pedal to adjust his/her speed. Three readings were collected, one at the start and two at the speed limit signs. The ADRT data collected in this case were used to omit the outliers of the acceleration reaction-time data collected during the start of the experiments. Twenty-five subjects participated in the additional experiments (16 males and 9 females), aged 18-70 years.

5.4 Data Analysis

5.4.1 Brake Reaction Time

As described previously, the type of scenario (normal, surprised, and stationary) and the speed-distance combinations within each scenario introduce expectancy and urgency. The mean BRT for each scenario for different speed-distance combination is shown in Fig. 5.3. As noted, there is a clear effect of the expectancy and urgency on the brake reaction time. As expected, the BRT decreased with the increase in the level of urgency behaviour of the lead vehicle (normal vs. surprised). The drivers react slowly for normal deceleration compared to the stationary and surprised conditions of the lead vehicle. The drivers also react slowly at larger spacing during the course of each scenario. In other words, the BRT is directly proportional to the available time to collision at the braking onset of the lead vehicle.

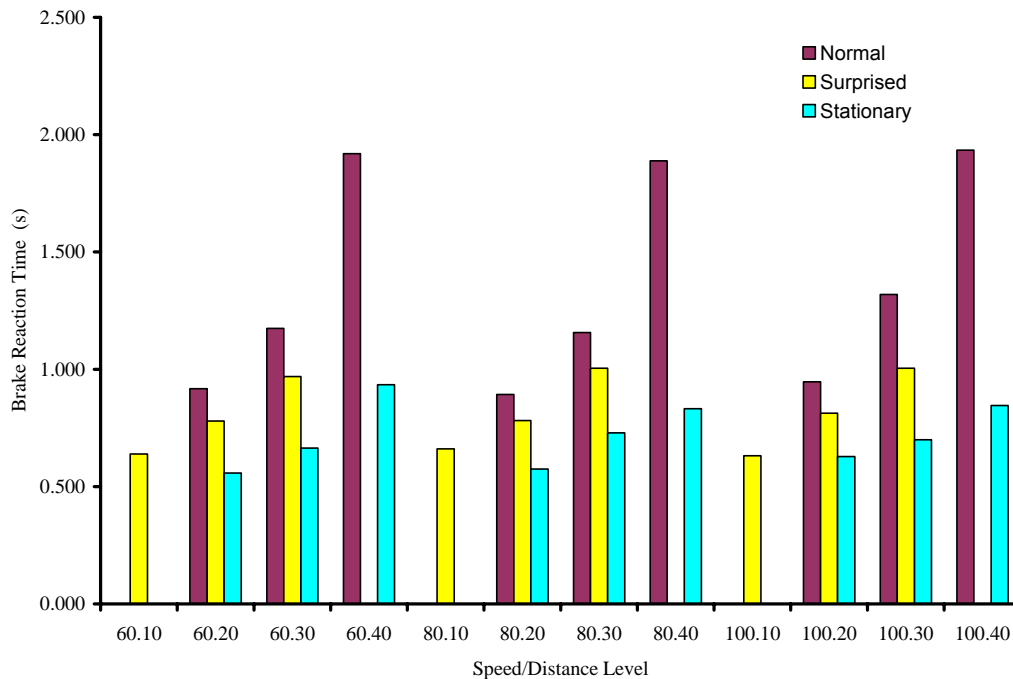


Figure 5.3: Brake reaction time for different speed/distance levels for each scenario

But the BRT also varies for different types of scenarios (normal, surprised, and stationary) at the same spacing and speed. Therefore, the results indicate that the level of expectancy and urgency has a significant effect on the brake reaction time in a car-following scenario.

The brake reaction time as a function of gender, age, driving experience, and driving intensity (driving hours per week) for each type of car-following scenario was analyzed. As an example, the variation of the BRT with gender is shown in Fig. 5.4. The BRT of females was larger than that of males in all scenarios. The BRT also increased for all age groups at normal, surprised, and stationary scenarios. However, there is a slight difference in the BRT for all age groups in all types of scenarios, except the normal scenario in which the middle and old age groups were found to be 0.12 s slower than the young age group.

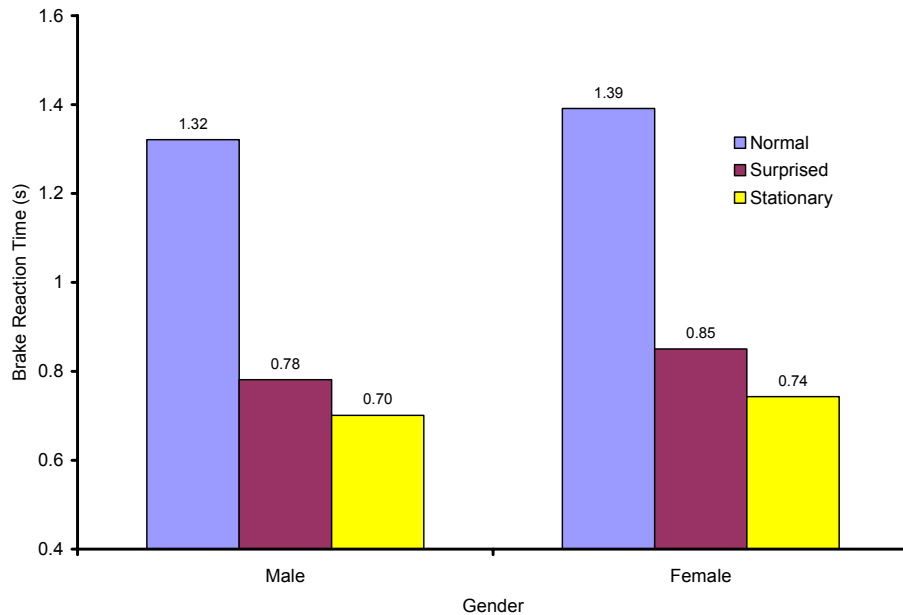


Figure 5.4: Comparison of brake reaction time based on gender

The driving experience and driving intensity have mixed effects on the brake reaction time. The brake reaction time of the fairly experienced drivers is higher than that of the beginners and well-experienced drivers in the normal and stationary scenarios, but smaller in the surprised scenario. The driving experience and driving intensity vary for drivers of different age groups and gender.

The difference between the BRT of stationary and surprised scenarios is smaller compared to that between the normal and the other two types of scenarios (surprised and stationary). The stationary scenario also acts like a surprised scenario since the stopping distance ranged from 20 to 40 m which is a surprised situation especially at higher speeds. However, the stationary scenario introduces more urgency since the lead vehicle is not moving. As expected, the BRT decreased markedly with the unexpected deceleration rates of the lead

vehicle for all variables. In other words, for the normal scenario in which the average deceleration rate of the lead vehicle is of a normal driving situation, drivers react slowly compared to the stationary and surprised scenarios, as expected.

5.4.2 Acceleration/Deceleration Reaction Time

As previously mentioned, the acceleration reaction time data were collected at the start of each simulation run of the BRT experiment and there were 27 simulation runs for each participant. The average of these runs was considered as the acceleration reaction time. The outliers in the first experiment were omitted and the resulting acceleration reaction-time data were analyzed. Based on the data of the second improved experiment, the ranges of the acceleration reaction time for the young, middle, and old age groups were 0.4-1.1 s, 0.6-1.3 s, and 0.6-1.5 s, respectively. For the deceleration reaction time, an independent t-sample test was conducted to identify whether the difference in the means of the acceleration and deceleration reaction times is significant. The null hypothesis that the means are equal was not rejected (Appendix B).

The ADRT as a function of gender, age group, driving experience, and driving intensity was also analyzed, as shown in Figs. 5.5. These driver characteristic are shown in Table 5.2. The ADRT of females was larger than that of males. The ADRT also increased for all age groups of young, middle, and old drivers. The ADRT of the fairly-experienced drivers is higher than that of the beginners and well-experienced drivers.

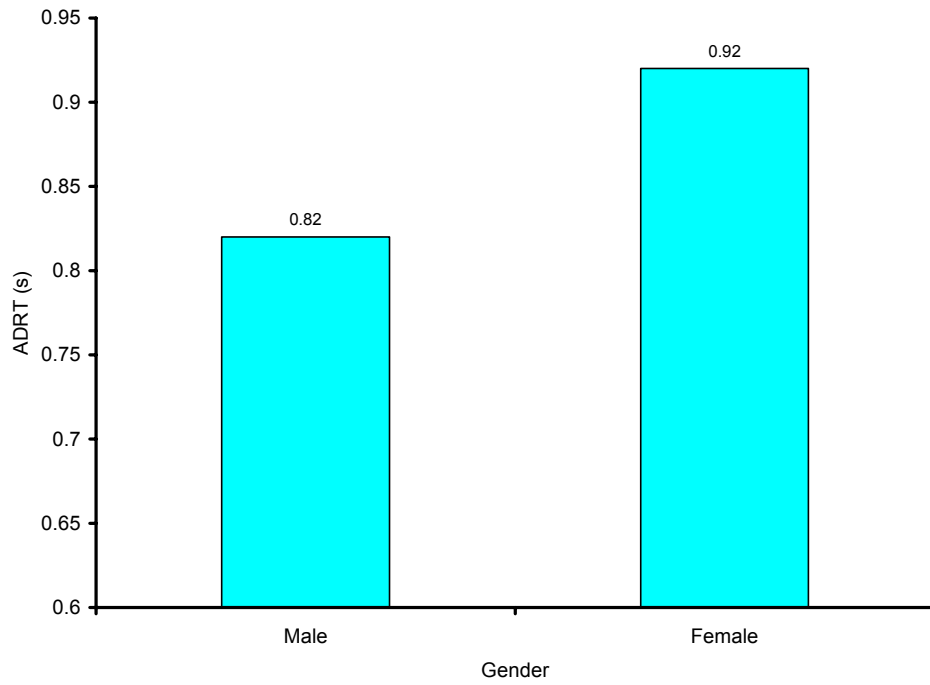


Figure 5.5a: Effect of gender on acceleration/deceleration reaction time

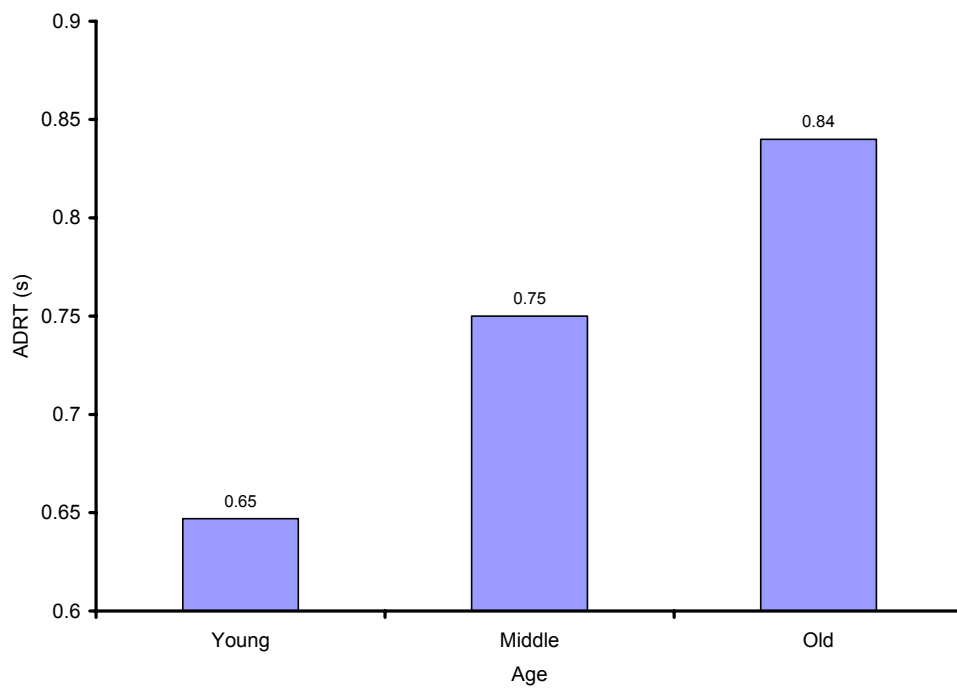


Figure 5.5b: Effect of age on acceleration/deceleration reaction time

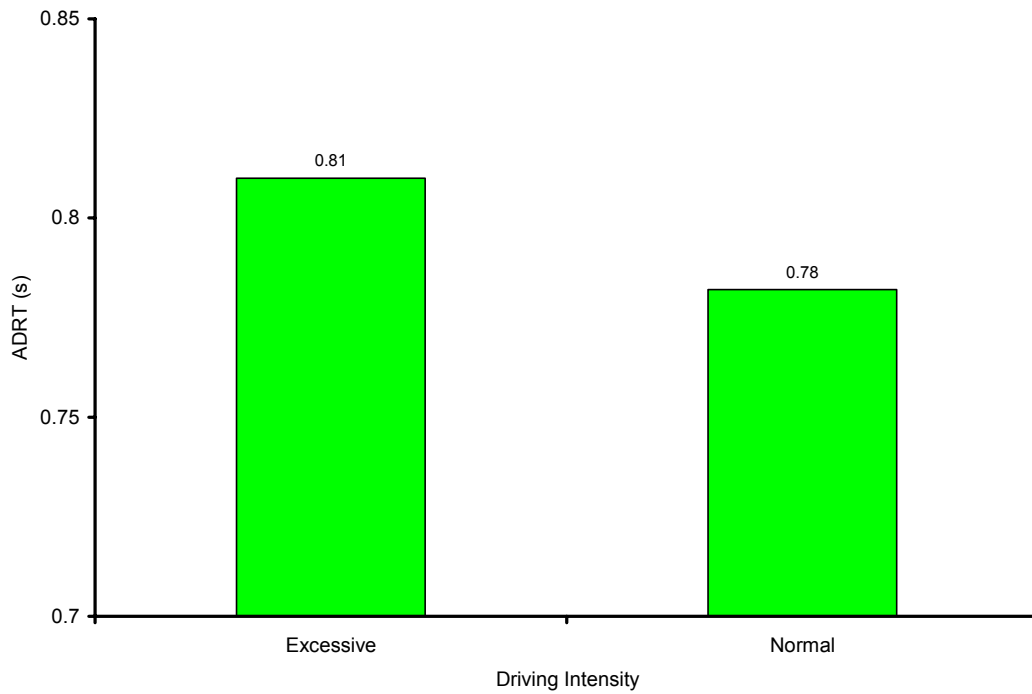


Figure 5.5c: Effect of driving intensity on acceleration/deceleration reaction time

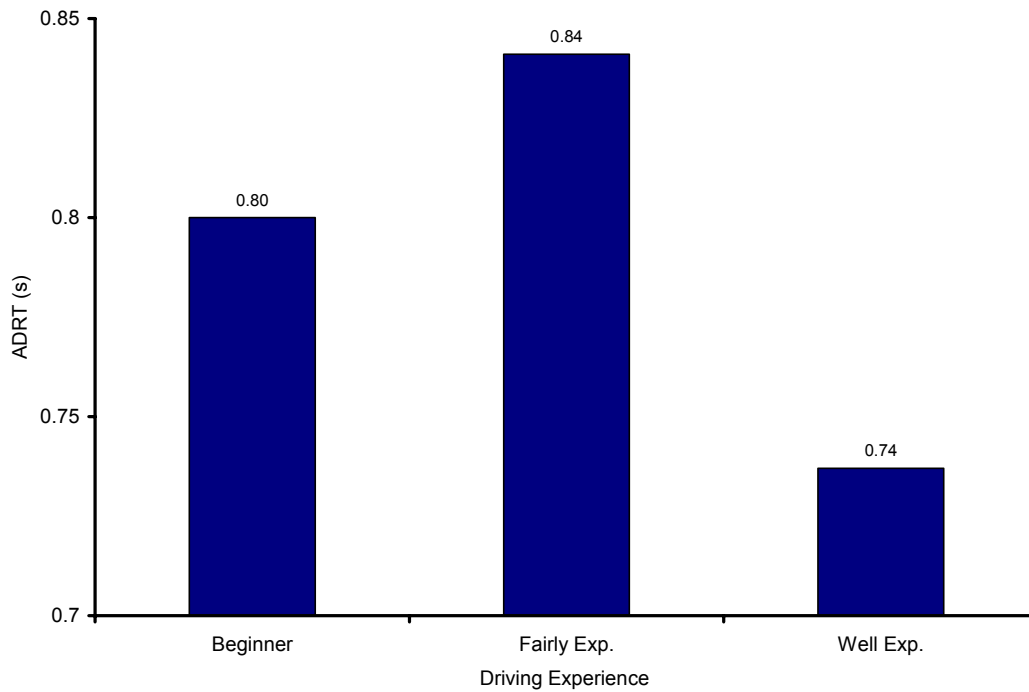


Figure 5.5d: Effect of driving experience on acceleration/deceleration reaction time

5.5 Modelling of Driver Reaction Time

As previously mentioned, the BRT data were collected for three driving conditions: normal, surprised, and stationary. Besides the BRT, the ADRT data were also collected during each simulation run of the experiments. The BRT data were analyzed using a $3 \times 2 \times 3 \times 2 \times 9 \times 3$ repeated measures ANOVA: (a) with age (three levels), gender (two levels), driving experience (three levels), and driving intensity (two levels) as between-subject factors, and (b) with the speed-distance headway combinations (nine levels) and scenario type (three levels) as within-subject factors. The variables and their levels are shown in Tables 5.2 and 5.3.

Table 5.2: Driver and scenario variables and their levels for repeated measures ANOVA

Variable	Level and Range		
	1	2	3
Age (years)	Young 18-24	Middle 25-54	Old 55+
Gender	Male	Female	n.a.
Driving Experience (years)	Beginner 0-5	Fairly experienced 6-20	Well experienced 21+
Driving Intensity (hrs/week)	Normal 0-20	Excessive 21+	n.a.
Scenario Type	Normal	Surprised	Stationary

Table 5.3: Speed and distance headway variables and their levels for repeated measures ANOVA

Variable	Level								
	1	2	3	4	5	6	7	8	9
V (km/h) - d (m) ^a	60-20	60-30	60-40	80-20	80-30	80-40	100-20	100-30	100-40
V (km/h) - d (m) ^b	60-10	60-20	60-30	80-10	80-20	80-30	100-10	100-20	100-30

^a Normal and Stationary scenarios.

^b Surprised scenario.

There was a significant difference in the means of the *BRT* at each level of normal, surprised, and stationary scenarios. Therefore, an independent repeated measures ANOVA was conducted for each scenario. This analysis helps to identify the independent variables that have significant effects on the *BRT* for each driving condition. The analysis revealed that speed, distance headway, age, and gender were significant factors that affect brake reaction time in all scenarios. The results of repeated measure ANOVA analysis for the normal, surprised, and stationary scenarios are given in Appendices C, D, and E, respectively. These analyses also provide the descriptive statistics and graphically representation of driver reaction time for each level of normal, surprised, and stationary scenarios.

Regression analysis was conducted to model the *BRT* for each driving condition. The independent variables were speed, distance headway, driver's age, gender, driving experience, and driving intensity. The repeated measures ANOVA revealed several significant variables that affect the *BRT* at different driving conditions. Several combinations of variables were tested to develop

models for the *BRT* for the three kinematic conditions. The models were developed using SPSS software. For the normal driving condition, three models were developed as follows (Appendix F),

$$BRT_n = 0.025 \text{ Age} + 0.401 \text{ Gender}, (R^2 = 0.78) \text{ (Normal: Model 1)} \quad (5.4)$$

$$BRT_n = 15.16 - 0.09 \exp(-3.63 \text{ Gender}) - 15.87 \exp(0.00003 V) + \exp(0.025 d), (R^2 = 0.66) \text{ (Normal: Model 2)} \quad (5.5)$$

$$BRT_n = 0.078 \text{ Gender} - 0.002 V + 0.049 d, (R^2 = 0.97) \text{ (Normal: Model 3)} \quad (5.6)$$

where,

BRT_n = brake reaction time at normal driving condition (s),

Age = age of the driver of the following vehicle (years),

Gender = gender of the driver of the following vehicle (0 for males and 1 for females),

V = speed of the following vehicle (km/h), and

d = distance headway between the following and lead vehicles (m).

The *Age* variable was significant only in Model 1, while *V* and *d* were significant only in Models 2 and 3. Model 3 is recommended here since it has better goodness of fit ($R^2 = 0.97$) and it also accounts for the speed and distance headway which are important variables in the calibration and validation of the car-following and rear-end collision warning algorithms. As expected, the *BRT* increases with the increase in distance headway and decreases as the speed increases. The positive sign of the *Gender* variable indicates that females are slower than males.

For the surprised and stationary scenarios, the developed BRT models are as follows (Appendices G and H),

$$BRT_{sr} = 0.001 \text{ Age} + 0.109 \text{ Gender} + 0.003 V + 0.023 d, (R^2 = 0.95) \text{ (Surprised: Model 1)} \quad (5.7)$$

$$BRT_{sr} = -5.21 + 4.8 \exp (0.02 \text{ Gender}) - 0.16 \exp (-0.00003 V) \\ + \exp (0.015 d) + 0.000002 \exp (0.136 \text{ Age}), (R^2 = 0.47) \text{ (Surprised: Model 2)} \quad (5.8)$$

$$BRT_{st} = -5.64 + 4.01 \exp (0.005 \text{ Gender}) + \exp (0.001 V) + \exp (0.01 d) \\ + 0.001 \exp (0.056 \text{ Age}), (R^2 = 0.42) \quad \text{(Stationary: Model 1)} \quad (5.9)$$

$$BRT_{st} = 0.002 \text{ Age} + 0.035 \text{ Gender} + 0.001 V + 0.017 d, (R^2 = 0.96) \text{ (Stationary: Model 2)} \quad (5.10)$$

where,

BRT_{sr} and BRT_{st} = brake reaction time for surprised and stationary scenarios (s), respectively.

As noted, the *BRT* increases with the age, speed, and distance headway in both scenarios. The results of regression models (Eqs. 5.7-5.10) suggest that drivers may have difficulty in decision-making in these scenarios (stationary and surprised) that results a slower reaction time with the increase of the driving speed. Please note that the likelihood of a collision was high when these scenarios (stationary and surprised) were tested for higher driving speeds (80, 100 km/h vs. 60 km/h). This also suggests that drivers demand an early collision warning if they are driving at a higher speed compared to a slower driving speed. The females are also slower in both of these scenarios. Model 1 (Eq. 5.7) and Model 2 (Eq. 5.10) are recommended for surprised and stationary scenarios since these models are simpler and have better goodness of fit.

Regression analysis was also conducted to model the acceleration/deceleration reaction time. Only *Age* and *Gender* were found to be significant variables. The developed model for the *ADRT* is as follows (Appendix I),

$$ADRT = 0.017 \text{ Age} + 0.159 \text{ Gender}, \quad (R^2 = 0.79) \quad (5.11)$$

where,

ADRT = acceleration/deceleration reaction time (s).

As noted, the *ADRT* increases with the age and the positive sign of the Gender variable indicates that the females are slower than the males. In estimating the models of Eqs. 5.4-5.11, the driving experience and driving intensity and were not found to be the significant variables.

5.6 Summary

This chapter described the development of driver reaction-time models based on human factors in car-following scenarios. The kinematic conditions introduced urgency and expectancy based on the braking behaviour of the lead vehicle at different speeds and spacing. The kinematic conditions were used for evaluating the *BRT* and are classified as normal, surprised, and stationary. Data were collected on a driving simulator integrated into a real car and included the *BRT* and *ADRT* (as dependent variables) and driver's age, gender, driving experience, driving intensity (driving hours per week), vehicle speed, and spacing (as independent variables). The results showed that there was a significant difference in the *BRT* at normal, surprised, and stationary scenarios and supported the hypothesis that both urgency and expectancy had significant effects on *BRT*. Driver's age, gender, speed, and spacing were found to be significant variables for the *BRT* in all scenarios. The results also showed that driver's age and gender were significant variables for the *ADRT*.

CHAPTER 6

DEVELOPMENT OF DRIVER-SENSITIVE CAR-FOLLOWING MODEL

This chapter describes the development of a driver-sensitive car-following model that addresses some limitations of the existing car-following models. The proposed car-following model explicitly considers driver characteristics such as age and gender and information on the lead and back vehicles in modelling the driver behaviour in a car-following situation. Actual vehicle tracking data obtained from the U.S. Federal Highway Administration were used to calibrate and validate the proposed model. Car-following modeling was only limited to the cars since enough data associated with the trucks were not available.

6.1 Introduction

Car-following models describe how a pair of vehicles interacts with each other in a traffic stream. Model performance is evaluated based on key factors that affect driver behaviour. Researchers have found a number of such factors that influence car-following behaviour. These factors are classified into two categories: individual and situational. The individual factors include age, gender, risk-taking behaviour, vehicle characteristics, and driving skill. The situational factors include time of day, day of week, weather and road conditions, and information on the lead and back vehicles such as speed and spacing.

Over the past 50 years, various car-following models were proposed that attempt to describe the driver car-following behaviour based on the follow-the-

leader concept. The existing car-following models assume that the dominant effect on driver behaviour comes from the next vehicle ahead (also called the lead vehicle). However, when driving in a traffic stream, the vehicle behind the following vehicle (called the back vehicle) somehow also influences driver behaviour in a car-following situation. These car-following models were developed based on various theoretical considerations and experimental observations. These observations include driver reaction time, speed, and spacing.

Existing car-following models also assume that all drivers of different age and gender have the same reaction time. Siuhi and Kaseko (2010) proposed that the driver's response times are lower for the deceleration response than for the acceleration response. The average reaction times for the acceleration and deceleration response were assumed to be 0.8 and 0.7 s, respectively. But in an earlier research, Subramanian (1996) suggested that drivers react faster under acceleration response than deceleration response. Both of these findings were quite different and were not based on some human factors study. The authors conducted a comprehensive driving simulator study (Mehmood and Easa 2009) to identify the effect of human factors and traffic kinematics on driver reaction time in a car-following situation. It was observed that the driver reaction time varies, in both acceleration and deceleration regimes, based on not only kinematic conditions such as speed and spacing but also on individual driver characteristics such as age and gender. There is a need to further develop

existing car-following models to incorporate the effect of the back vehicle and driver characteristics on the car-following behaviour.

In this chapter, the System Dynamics (SD) principles were applied to address the limitations of the existing car-following models. The simulation environment in SD provides a computational platform to simulate and examine complex problems. This platform is characterized by many nonlinear relationships including heuristic and empirical with numerous feedback loops. The primary objective of this chapter is to develop a new car-following model, that is driver-sensitive and accounts for the effects of the back vehicle, and calibrate and validate the model using actual vehicle tracking data.

The chapter is organized into four sections: *Model development* that describes the logic of the proposed car-following model, data collection, and mathematical relationships, *Calibration*, *Validation* of the proposed model and followed by the *Summary* of this chapter.

6.2 Model Development

This section describes the development of a driver-sensitive car-following model. The assumptions and logical framework of the proposed model are first presented, followed by the mathematical equations of the proposed model and the data collection.

6.2.1 Logic of Proposed Model

The car-following situation considered in the proposed model assumes a string of three vehicles: lead vehicle, following vehicle, and back vehicle, all travelling

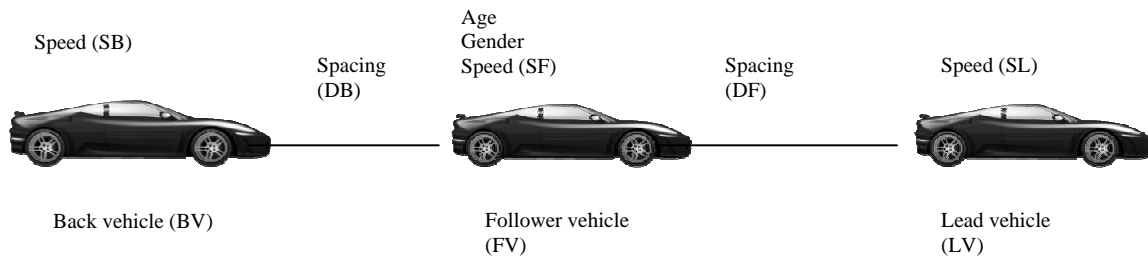


Figure 6.1: Car-following vehicle dynamics

along a single lane (Fig. 6.1). It is assumed that the driver of the following vehicle perceives information either from both the lead and back vehicles or only from the lead vehicle depending on their kinematic conditions such as speed and spacing. The spacing is defined as the longitudinal distance measured from the back bumper of the lead vehicle to the front bumper of the following vehicle.

The three vehicles are assumed to be passenger cars (since data related to other vehicle classes were not available). The driver of the following vehicle is assumed to drive in three regimes: coasting, accelerating, and decelerating. Based on a previous study by the authors (Mehmood and Easa 2009), the driver reaction time in these regimes is considered to be different and depends on the vehicle spacing, speed, and driver characteristics such as age and gender. The reaction time is also different for the cases of deceleration using the gas pedal or using the brake (as a result of the braking of the lead vehicle).

The proposed model predicts the acceleration/deceleration rate of the following vehicle based on the information of the lead and back vehicles and the desired speed and reaction time of the driver of the following vehicle. The desired speed is affected by the acceleration and deceleration parameters and the current spacing between the following and lead vehicles. It is assumed that the

back vehicle only contributes to the acceleration regime when it is approaching a following vehicle with higher speed. The following vehicle can also accelerate based on the desired speed, if it is more than the current speed. The desired speed is defined as the maximum speed at which the driver of the following vehicle would travel based on the given kinematic conditions. The logic of the proposed car-following model is shown in Fig. 6.2 and is highlighted in the following steps (the step number is indicated in the figure):

1. Initially at time t_0 , the current speed of the following vehicle and spacing between the following and the lead vehicles are inputted to the proposed model.
2. The desired speed of the following vehicle is calculated at any time t (Eq. 6.2, shown later).
3. The following vehicle can accelerate or decelerate based on the desired speed at any time t . For the deceleration regime, brake reaction time (Eq. 6.7) is used when the brake of the lead vehicle is ON; otherwise deceleration reaction time (Eq. 6.6) with throttle input is used. For the acceleration regime, the acceleration reaction time (Eq. 6.6) with throttle input is used.
4. The acceleration/deceleration rate of the following vehicle is calculated based on the desired speed, the current speed, and the reaction time values at time t (Eq. 6.1).
5. The acceleration/deceleration rate calculated at time t_0 is used to calculate the current speed of the following vehicle at time $(t_0 + \Delta t)$.

6. The acceleration/deceleration rate at time $(t_0 + \Delta t)$ is calculated based on the desired speed, the current speed, and the reaction-time values at time $(t_0 + \Delta t)$.
7. The speeds of the lead and back vehicles are input into the model which is used to calculate the calibration parameters and the spacings between the following vehicle and both the lead and back vehicles.
8. The age and gender values were the calibration parameters in the calibration process, but for an application these values would be an input based on the statistical distribution of the driver's population.

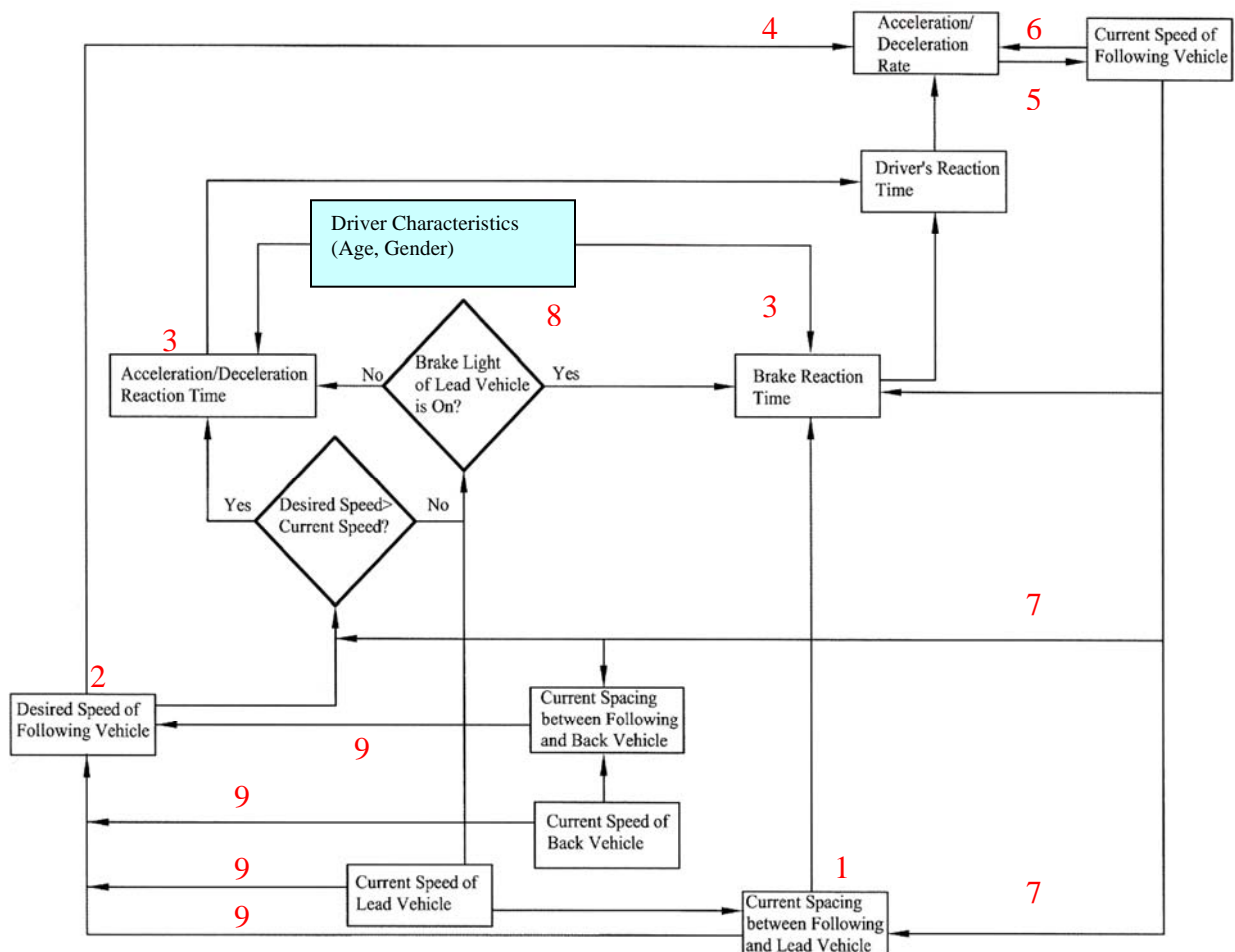


Figure 6.2: Logic of the proposed car-following model

9. Desired speed of the following vehicle is affected by the calibration parameters (b_1 , b_2 , and b_3) based on the car-following acceleration or deceleration regimes. The calibration parameters are defined in Eqs. 6.11, 6.12, and 6.13 that depend on the speed difference between the following and lead or back vehicles and the spacing between them. It should be noted that the lead vehicle is dominant in the deceleration regime and the back vehicle only contributes to the acceleration regime.

More details on the model logic are presented later in the mathematical relationships. The desired speed was calibrated based on the spacing between the following and lead vehicles. The acceleration and deceleration parameters were calibrated based on the inverse-time-to-collision (*INVT*) associated with the lead and back vehicles. The *INVT* associated with the lead vehicle depends on the relative speed and spacing between the following and lead vehicles. Similarly, the *INVT* associated with the back vehicle depends on the relative speed and spacing between the following and back vehicle.

6.2.2 Data Collection

The vehicle trajectory data used for calibration and validation of the proposed car-following model were collected by the US Federal Highway Administration as part of the Next Generation Simulation (NGSIM) program (Hranac et al. 2005). The data were collected between 7:15 a.m and 8:05 a.m on June 15, 2005, using video cameras mounted on a 36-storey building which is located adjacent to the

U.S. Highway 101 and Lankershim Boulevard interchange in the Universal City neighbourhood.

Vehicle trajectory data for a sample of 80 following vehicles were extracted from the NGSIM database. As mentioned earlier, each sample consists of a string of three vehicles, the following, lead, and back vehicles. The Highway Capacity Manual (HCM 2000) suggests a time headway of 3 s as the critical headway to identify whether a vehicle is in a car-following situation or not. Therefore, the time headway for the pair of vehicles constrained was 3 s or less. Motorcycles and trucks were excluded from the data in order to work with more homogeneous vehicle characteristics. These vehicle types represented less than 2% of the total vehicle population. Vehicles that appeared in more than one lane were not considered for car-following analysis. The right-most lanes near the on and off-ramps were also excluded from the data analysis since the vehicles entering and existing the freeway continually disturb the car-following behaviour of other vehicles in this lane.

The variables collected for each subject vehicle include observation time, following vehicle ID, lane number, vehicle speed, vehicle class, vehicle acceleration/deceleration rate, longitudinal position, the lead and back vehicle IDs, and vehicle length, etc. (Tables 6.1a and 6.1b).

Table 6.1a: Sample variables extracted from the NGSIM database (for veh. ID = 116)

Veh ID	Frame ID	Global Time	Local X	Local Y	Global X	Global Y	Veh Length
116	279	1.11885E+12	5.2635912	34.15894	1966322.332	570977.9962	6.5532
116	280	1.11885E+12	5.2763928	35.22696	1966323.049	570977.2064	6.5532
116	281	1.11885E+12	5.2891944	36.29802	1966323.766	570976.4167	6.5532
116	282	1.11885E+12	5.3026056	37.36513	1966324.489	570975.6199	6.5532
116	283	1.11885E+12	5.3190648	38.41730	1966325.196	570974.8366	6.5532

Table 6.1b: Sample variables extracted from the NGSIM database (for veh. ID = 116)

Veh Width	Veh Class	Velocity	Acceleration	Lane	Lead Veh ID	Back Veh ID	Space Headway
1.64592	2	10.671048	0.073152	2	105	120	18.254472
1.64592	2	10.677144	0.039624	2	105	120	18.251424
1.64592	2	10.646664	-0.496824	2	105	120	18.251424
1.64592	2	10.555224	-1.304544	2	105	120	18.248376
1.64592	2	10.415016	-1.694688	2	105	120	18.263616
1.64592	2	10.271760	-1.316736	2	105	120	18.297144
1.64592	2	10.180320	-0.490728	2	105	120	18.345912
1.64592	2	10.152888	0.033528	2	105	120	18.403824

The data were further processed to filter the speed of the lead and back vehicles.

In addition to the speeds, the spacings between the following and the lead vehicles and between the following and the back vehicles were determined for each representative sample. The spacing was calculated from the front to the rear bumpers of the respective vehicles using vehicle lengths.

6.2.3 Mathematical Relationships

Following the underlying assumptions and logic of the proposed car-following model, as described in section 6.2.1, a stock flow diagram was developed using the VENSIM DSS program (Fig. 6.3a and 6.3b).

This program provides a user-friendly and flexible environment to define/code, calibrate, and validate the mathematical relationships (Ventana Systems 2007). Additionally, the program has a wide range of built-in mathematical functions and optimization procedures that could facilitate calibration and validation.

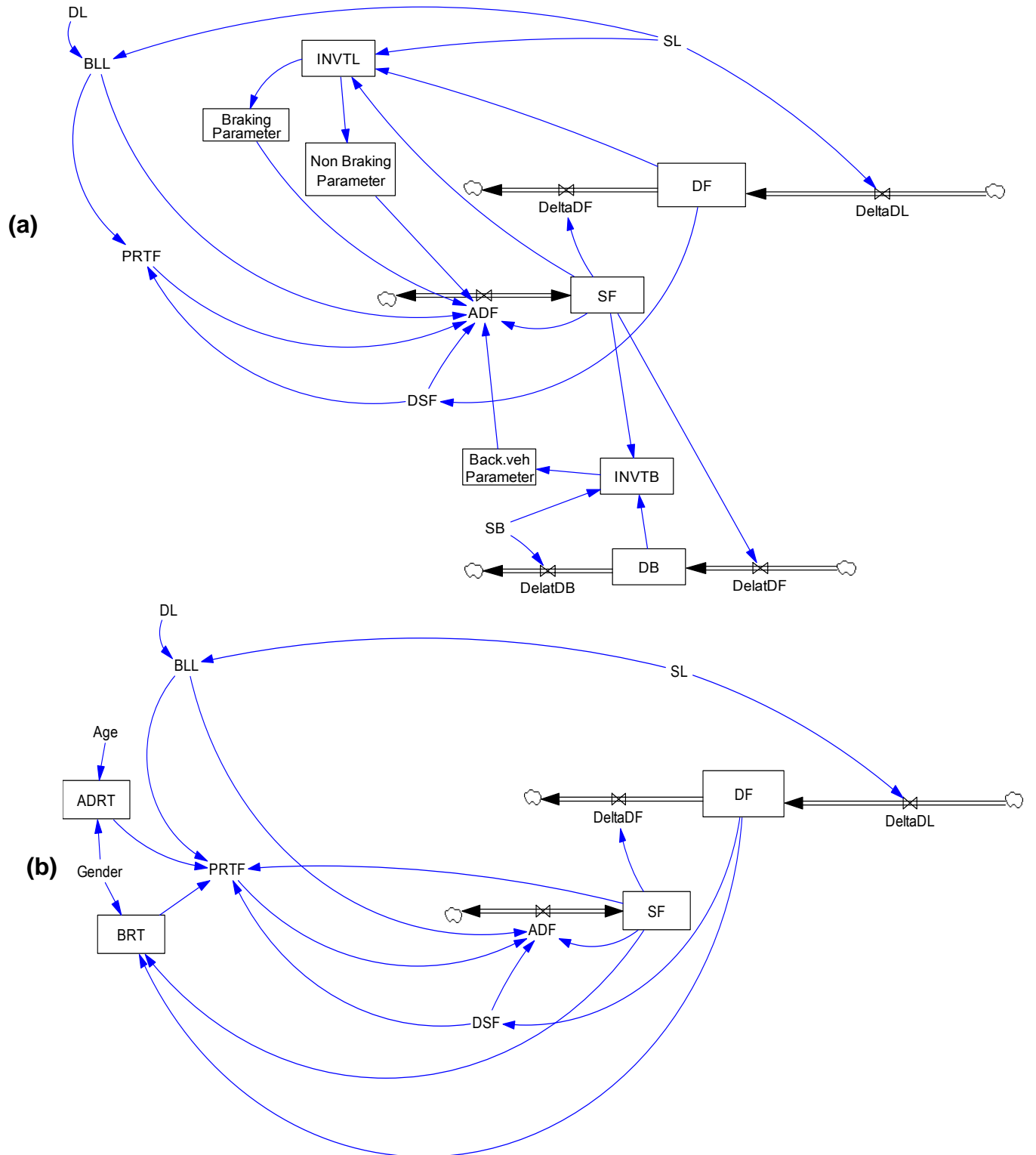


Figure 6.3: Stock flow diagram of the model (a) Vehicle dynamics, (b) Reaction time

In Figure 6.3:

- BLL* = status of the brake light of the lead vehicle at time t (0 or 1).
- SL* = input speed of the lead vehicle at time t (m/s).
- SB* = input speed of the back vehicle at time t (m/s).
- SF* = current speed of the following vehicle at time t (m/s).
- DSF* = desired speed of the following vehicle driver at time t (m/s).
- ADF* = acceleration/deceleration rate of the following vehicle at time t (m/s^2).
- DL* = input deceleration rate of the lead vehicle at time t (m/s^2).
- INVTL* = inverse-time-to-collision at time t associated with the lead vehicle which is calculated using the speed of the lead and following vehicles and spacing in between them (1/s).
- INVTB* = inverse-time-to-collision at time t associated with the back vehicle which is calculated using the speeds of the following and back vehicles and spacing in between them (1/s).
- DeltaDF* = change in spacing between the following and lead vehicles at time t calculated based on the current speed of the following vehicle (m).
- DeltaDL* = change in spacing between the following and lead vehicles at time t calculated based on the current speed of the lead vehicle (m).
- DF* = current spacing between the following and lead vehicles at time t calculated based on the *DeltaDL* and *DeltaDF* (m).
- DeltaDB* = change in spacing between the following and back vehicles at time t calculated based on the current speed of the back vehicle (m).

DB = current spacing between the following and back vehicles at time t calculated based on the *DeltaDB* and *DeltaDF* (m).

Braking parameter = defined by a lookup function and depends on the inverse-time-to-collision associated with the lead vehicle.

Non-braking parameter = defined by a lookup function and depends on the inverse-time-to-collision associated with the lead vehicle.

Back veh. parameter = defined by a lookup function and depends on the inverse-time-to-collision associated with the back vehicle.

Age = age of the following vehicle driver (calibration parameter), initially defined by an input value.

Gender = gender of the following vehicle driver (calibration parameter), initially defined by an input value (0 or 1).

ADRT = acceleration/deceleration reaction time of the following vehicle driver at time t .

BRT = brake reaction time of the following vehicle driver at time t (s).

PRTF = perception reaction time of the following vehicle driver at time t , it is either *ADRT* or *BRT* depending upon the situation (s).

Like many existing car-following models, the proposed model also predicts the acceleration/deceleration rate of the following vehicle at each simulation time step during a continuous traffic flow. This rate is defined as follows,

$$ADF(t) = \left[\frac{DSF(t) - SF(t)}{PRTF(t)} \right] \quad (6.1)$$

As previously mentioned, the following vehicle driver travels in three regimes: coasting, accelerating, and decelerating. At each simulation time interval (say $dt = 0.1$ s) the following vehicle driver adjusts the speed difference, if any, between his/her current speed and the desired speed. The desired speed (DSF) is the maximum speed that a driver would like to travel for the given kinematic conditions.

The steady state condition emulates the situation when the relative speed between the following and the lead vehicles is zero, and in non-steady condition this relative speed is not zero. The desired speed in a steady-state condition at simulation time t is assumed to depend on the spacing between the following and lead vehicles (DF). The relationship between the desired speed and the spacing between the following and lead vehicles was calibrated using the NGSIM individual vehicle tracking data. For each pair of vehicles, the speed of the following vehicle and its corresponding distance headway were extracted. For each observed speed, the mean distance headway from all the vehicles observed to travel at this speed was computed. The developed relationship between the desired speed in the steady-state conditions and the observed mean spacing is illustrated in Fig. 6.4.

Based on field data observations obtained from the NGSIM database, it is assumed that for the DF of 50 m the DSF is 80 km/h and for DF of 6 m the DSF is 0 (Fig. 6.4). These constraint values imply that a jam density of 110 vehicles/km and the pairs of vehicles do not interact in a car-following situation at a spacing of 50 m or more.

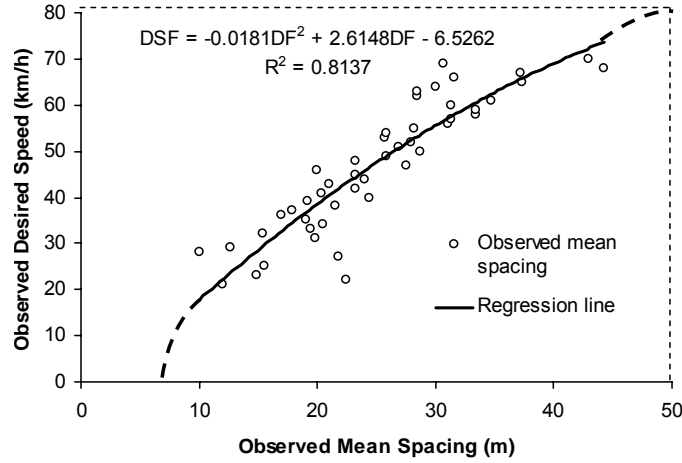


Figure 6.4: Calibrated desired speed relationship

Thus, the desired speed of the following vehicle is defined as follows:

$$DSF(t) = \begin{cases} 80 \text{ km/hr,} & DF(t) \geq 50 \text{ m} \\ (-0.0181DF^2(t) + 2.6148DF(t) - 6.5262) \times 0.278, & 6\text{m} < DF(t) < 50 \text{ m} \\ 0, & DF(t) \leq 6 \text{ m} \end{cases} \quad (6.2)$$

The variable $DF(t)$ is determined as follows:

$$DF(t) = DF(t - dt) + [SL(t) - SF(t)] dt \quad (6.3)$$

where,

$DF(t - dt)$ = current spacing between the following and the lead vehicles at time $(t - dt)$, initially, it is externally defined at time $t = 0$ (m), and dt = assumed simulation interval = say 0.1 s.

The current speed of the following vehicle, $SF(t)$, is determined as follows:

$$SF(t) = SF(t - dt) + ADF(t - dt) dt \quad (6.4)$$

In Equation 6.4:

$SF(t - dt)$ = speed of the following vehicle at time $(t - dt)$, which is externally defined at $t = 0$ (m/s), and

$ADF(t - dt)$ = acceleration/deceleration rate of the following vehicle at time $(t - dt)$, calculated using Eqs. 6.8-6.10 at time $(t - dt)$ (m/s^2).

The desired speed relationship as illustrated in Fig. 6.4, and defined in Eq. 6.2, is consistent with the relationship derived based on the SAVE database (Ervin et al. 2001). As mentioned earlier, the proposed model assumed that the following vehicle driver travels in three regimes: coasting, accelerating, and decelerating. The following vehicle drivers accelerate or decelerate in response to the actions of the lead and back vehicles. The lead vehicle actions are dominant during the deceleration regime of the following vehicle. However, while driving in a traffic stream, the back vehicle is also pushing the lead vehicle if the back vehicle approaches the lead vehicle with an increasing rate of change of spacing. Therefore, it is assumed that the back vehicle dynamics will only affect the acceleration regime of the following vehicle.

The proposed model also assumes that the reaction times during the acceleration and deceleration regimes are different. In the previous chapter, the authors (Mehmood and Easa 2009) conducted a simulator experiment to evaluate the effect of human factors on driver reaction time in car-following scenarios. The car-following driver reacts to adjust his/her speed by using the gas pedal only or by using the brake pedal in the case the lead vehicle is braking and its brake light is ON. The term acceleration/deceleration reaction time ($ADRT$) is used when the driver reacts to adjust his/her speed by only using the

gas pedal. The term brake reaction time (*BRT*) is used when the driver reacts to brake in response to the lead vehicle's braking. Reaction time models were developed for both *ADRT* and *BRT*. The deceleration regime is classified into two states: when the lead vehicle is braking or not braking. The brake light status of the lead vehicle (BLL) is determined using the relationship suggested by Ozaki (1993), which is given by

$$BLL = \begin{cases} \text{ON} & DL(t) < -0.013 SL(t) \\ \text{OFF} & \text{Otherwise} \end{cases} \quad (6.5)$$

The reaction-time models for *ADRT* and *BRT* have been developed in the previous chapter as follows,

$$ADRT(t) = 0.017 \text{ Age} + 0.159 \text{ Gender} \quad (6.6)$$

$$BRT(t) = 0.078 \text{ Gender} - 0.002 SF(t) + 0.049 DF(t) \quad (6.7)$$

where,

BRT(t) = brake reaction time at time *t* (s),

ADRT(t) = acceleration/deceleration reaction time at time *t* (s),

Age = age of the driver of the following vehicle (years), and

Gender = gender of the driver of the following vehicle (0 for males and 1 for females)

These reaction-time models depend on both vehicle dynamics and driver characteristics. It is evident that driver reaction time increases with age (Eq. 6.6) and females are slower than males (Eqs. 6.6 and 6.7). The acceleration and deceleration regimes will introduce non-steady-state conditions: one for acceleration and the other for deceleration. Therefore, for non-steady state conditions three calibration parameters are introduced, and for each non-steady-state condition, Eq. 6.1 is modified as follows,

$$ADF(t) = \left[\frac{DSF(t)b_1 - SF(t)}{ADRT(t)} \right] \quad (\text{non-braking scenario, deceleration regime}) \quad (6.8)$$

$$ADF(t) = \left[\frac{DSF(t)b_2 - SF(t)}{BRT(t)} \right] \quad (\text{braking scenario, deceleration regime}) \quad (6.9)$$

$$ADF(t) = \left[\frac{DSF(t)b_3 - SF(t)}{ADRT(t)} \right] \quad (\text{non-braking back-lead vehicle scenario, acceleration regime}) \quad (6.10)$$

where,

b_1 = parameter for the lead vehicle non-braking scenario (deceleration regime),

b_2 = parameter for the lead vehicle braking scenario (deceleration regime), and

b_3 = parameter for the non-braking back vehicle scenario (acceleration regime).

6.3 Model Calibration

This section describes the calibration of the model parameters. The calibration parameters include b_1 , b_2 , b_3 , *Age*, and *Gender* of the driver of the following

vehicle. The calibration involves finding the values of the parameters to best fit the outcomes of the proposed model with the observed actual data. The model outcomes used in the calibration include speed and spacing profiles of the following vehicle. When a model is structurally complete and properly simulates the process, the calibration of the model can proceed. In VENSIM there are two ways to calibrate the model: (1) changing the values manually and performing simulation to achieve a better fit between simulated and actual data, and (2) using optimization. In optimization, the program automatically changes the parameters of the choice and look for the best fit between the simulation output and actual data. The optimization starts with different starting input values of the parameters. The model parameters along with their lower and upper bounds can be defined in the optimizer before a simulation run. The procedure adopted for calibration is as follows:

1. The 45 samples extracted earlier from the NGSIM database were used for the calibration of the car-following model. These samples represent varied scenarios including braking (deceleration regime), non-braking (deceleration regime), and non-braking (acceleration regime).
2. The unknown parameters for each of the car-following scenario (b_1 , b_2 , and b_3) were considered as a function of the INVT (inverse-time-to-collision). The INVT is defined as the ratio of the speed difference between the following and the lead or back vehicles and the spacing between them.

3. Initially, three potential curves were defined for each parameter. For example for parameter b_1 the defined curves as a function of INVT are (Curve A, B, and C shown in Fig. 6.5), for parameter b_2 the defined curves as a function of INVT are (Curve D, E, and F shown in Fig. 6.6), and similarly, for parameter b_3 the defined curves as a function of INVT are (Curve G, H, and I shown in Fig. 6.7). These defined curves provide the trend and ranges for the given parameters b_1 , b_2 , and b_3 . It was assumed that the drivers behave differently in response to a crash potential for the given driving situation such as braking (deceleration regime), non-braking (deceleration regime), and non-braking (acceleration regime). The curves were defined based on the hypothesis that the drivers are less or more sensitive to a rear-end crash potential in each of the car-following scenarios. For example, Curve C is relatively less sensitive to a small increase in rear-end crash potential (i.e., small negative values of inverse-time-to-collision) compared to Curve A which is more sensitive to small increase in crash potential.
4. Initially, *Age* and *Gender* values for each sample were defined as the input assumed values. The optimizer was turned on from the simulation control and the ranges for *Age* and *Gender* values were also defined. The minimum and maximum bounds for the *Age* were input as 18 and 80, respectively. The *Gender* had only two possible values of 1 (female) or 0 (male).

5. The simulation runs result in the calibration parameters b_1 , b_2 , b_3 , Age , and $Gender$ for the best fit between the simulation output and actual data.
6. To identify the best curves for b_1 , b_2 , and b_3 , all possible combinations of curves were tested through simulation runs. The estimated number of simulation runs was $27 \times 45 = 1215$. For each simulation run, the RMSE associated with the estimating speed of the following vehicle was calculated. The average RMSEs for the simulation runs of all curve combinations for 45 samples are given in Table 6.2.

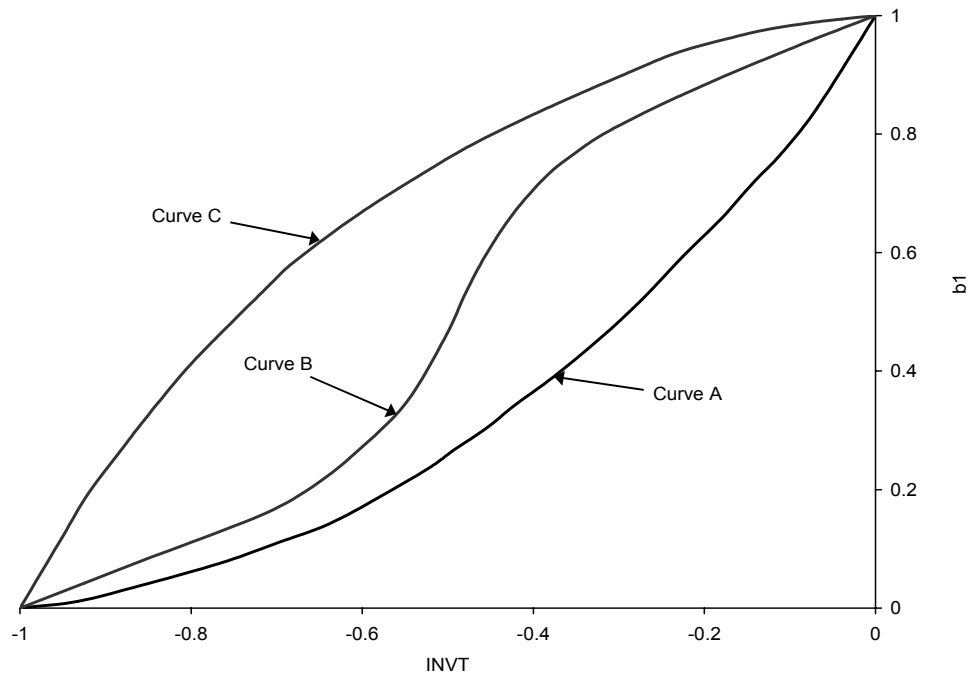


Figure 6.5: Assumed potential curves for calibration parameters of b_1

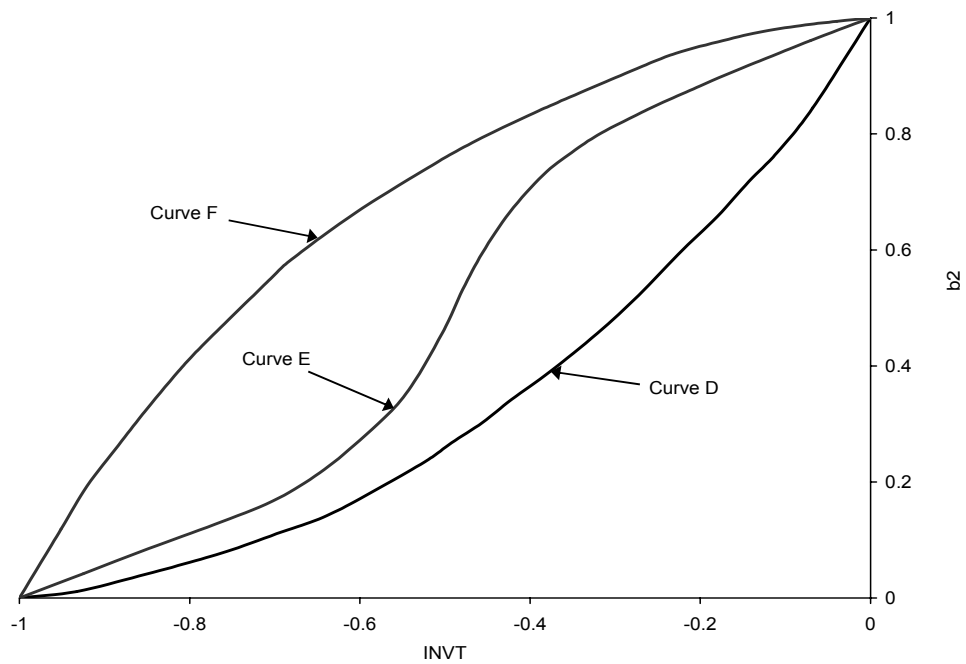


Figure 6.6: Assumed potential curves for calibration parameter b_2

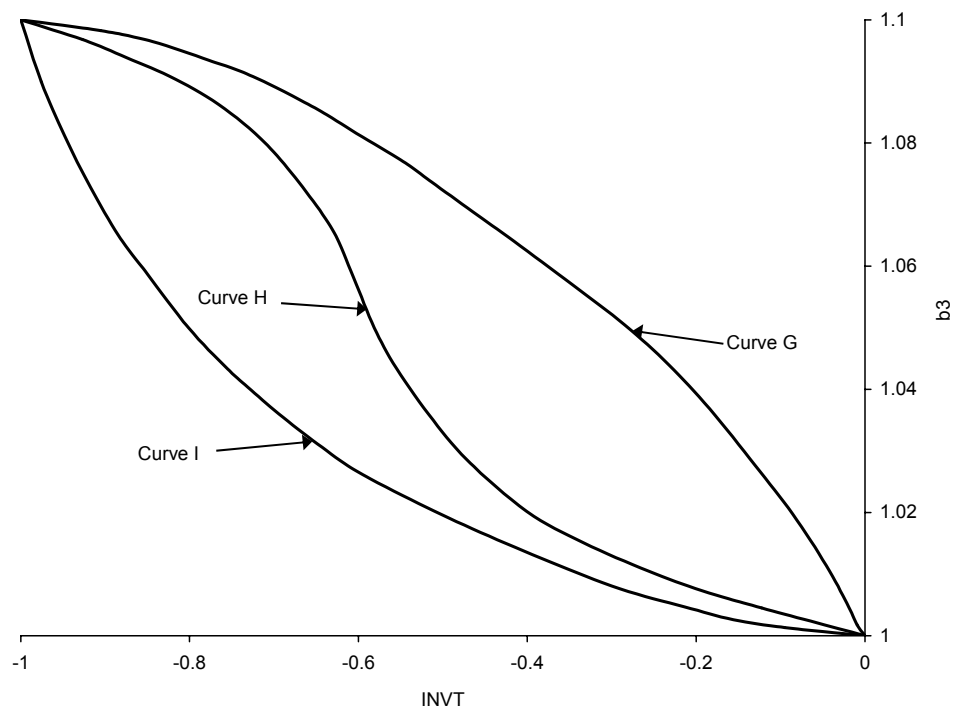


Figure 6.7: Assumed potential curves for calibration parameter b_3

Table 6.2: Average RMSE associated with estimated following vehicle speed based on 45 observed samples for all combination of curves (km/h)

Curve Combination	RMSE	Curve Combination	RMSE	Curve Combination	RMSE
A,D,G	3.9	A,E,G	8.2	C,D,G	2.2
A,D,H	5.1	A,E,H	9.4	C,D,H	3.4
A,D,I	6.7	A,E,I	11.3	C,D,I	4.8
B,E,G	4.1	B,D,G	3.5	B,F,G	8.6
B,E,H	5.3	B,D,H	4.9	B,F,H	9.7
B,E,I	6.1	B,D,I	5.5	B,F,I	11.4
C,F,G	4.5	A,F,G	6.7	C,E,G	3.7
C,F,H	6.3	A,F,H	8.4	C,E,H	4.6
C,F,I	7.5	A,F,I	12.6	C,E,I	5.8

7. The combination of curves that resulted in the lowest average RMSE was chosen and the points associated with the chosen combination of curves were extracted. The results show that the combination of curves C, D, and G represents the lowest average RMSE of 2.2 km/h. The calibrated values of b_1 , b_2 , and b_3 for 45 samples and their respective inverse-time-to-collision values for curves C, D, and G were accumulated to calibrate the relationships for b_1 , b_2 , and b_3 as shown in Figs. 6.8, 6.9, and 6.10, respectively.

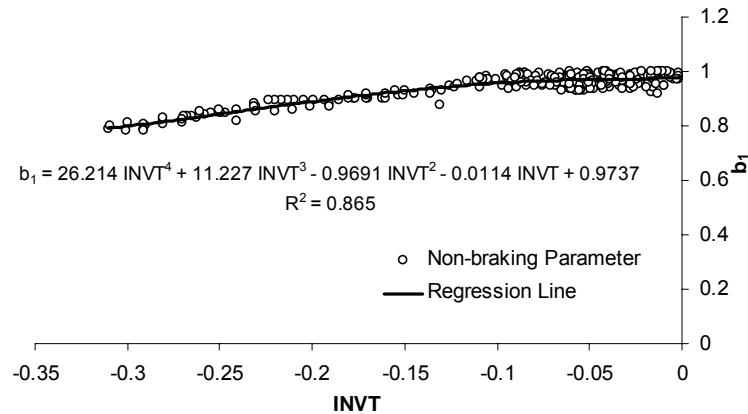


Figure 6.8: Calibrated non-braking parameter relationship

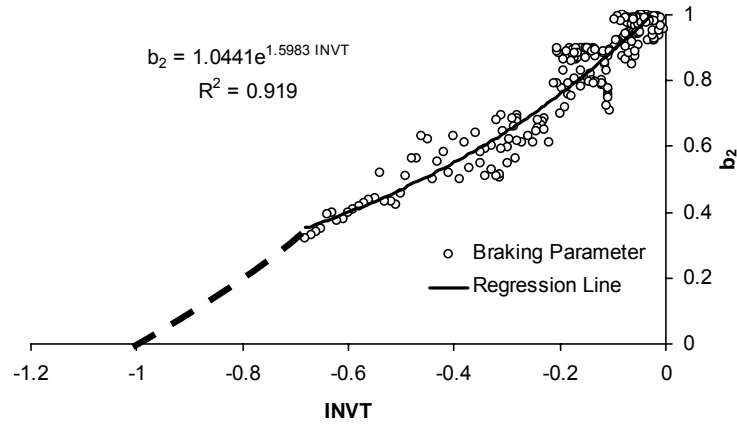


Figure 6.9: Calibrated braking parameter relationship

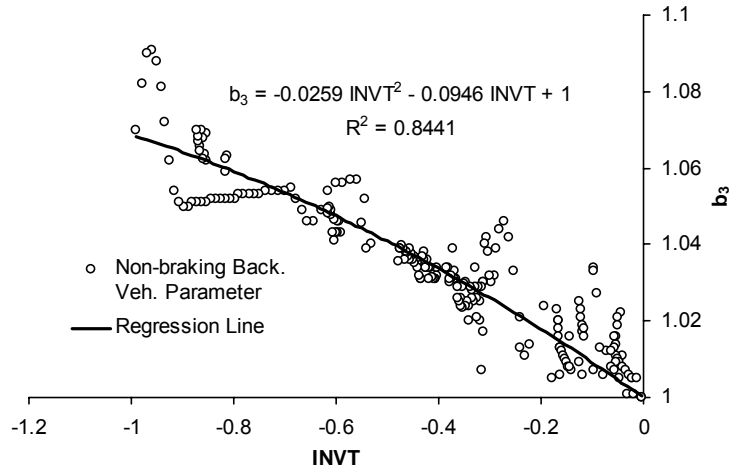


Figure 6.10: Calibrated non-braking back vehicle parameter relationship

The calibrated relationships for b_1 , b_2 , and b_3 are described in the following Eqs.:

$$b_1(t) = \begin{cases} 1, & INVT(t) \geq 0 \\ 26.214 INVT(t)^4 + 11.227 INVT(t)^3 - 0.9691 INVT(t)^2 \\ - 0.0114 INVT(t) + 0.9737, & -0.33 < INVT(t) < 0 \\ 0.8, & INVT(t) \leq -0.33 \end{cases} \quad (6.11)$$

where,

$b_1(t)$ = non-braking parameter (deceleration regime) at time t ,

$INVT(t)$ = inverse-time-to collision associated with the lead vehicle at time t =

$$\frac{SL(t) - SF(t)}{DF(t)}.$$

$$b_2(t) = \begin{cases} 1, & INVT(t) \geq 0 \\ 1.044 \exp [1.5983 INVT(t)], & -1 < INVT(t) < 0 \\ 0, & INVT(t) \leq -1 \end{cases} \quad (6.12)$$

where,

$b_2(t)$ = braking parameter (deceleration regime) at time t ,

$INVT(t)$ = inverse-time-to collision associated with the lead vehicle at time t =

$$\frac{SL(t) - SF(t)}{DF(t)}.$$

$$b_3(t) = \begin{cases} 1, & INVTB(t) \geq 0 \\ -0.0259 INVTB(t)^2 - 0.0946 INVTB(t) + 1, & -1 < INVTB(t) < 0 \\ 1.1, & INVTB(t) \leq -1 \end{cases} \quad (6.13)$$

where, $b_3(t)$ = non-braking parameter (acceleration regime) at time t ,

$INVT(t)$ = inverse-time-to collision associated with the back vehicle at time t =

$$\frac{SF(t) - SB(t)}{DB(t)}.$$

The calibration also resulted in a sample of age and gender values for 45 samples used for the calibration process. This sample was used to develop the statistical distributions of age and gender that were assumed to represent the given NGSIM database. The developed statistical distributions for *Age* and *Gender* are shown in Figs. 6.11 and 6.12, respectively.

The samples used for the calibration represent the vehicle dynamics on freeways. The calibration parameters suggest that in the case of deceleration regimes, the rate of change of speed is higher when the following vehicle is braking compared to when it is not braking and decelerating with only the throttle input.

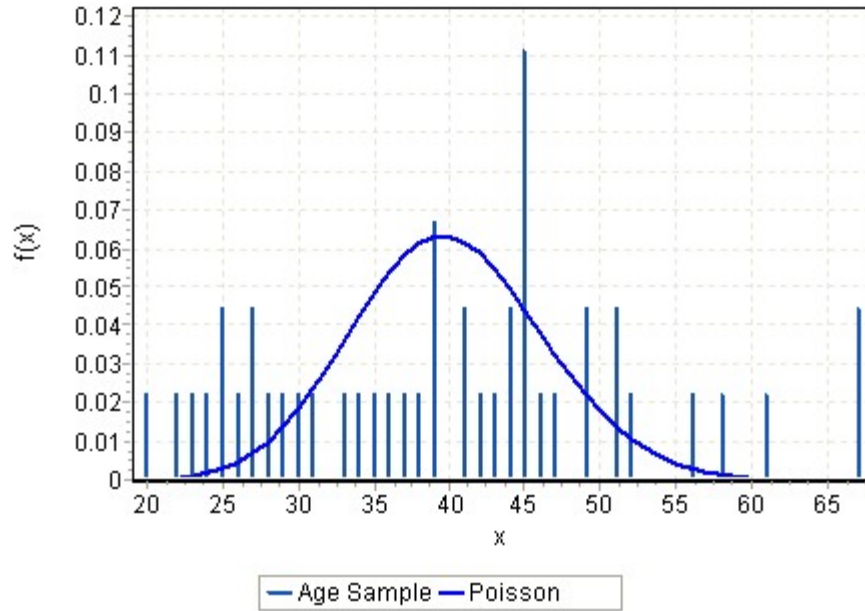


Figure 6.11: Statistical distribution of age

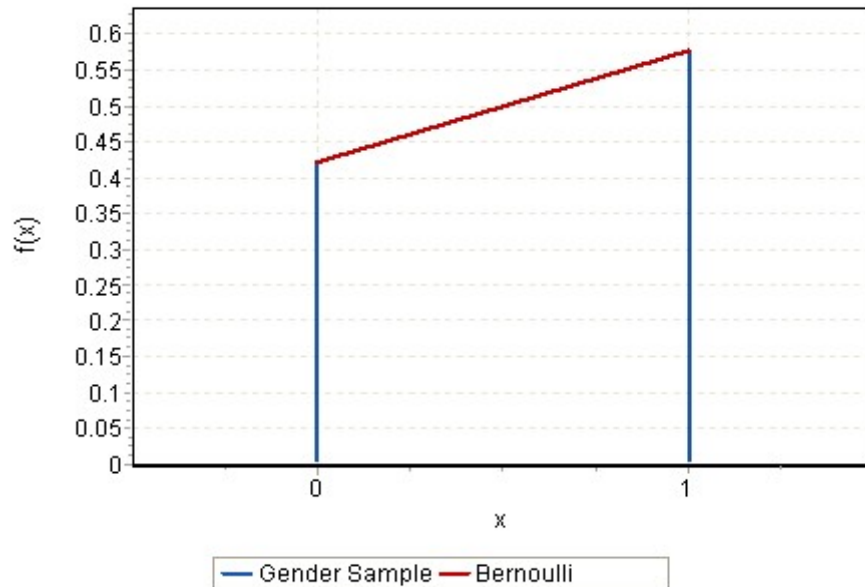


Figure 6.12: Statistical distribution of gender

The parameters also suggest that drivers use the throttle input for the deceleration regime when they tend to reduce their desired speeds by 20% (Fig. 6.8). It is also observed that the lead vehicle has a dominant influence on the actions of the driver of the following vehicle. But the back vehicle can also contribute to the acceleration regime when it is approaching the following vehicle with higher speeds. In a usual practice, drivers either change their lane to avoid a conflict with the back vehicle or increase their speeds to remain in a continuous traffic flow. This study is limited to the car-following modelling and the contribution of the back vehicle in a lane-change manoeuvre can further be studied in the lane-change modelling.

6.4 Model Validation

For validation, 15 random samples of three-vehicle platoons were extracted from the NGSIM database. The samples used for the validation were different from the samples used for calibration of the proposed car-following model. The trajectory of the lead and back vehicles, and the initial position and speed of the following vehicle were provided as input to the calibrated car-following model. The age and gender of the following vehicle driver were generated based on their statistical distributions developed in the previous section as:

Random [Bernoulli Distribution [p (female) =0.57, 15]

Out [gender] = [1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 0, 1, 1, 1]

Random [Poisson Distribution [$\lambda = 40.02$, 15]

Out [age] = [42, 31, 38, 33, 44, 38, 35, 42, 42, 39, 30, 45, 47, 43, 49]

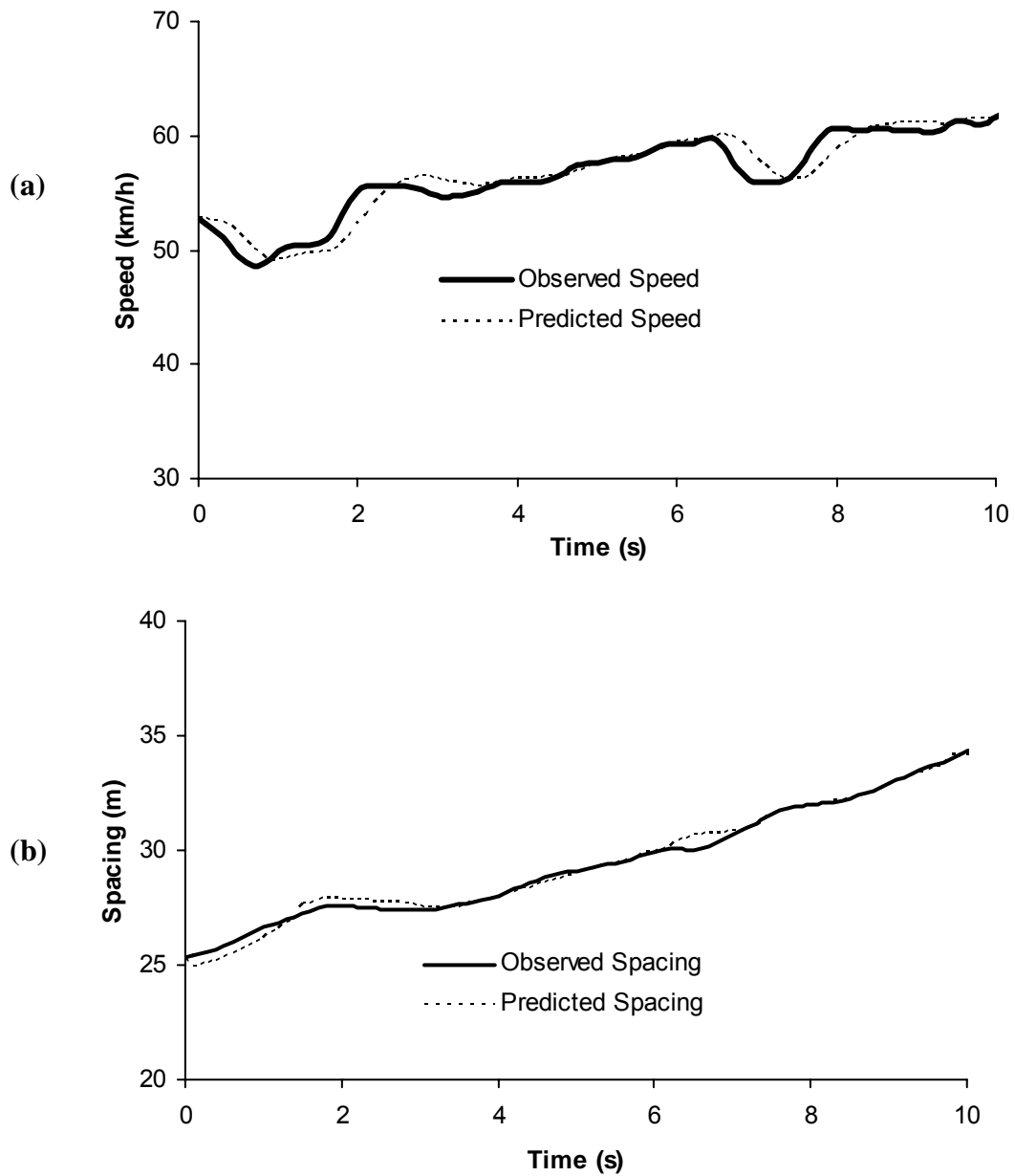


Figure 6.13: Observed and predicted speed (a) and spacing (b) profiles

These values were inputted to the proposed model. Validation of the proposed car-following model was conducted by comparing the model estimates of the speed and spacing of the following vehicle with those observed in the NGSIM database. Fig. 6.13 shows the observed and predicted results associated with the following vehicle. Qualitative validation of some other samples is shown in Appendix J. It is evident that the speed and spacing profiles predicted by the proposed model closely follow those of the observed field data.

For each of 15 samples, the root-mean-square (RMS) error associated with the prediction of speed and spacing of the following vehicle was estimated by using Eqs. 6.14 and 6.15, respectively.

$$\text{RMS Error } (SF) = \sqrt{\frac{1}{n} \sum_{i=1}^n (SF_i(t)_{\text{Model}} - SF_i(t)_{\text{Observed}})^2} \quad (6.14)$$

where,

RMS Error (SF) = root-mean-square error associated with the speed of the following vehicle (km/h),

n = number of observations ($i = 1, 2, 3 \dots n$),

$SF_i(t)_{\text{Model}}$ = speed of the following vehicle estimated from the proposed model at time t (km/h) for sample i , and

$SF_i(t)_{\text{Observed}}$ = speed of the following vehicle observed in the NGSIM database at time t (km/h) for sample i .

$$\text{RMS Error (DF)} = \sqrt{\frac{1}{n} \sum_{t=1}^n (DF_i(t)_{\text{Model}} - DF_i(t)_{\text{Observed}})^2} \quad (6.15)$$

where, RMS Error (DF) = root-mean-square error associated with the spacing of the following vehicle (m),

$DF_i(t)_{\text{Model}}$ = spacing between the following and lead vehicles estimated from the proposed model at time t (m) for sample i , and

$DF_i(t)_{\text{Observed}}$ = spacing between the following and lead vehicles observed in the NGSIM database at time t (m) for sample i .

The estimated root-mean-square (*RMS*) errors associated with the prediction of the speed and spacing profiles (speed and spacing vs. simulation time) of the following vehicle are given in Table 6.3. The average *RMS* error values for the speed and spacing for the 15 samples were 1.72 and 0.67, respectively.

Table 6.3: RMSE associated with speed and spacing of the following vehicle

Sample	Ave. Observed Speed	RMSE (Speed)	Ave. Observed Spacing	RMSE (Spacing)	Number of Observations
1	44.5	1.34	18.51	0.19	151
2	47.0	2.17	15.18	0.32	145
3	58.9	1.11	30.32	0.24	123
4	51.4	5.01	8.330	0.45	60
5	48.5	1.27	13.44	0.29	64
6	45.3	1.65	16.45	0.56	159
7	44.2	1.86	16.98	0.50	162
8	53.4	0.76	16.02	0.28	205
9	55.0	1.29	23.67	0.38	207
10	46.3	1.26	15.45	0.32	185
11	55.1	1.63	22.3	1.12	168
12	38.7	1.20	13.4	0.64	121
13	56.2	0.96	12.6	0.78	91
14	43.5	1.85	26.8	1.86	105
15	35.3	2.35	28.6	1.86	118
Average	48.2	1.72	18.53	0.67	138

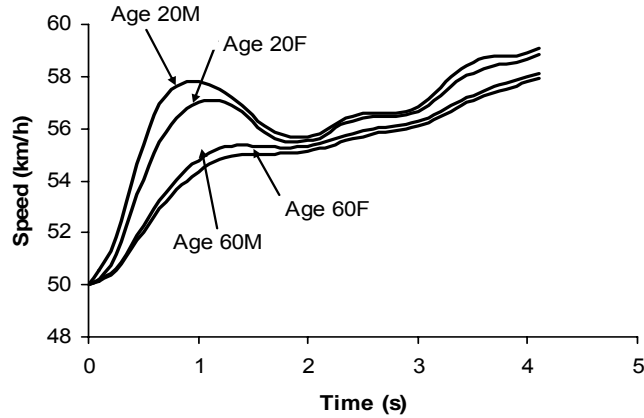


Figure 6.14: Effect of age and gender on speed profile

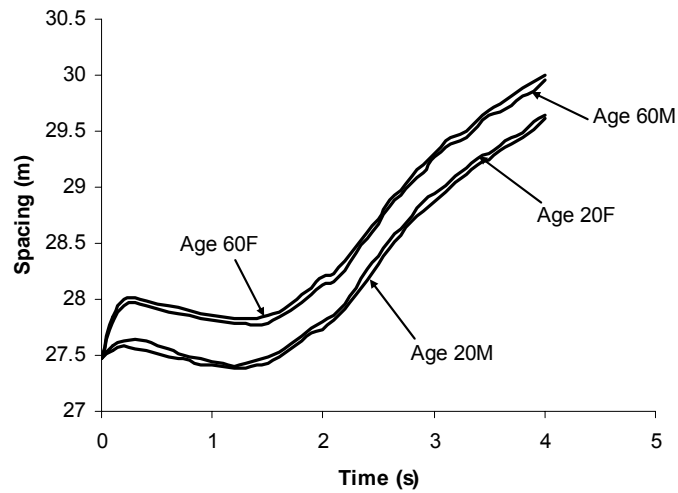


Figure 6.15: Effect of age and gender on spacing profile

Figs. 6.14 and 6.15 show the simulation results of a representative sample in which different driver characteristics were tested to check how the age and gender of the driver affect the speed and spacing profile of the following vehicle. It is observed that the average speeds of the females are less than those of the males. The results also show that older drivers tend to drive at lower speeds and higher spacings than young drivers under the same traffic conditions. The

sample length of the representative sample used for testing the driver characteristics was only 4 seconds.

6.5 Summary

One of the important components of traffic simulation models is a car-following model that describes the driver behaviour in a car-following situation. The existing car-following models have some limitations that may adversely affect their performance when used for the evaluation of an in-vehicle rear-end collision warning systems. This chapter presents a car-following model that addresses some limitations of the existing models. The proposed model considers variations in the driver reaction time and the impact of the front and back vehicles in the car-following situation. The proposed model explicitly considers the driver's age and gender in car-following modelling. Actual vehicle tracking data obtained from the U.S. Federal Highway Administration were used to calibrate and validate the proposed model. The results of the proposed model in terms of replicating actual speed and spacing profiles of the following vehicle are promising. In the next chapter, the developed model will be implemented for the evaluation of a proposed rear-end collision warning algorithm.

CHAPTER 7

DEVELOPMENT OF IN-VEHICLE REAR-END COLLISION WARNING ALGORITHM CONSIDERING DRIVER CHARACTERISTICS

This chapter describes the development of an in-vehicle rear-end collision warning algorithm that considers the driver characteristics and risk factor in the decision rule to initiate the warning to a potential rear-end collision situation. The driver characteristics include age and gender that affect the driver reaction time. The risk factor continuously monitors the driver actions in response to the actions of the lead vehicle. The risk factor is designed to minimize the nuisance warnings and enhance the reliability of the rear-end collision warning systems (RECWS). The performance of the proposed algorithm is evaluated and validated with the car-following model developed in the previous chapter.

7.1 Introduction

In this chapter, a driver-sensitive rear-end collision warning algorithm is proposed which was simulated with a previously developed car-following model to present an application example. The proposed algorithm overcomes the limitations of the existing systems. This chapter is organized into three sections: *Algorithm Development* that describes the logic of the proposed algorithm and its formulation and *System Validation* which is followed by *Summary* of the chapter.

7.2 Algorithm Development

7.2.1 Logic of the Proposed Algorithm

A potential rear-end collision threat exists when it is expected that a following vehicle will collide or will nearly miss a leading vehicle travelling in its forward pathway. Three cases have been defined that may result in a rear-end collision (Lee 1976): when a lead vehicle is stationary, when a lead vehicle is moving at a constant slower speed, or when a lead vehicle is decelerating. In these cases the lead vehicle is either moving or stationary. The collision situation of the proposed algorithm considers two vehicles: a following vehicle and a lead vehicle either moving or stationary at a certain distance (Fig. 7.1).

The proposed algorithm presented in this chapter is a kind of kinematics-based algorithm. There are three main differences between the proposed algorithm and the existing kinematics-based algorithms: the assumption of a constant driver reaction time is removed, it continuously monitors the risk factor that helps to identify a potential collision threat, and the required deceleration rate that depends on the likelihood of the warning (L_w) which also represents the level of a collision threat.

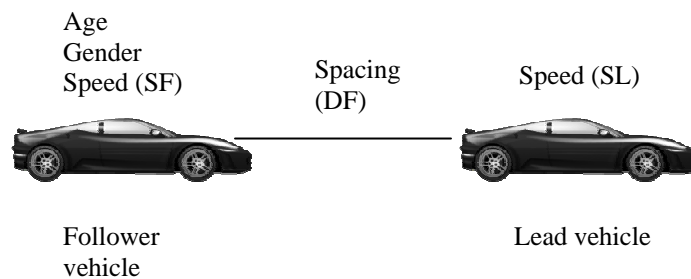


Figure 7.1: Car-following scenario for a rear-end collision

Rear-end collision warning criterion is developed based on the available and required deceleration times (T_a and T_r) for the following vehicle to avoid a potential collision with the lead vehicle. However, these deceleration times are proposed to be calculated for the two stages: one at the risk factor (RF) and the other at the likelihood for the warning (L_w). The risk factor is introduced to avoid the false alarms. If the RF is less than one, the algorithm will stop and will start recalculating the values based on the updated input data. If the RF is more than or equal 1, then the algorithm will calculate the likelihood of the warning (L_w) which is calculated based on the revised available and required deceleration times (T_{ar} and T_{rr}). The logic of the algorithm is presented in Fig. 7.2. The text in italic designates the input. The steps of the algorithm are as follows (the step number is indicated in the figure):

1. The spacing between the following and lead vehicles at time t depends on the speed of the following and lead vehicles (Eq. 7.3).
2. Reaction time of the following vehicle driver to a driving situation at time t depends on driver characteristics, speed of the following vehicle, and spacing between the following and lead vehicles (Eqs. 7.4 and 7.5).
3. The available deceleration time (T_a) at time t depends on the driver reaction time, safe buffer distance, current spacing between the following and lead vehicles, and current speed of the following vehicle (Eq. 7.2).
4. Driver characteristics such as age and gender are user input values.
5. Comfortable deceleration rate at time t depends on the current speed of the following vehicle (Eq. 7.10).

6. The required deceleration time (T_r) at time t depends on the current speed and deceleration rate of the following vehicle (Eq. 7.6).
7. The risk factor at time t depends on the available and required deceleration times (Eq. 7.1).
8. The driver reaction time to the warning (RT_w) depends on driver characteristics such as age and gender (Eq. 7.14).
9. The revised available deceleration time (T_{ar}) at time t depends on the reaction time to the warning, sensor delay, current speed of the following vehicle, and the spacing between the following and lead vehicles (Eq. 7.13).
10. The likelihood of the warning (L_w) at time t depends on the revised available and required deceleration times (Eq. 7.12).
11. The warning will only be initiated when both the risk factor and the likelihood of the warning will be equal to or more than 1.
12. In case of a warning initiation, the required deceleration rate depends on the comfortable deceleration rate, the likelihood of the warning, and the risk factor.

7.2.2 Algorithm Formulation

The variables considered in the algorithm include age, gender and reaction time of the driver of the following vehicle, speed of the lead and following vehicles, grade of the terrain, comfortable deceleration rate of the following vehicle, and spacing between the lead and following vehicles. Depending on the vehicle user's information, driver age and gender would be as the input variables into the

proposed algorithm. The grade of the terrain can be measured using a Global Positioning System (GPS). Various systems are available to collect the data associated with the lead and following vehicles such as their speeds and spacing between them. These systems use different technologies such as optical, electromagnetic radar, and ultrasonic.

The T_a of the risk factor is calculated based on the reaction time (RT) of the driver of the following vehicle for the given driving situation, while T_{ar} for the L_w is calculated based on the reaction time to the warning (RT_w). The reaction time to the warning only depends on the age and gender of the driver of the following vehicle. However, in addition to the age and gender, the reaction time to a driving situation also depends on the speed of the following vehicle and the spacing between the following and lead vehicles. It is observed that at a lower TTC , the driver will have a reaction time lower than the reaction time to the warning (RT_w). Under such circumstances, the RF will be dominant for the calculation of the required deceleration rate (A_r).

The RF at time t is calculated as follows:

$$RF(t) = \frac{T_r(t)}{T_a(t)} \quad (7.1)$$

where,

$T_r(t)$ and $T_a(t)$ = the required and available deceleration times at time t , respectively (s).

The T_r is the time during which drivers apply deceleration rate and stop the vehicle safely. In an ideal safe driving situation the T_r will be equal to T_a .

The T_a is calculated as follows:

$$T_a(t) = \frac{DF(t) - \min(2, RT(t))SF(t) - S_b}{SF(t)} \quad (7.2)$$

where,

$SF(t)$ = current speed of the following vehicle at time t (m/s),

S_b = safe buffer distance between the following and the lead vehicles, say 1 m,

RT = reaction time to the driving situation at time t (s). The maximum reaction time of 2 s is proposed since at a very high TTC the RT will also be very high and it will reduce the reliability of the system, and

$DF(t)$ = current distance headway between the following and lead vehicles at time t (m) which is calculated as follows:

$$DF(t) = DF(t - dt) + [SL(t) - SF(t)] dt \quad (7.3)$$

where,

$DF(t - dt)$ = spacing between the following and lead vehicles at time $(t - dt)$ (m),

SL = current speed of the lead vehicle at time t (m/s), and

dt = time interval, say 0.1.

In an earlier study, Mehmood and Easa (2009) conducted a driving simulator study to identify the effect of human factors such as the age and gender and kinematics (speed and spacing) on driver reaction time in a car-following situation. Three car-following situations were studied: the lead vehicle

decelerating with a normal deceleration rate, the lead vehicle decelerating with an emergency deceleration rate (surprised), and the lead vehicle is not moving (stationary). The reaction-time models for each driving situation were developed based on the data collected in the simulator study. The surprised and the lead vehicle stationary scenarios were more probable to the rear-end collisions. Therefore, it is assumed that the reaction-time models developed for the surprised and stationary conditions can be used for a rear-end collision analysis. The developed reaction-time models are as follows:

$$RT_{sr}(t) = 0.001 \text{ Age} + 0.109 \text{ Gender} + 0.003 \text{ SF}(t) + 0.023 \text{ DF}(t) \quad (7.4)$$

$$RT_{st}(t) = 0.002 \text{ Age} + 0.035 \text{ Gender} + 0.001 \text{ SF}(t) + 0.017 \text{ DF}(t) \quad (7.5)$$

where,

$RT_{sr}(t)$ and $RT_{st}(t)$ = brake reaction times for the surprised and stopped driving situations at time t (s), respectively,

Age = age of the driver of the following vehicle (years), and

Gender = gender of the driver of the following vehicle (0 for males and 1 for females).

The T_r at time t can be calculated as follows:

$$T_r(t) = \frac{SF(t)}{2ADF(t)} \quad (7.6)$$

where, $ADF(t)$ = deceleration rate of the following vehicle at time t (m/s^2) and can be defined by a car-following model (Mehmood and Easa 2010a),

$$ADF(t) = \left[\frac{DSF(t)b_2(t) - SF(t)}{BRT(t)} \right] \quad (7.7)$$

where,

$DSF(t)$ = desired speed of the following vehicle at time t (m/s),

$BRT(t)$ = brake reaction time of the driver of the following vehicle at time t (s) and is defined in Eqs. 7.4 and 7.5, and

b_2 = calibration braking parameter at time t .

The relationships for the desired speed (DSF) and the calibration braking parameter (b_2) were calibrated using the NGSIM vehicle tracking data. The calibration is already discussed in the previous chapter. These relationships are as follows:

$$DSF(t) = \begin{cases} (-0.0181DF^2(t) + 2.6148DF(t) - 6.5262) \times 0.278 & DF(t) > 6 \text{ m} \\ 0 & DF(t) \leq 6 \text{ m} \end{cases} \quad (7.8)$$

$$b_2(t) = \begin{cases} 1 & INVT(t) \geq 0 \\ 1.044 \exp [1.5983 INVT(t)] & -1 < INVT(t) < 0 \\ 0 & INVT(t) \leq -1 \end{cases} \quad (7.9)$$

where,

$b_2(t)$ = braking parameter (deceleration regime) at time t ,

$INVT(t)$ = inverse-time-to-collision associated with the lead vehicle at time t =

$$\frac{SL(t) - SF(t)}{DF(t)}.$$

Krishnan et al. (2001) developed an equation to determine the comfortable deceleration rate (A_f) that was dependent on the current speed of the following vehicle. The ADF was constraint to be less than or equal to the comfortable deceleration rate,

$$ADF(t) \geq A_f(t) = -0.735 - 0.0859 SF(t) \quad (7.10)$$

Eq. 7.6 corresponds to a level terrain. However, the braking manoeuver can also occur on a downgrade or an upgrade terrain. Therefore, the analysis should include the gradient of the roadway. As defined by AASHTO (2004), Eq. 7.6 can be modified as follows:

$$T_r(t) = \frac{SF(t)}{2g \left(\frac{ADF(t)}{g} \pm G \right)} \quad (7.11)$$

where,

g = acceleration due to gravity (9.81 m/s^2), and

G = grade in slope (%)

The likelihood for the warning at time t is calculated as follows:

$$L_w(t) = \frac{T_{rr}(t)}{T_{ar}(t)} \quad (7.12)$$

The $T_{rr}(t)$ will be the same as of in Eq. 7.11 but T_{ar} will be calculated based on the reaction time to the warning (RT_w).

$$T_{ar}(t) = \frac{(DF(t) - RT_w SF(t) - S_b)}{SF(t)} \quad (7.13)$$

Dabbour and Easa (2009) developed an equation to determine the reaction time (RT_w) of the driver in response to the warning of a collision warning system. It was found that the reaction time to the warning depends on the age and gender of the driver of the vehicle and is given by

$$RT_w = 0.2466 + 0.0241 \text{ Age} + 0.1353 \text{ Gender} \quad (7.14)$$

The system will only trigger the warning if both RF and L_w are more than or equal to one. As mentioned previously, the minimum of RF and L_w will be used to calculate the required deceleration rate. The required deceleration rate at time t , A_r (m/s²) will be calculated as follows:

$$A_r(t) = \text{Min} [RF(t), L_w(t)] A_f(t) \quad (7.15)$$

It is assumed that drivers will follow the warning otherwise the required deceleration will be increased with the delay in response to the warning. It is also anticipated that drivers will apply an emergency deceleration rate which ranged from 5-8 m/s². In case of a warning, the required deceleration rate will always be more than the normal or comfortable deceleration rate which is usually 3.4 m/s²

or less (AASHTO 2004). The percentage increase in the required deceleration rate compared to the comfortable deceleration rate will show a potential critical situation for a driver of the following vehicle.

7.3 Validation of the Proposed Algorithm

When a rear-end collision warning system initiates a warning its performance can be evaluated by answering some questions: (a) Was the warning early, late, or appropriate? (b) Has the collision occurred or not? (c) If a collision has occurred, what was the impact velocity? The system performance can be validated with performance measures such as deceleration rate and driver reaction time. An application example is presented to evaluate and validate the performance of the proposed rear-end collision warning algorithm. In application example, the following vehicle is posed to a potential rear-end collision situation. The proposed warning algorithm will initiate the warning if it is determined that the following vehicle is in an uncomfortable driving situation and a rear-end collision may occur. When the warning is issued, the proposed rear-end collision warning algorithm also determines the required deceleration rate to avoid the collision. The same rear-end collision situation was then simulated with the car-following model developed in Chapter 6. Car-following model assumes that the driver is attentive, in the same way when a warning is issued and the driver becomes attentive. To validate the system performance, the deceleration rate produced by the car-following model is compared to the required deceleration rate determined by the proposed rear-end collision warning algorithm. The proposed system

performance is also compared to an existing kinematics-based rear-end collision warning algorithm developed by Burgett et al. (1998) as explained earlier in Chapter 2.

Before presenting an application example, it is necessary to describe the system input and output variables, warning criterion, warning threshold, and assumed assumptions. Table 7.1 summarizes the input and output variables, warning criteria, and warning threshold used in the proposed and Burgett et al. (1998) algorithms. Weather was not considered in testing of these systems since unfavourable roadway conditions can influence the occurrence of a rear-end collision rather than a driver distraction. It is identified that 74% of the rear-end collisions occurred when the drivers were inattentive and 86% of those collisions occurred during the daytime (Baldock et al. 2005). Therefore, it is assumed that the day is sunny, weather is fine, and the driver is inattentive when he/she is posed to a potential rear-end collision situation.

Table 7.1: Description of collision warning systems

Algorithm	Warning Criteria	Warning Threshold	Input Variables	Output Variables
Proposed Algorithm	RF, L_w	$RF \& L_w > 1$	$SF, SL, DF, Age, Gender$	$RF, L_w, RT_w, RT_{st}, Warning, A_r$
Burgett et al. (1998)	R_w	R_w	$SF, SL, DF, RT=1.5 \text{ sec}, A_r=7.35 \text{ m/s}^2$	$R_w, Warning$

In Table 7.1:

R_w = range for the warning and explained earlier in Chapter 2 (Eq. 2.7).

7.3.1 Application Example

It is assumed that a following vehicle is travelling on a level terrain ($g = 0$) at a speed of 100 km/h and approaching a lead vehicle which is stationary at distance of 130 meters. As explained earlier, it is assumed that the driver is distracted and did not observe the stationary lead vehicle. It is also assumed that the driver of the following vehicle is 20 years old and is female. Performance of the proposed and Burgett et al. (1998) algorithms are evaluated for this potential rear-end collision situation. The input and output data based on these two algorithms are described in Table 7.2.

For the given driving situation, the proposed algorithm initiated the warning at a distance of 130 meters while Burgett et al. (1998) algorithm initiated the warning at a warning range of 96 meters. The proposed algorithm calculated the expected reaction time of the driver of the following vehicle as 0.87 sec. The Burgett et al. (1998) algorithm assumes the driver reaction time as 1.5 sec. If the driver of the following vehicle will follow the warning initiated by the proposed algorithm then he/she will start braking at a distance of 106 meters.

Table 7.2: Application example input & output data

Algorithm	Input Data	Output Data
Proposed Algorithm	$SF=100$ km/h, $SL=0$, $DF=130$ m, $Ag=20$, $Gender=Female$	$RF=1.66$, $L_w=1.16$, $RT_{st}=2.39$ sec $RT_w=0.87$ sec, $A_r=3.63$ m/s ² $Warning=Yes$,
Burgett et al. (1998)	$SF=100$ km/h, $SL=0$, $DF=130$ m, $RT=1.5$ sec, $A_r=7.35$ m/s ²	$R_w=96$ m, $Warning=Yes$

The driver of the following vehicle equipped with Burgett et al. (1998) algorithm will start braking at a distance of 54 meters. The proposed algorithm determines the required deceleration rate as 3.63 m/s^2 . The Burgett et al. (1998) algorithm assumes the required deceleration rate of 7.35 m/s^2 . After the initiation of a warning, it is assumed that the driver will become aware of the situation and will follow the required deceleration rate to avoid the potential rear-end collision. The proposed algorithm initiates the warning only when the required deceleration rate is more than the normal or comfortable deceleration rate.

The performance of the proposed and Burgett et al. (1998) algorithms were evaluated by answering the same questions as defined earlier in section 7.3 (Table 7.3). To validate the system performance, the same driving situation was simulated with the car-following simulation model described in Eqs. 7.8 and 7.9 but the condition of comfortable deceleration rate defined in Eq. 7.10 was released. The required deceleration rates of the both algorithms are compared with the average deceleration rate calculated by the car-following simulation model.

Table 7.3: Evaluation and validation of the system performance for application example

Algorithm	Warning/ELA	Collision	Impact Velocity (km/h)	A_r (m/s^2)	ADF (m/s^2)	% Match
Proposed Algorithm	Yes/A	No	0	3.67	4.45	82%
Burgett et al. (1998)	Yes/L	Yes	6 km/h	7.35	6.90	94%

In Table 7.3:

ELA = E stands for “early warning”, L stands for “late warning”, and A stands for “appropriate warning”.

Table 7.3 shows that the proposed algorithm initiates an appropriate warning that avoids the collision and the required deceleration rate also closely matched with the average deceleration rate produced by the car-following simulation model. The required deceleration rate assumed by the Burgett et al. (1998) algorithm also matched with the average deceleration rate produced by the car-following model but it overestimates the required deceleration rate that results in a collision and the warning turns out to be a late warning. Humans are not perfect and one cannot expect that all drivers will follow exactly the same assumed deceleration rate (7.35 m/s^2) for all potential rear-end collision situations, as suggested by the Burgett et al. (1998). Wear and tear of the old cars also reduces the braking capability of the vehicles that may also hamper in achieving the maximum required deceleration rate of 7.35 m/s^2 .

The proposed algorithm calculates the driver reaction time and deceleration rate of the following vehicle based on the driving situation such as speeds of the following and back vehicles, distance headway as well as driver characteristics such as age and gender of the driver of the following vehicle. Since these parameters vary for different drivers, the warning initiated by the proposed algorithm also varies for different types of drivers. If it is supposed that the driver would have been 55 years old female then the proposed algorithm calculates the driver reaction time and the required deceleration rate as 1.7 sec

and 4.72 m/s^2 , respectively. Results also suggest that the warning is only triggered when the required deceleration rate is more than the normal or comfortable deceleration rate. When the lead vehicle is moving, the available deceleration time will be more compared to when the lead vehicle is not moving. The warning is only issued when the RF and L_w will be equal to or more than 1.

7.3.2 Sensitivity Analysis

To further evaluate and validate the proposed system performance, a sensitivity analysis was done in which the driver reaction time and required deceleration rates were tested for potential rear-end collision situations at different speeds and spacing for drivers of different age and gender. Sensitivity analysis depicts that how a given system output depends upon the input parameters for a given driving situation. This is an important method to check the quality, robustness, and reliability of the system output parameters. The warning algorithm depends on the current speeds of the lead and following vehicles, current following distance, and age and gender of the driver of the following vehicle. The output parameters include driver reaction time and deceleration rate of the following vehicles. Each scenario was also simulated with the car-following simulation model (Eqs. 7.7 and 7.8) and deceleration rates (ADF) were compared with the required deceleration rate (A_r) determined by the proposed algorithm. It is evident that the ADF and A_r were closely matched (Table 7.4) that supports the hypothesis that the results produced by the proposed algorithm are reliable.

Table 7.4: Evaluation and validation of the system performance for different scenarios

System Input Data	Impact Velocity (km/h)	RT_w (sec)	RT_{st} (sec)	A_r (m/s ²)	ADF (m/s ²)	% Match
<i>SF=100 km/h, SL=0, DF=130 m, Age=55, Gender=Female</i>	0	1.70	2.45	4.72	5.86	80%
<i>SF=50 km/h, SL=0, DF=30 m, Age=30, Gender=Male</i>	0	0.96	0.62	4.97	5.55	90%
<i>SF=40 km/h, SL=0, DF=20 m, Age=45, Gender=Male</i>	0	1.33	0.47	4.83	5.27	92%
<i>SF=60 km/h, SL=0, DF=40 m, Age=35, Gender=Male</i>	0	1.10	0.81	5.66	6.43	88%

7.4 Summary

The proposed rear-end collision warning algorithm presented in this chapter is a kind of kinematics-based algorithm. The main differences between the proposed algorithm and the existing kinematics-based algorithms are related to the driver reaction time, risk factor, and required deceleration rate. Specifically, the driver reaction time used in the proposed new collision warning algorithm is based on both kinematics and individual driver characteristics. The risk factor which depends on the available and required deceleration times continuously tracks the actions of the following vehicle driver in response to the actions of the lead vehicle. If the driver is attentive and responding properly in response to the actions of the leading vehicle then the risk factor will not allow the algorithm to trigger the warning. This reduces the number of false warnings and will improve

the reliability of the proposed collision warning algorithm. The performance of the proposed rear-end collision warning system was evaluated and validated by presenting an application example and sensitivity analysis for different scenarios. The results of the application example were also compared to an existing Burgett et al. (1998) rear-end collision warning system. It is observed that the proposed system is functioning properly and triggering acceptable and reliable warnings.

CHAPTER 8

CONTRIBUTIONS, CONCLUSIONS, AND FUTURE RESEARCH

This chapter describes a summary of the thesis contributions and presents conclusions and suggestions for future research.

8.1 Thesis Contributions

This thesis presents a driver-sensitive framework for the design of a rear-end collision warning algorithm. The framework comprised of three main components: modelling driver reaction time in car-following situations based on human factors, developing an improved driver-sensitive car-following simulation model, and testing of the proposed new rear-end collision warning system using the developed car-following model. The summary of the contributions and concluding remarks on the framework are described in the following sections.

8.1.1 Contributions in Modelling Driver Reaction Time

A comprehensive driving simulator study was conducted in which car-following simulation scenarios were designed to study the effect of kinematics (speed and spacing) and individual driver characteristics (e.g., age, gender) on driver reaction time. The car-following scenarios tested for modelling the driver reaction time include normal, surprised, stationary, and acceleration regime. These scenarios were designed based on the deceleration behaviour of the lead vehicle. In normal, surprised, and stationary scenarios, the lead vehicle is decelerating with a normal deceleration rate, surprised deceleration rate (more

than normal), and stationary, respectively. It was found that both kinematics (such as the speed and the spacing between the following and lead vehicles) and individual driver characteristics (such age and gender) have significant effects on driver brake reaction time (BRT) in a car-following situation. For a car-following acceleration regime, a visual signal such as speed limit sign was used to determine the driver acceleration reaction time (ADRT). The reaction-time models were developed for all of the tested car-following situations (normal, surprised, stationary, and acceleration regime). The developed reaction-time models were used in developing the car-following model and a rear-end collision warning algorithm.

Overall, this human factors study has explored the effect of driver and situational factors on driver reaction time and presented analytical models for BRT and ADRT which are necessary inputs for car-following and rear-end collision warning algorithms. The driver factors include age, gender, driving experience, and driving intensity and the situational factors include speed, spacing, urgency, and expectancy. Based on this study the following comments are offered:

- 1) The results of this study have important theoretical and practical implications.

The theoretical issues concern the different driver behaviours in the normal, surprised, and stationary conditions and the variables that influence driver reaction time. The reaction time addressed in this study includes brake reaction time and acceleration-deceleration reaction time. The practical issues concern the modelling of the driver reaction time in different driving

situations and its application in car-following and rear-end collision warning algorithms. At higher speeds, for example 90 km/h, every hundredth of a second can reduce the stopping distance by 0.25 m. Therefore, every fraction of a second is important in modelling driver reaction time in a car-following situation.

- 2) The results support the hypothesis that both urgency and expectancy have significant effects on brake reaction time. The age, gender, speed, and distance headway were found to be significant variables that affect BRT in the normal, surprised, and stationary conditions. However, age was not found to be a significant variable in predicting the BRT for the normal scenario when it was combined with gender, speed, and distance headway. The age and gender variables were found to be significant in predicting the acceleration/deceleration reaction time. The study also supports the hypothesis that BRT increases with age and that females are slower than males. The trend of both age and gender is the same in the analysis of BRT and ADRT.
- 3) For the situational factors, the BRT decreases with the increase in speed in the normal scenario, and increases with the increase in speed in the surprised and stationary scenarios. This variation of the speed behaviour is most likely due to the braking behaviour of the lead vehicle. The stationary scenario also acts like a surprised scenario when a lead stationary vehicle appears, for a following vehicle driver, in a surprised way. Therefore, the effect of speed (BRT increases with the speed) in both of these scenarios is the

same. It was also found that the BRT increases with the increase in distance headway in all scenarios. The repeated measures ANOVA and regression analysis do not support the hypothesis that driving experience and driving intensity are significant variables that affect the brake reaction time in a normal, surprised, or stationary scenario.

- 4) The results for the effect of age and gender on BRT agree with those of Broen and Chiang (1996) and Lings (1990), respectively. The results for the effect of speed and distance headway agree with those of Schweitzer et al. (1995). Besides exploring these effects, the thesis research has presented analytical models that are necessary for car-following analysis. Specifically, the BRT model (for the normal scenario) and the ADRT model were useful in modelling the car-following simulation algorithm. The surprised and stationary car-following situations will more likely contribute to a rear-end collision situation compared to normal situations in which the lead vehicle's braking behaviour is within the normal deceleration rates. Therefore, the BRT models for the surprised and stopped conditions are useful in modelling rear-end collision warning systems.

8.1.2 Contributions in Car-following Modelling

This research has presented a new and improved car-following model, based on the system dynamics principles, that has addressed some limitations of existing car-following models. The existing models do not consider driver characteristics in modelling driver behaviour in a car-following situation. Besides, they only use the information associated with the lead vehicle such as its speed and the

spacing between the following and lead vehicles. The proposed car-following model explicitly considers driver characteristics (age and gender) and accounts for the information about the back vehicle in modelling driver behaviour. These improvements represent the key contributions of the present study to car-following modelling. Based on this research, the following comments are offered:

- 1) The proposed car-following model is driver-sensitive and accounts for the information about the back vehicle of the following vehicle. The model assumes that the drivers travel in three regimes: coasting, accelerating, and decelerating. The deceleration regime is further classified into two regimes based on the lead vehicle's braking and non-braking scenarios. The reaction time used in the acceleration and deceleration regimes is assumed to depend on vehicle dynamics and driver characteristics. Unique parameters are developed for the acceleration and deceleration regimes. The results show that the rate of change of speed is higher for the braking deceleration regime than that for the non-braking deceleration regime. The back vehicle can only contribute to the acceleration regime if it is approaching the following vehicle with a speed higher than the speed of the following vehicle.
- 2) The calibration of the parameters was performed using the NGSIM vehicle trajectory data collected on freeways. Therefore, the observations for the calibration parameters may vary for other roadway classes. The calibration process resulted in a sample of driver population that represents the NGSIM data. For validation purposes, the statistical distributions of that sample were used to generate the age and gender values. This was a fair assumption as it

is similar to other calibration parameters that were assumed to represent the NGSIM data.

- 3) This research is the first attempt of car-following modelling in which driver characteristics were considered explicitly in determining the acceleration/deceleration rate of the following vehicle. It was found that males and young drivers drive at higher speeds and lower spacing than females and older drivers, respectively. The model estimates of the spacing and speed profiles of the following vehicle were compared with actual field data and the model showed excellent correspondence.

8.1.3 Contributions in Developing Rear-end Collision Warning Algorithm

This research also proposed a new rear-end collision warning algorithm (RECWA). The proposed RECWA addressed some limitations of the existing systems. The existing systems assume specific values of driver reaction time in their design and evaluation. It is also known that existing algorithms initiate early or late warnings that may undermine their performance and reliability. Based on this research, the following comments are offered:

- 1) Unlike existing rear-end collision warning algorithms, the driver reaction time in the proposed algorithm depends on the driving situation and individual driver characteristics such as age and gender. A risk factor is also introduced which continuously tracks the driver actions in response to the lead vehicle actions. If the driver is attentive and responding properly to the actions of the lead vehicle, the risk factor is less than 1; then the proposed algorithm will not

initiate the warning (Mehmood and Easa 2010b). This will minimize the nuisance warnings and will enhance the reliability of the proposed RECWA.

- 2) The risk factor and the likelihood of warning depend on the available and required deceleration times. The available deceleration time was calculated based on driver reaction time, speed of the following and lead vehicles, and the spacing between them. The required deceleration time depends on the current speed and the comfortable deceleration rate.
- 3) The performance of the proposed RECWA is evaluated by using a car-following simulation model which was developed earlier in this research study. The proposed algorithm initiates the warning when a driver is inattentive and poses a driving condition where the required deceleration rate is higher than the normal or comfortable deceleration rate. The proposed algorithm also calculates the required deceleration rate at the onset of the warning. A sensitivity analysis was done in which a few potential rear-end collision scenarios were simulated, for drivers of different ages and genders, with the car-following simulation model. The required deceleration rates calculated by the proposed rear-end collision warning algorithm closely matched the average deceleration rates predicted by the car-following simulation model. These results proved that the proposed RECWA is functioning properly and producing reliable results.

8.2 Conclusions

The thesis research presented a framework for the development of an in-vehicle rear-end collision warning algorithm (RECWA). The proposed RECWA is a kind of kinematics-based algorithm that considers driver characteristics in its design and evaluation and initiates reliable warnings. As part of the framework development, a human factors study was conducted to model the driver reaction time in car-following scenarios. It is concluded that the driver reaction time in car-following scenarios depends on individual driver characteristics such as age and gender, and kinematics such as the speed of the following vehicle and the spacing between the following and lead vehicles. The driver reaction-time models were used to develop a car-following model that considered driver characteristics and addressed some limitations of the existing models. The improved car-following model considers different driver reaction times in acceleration and deceleration regimes and considers the information of the back vehicle in modelling the car-following driver behaviour. It is concluded that older drivers and females drive at lower speeds and higher spacing compared to young drivers and males, respectively. The car-following model is calibrated and validated with NGSIM individual vehicle tracking data.

The car-following model is validated qualitatively as well as quantitatively. Since driver characteristics are considered in the design of the proposed RECWA, the algorithm will produce timely warnings for the drivers of different ages and genders. The reliability of the proposed algorithm is improved by introducing a risk factor that determines the risk of a potential rear-end collision.

The performance of the proposed algorithm is validated with the developed driver-sensitive car-following simulation model. The results are encouraging and it is concluded that the algorithm is functioning properly. It helps to reduce the likelihood of a collision when issued to a distracted driver.

The human factors that need to be considered in the design of a rear-end collision warning system include driver performance, driver control requirements, driver reaction time, false alarms, warning message timing, baseline driver behaviour, system standardization and guidelines, and warning message modality and design. The factors considered in the design of the proposed rear-end collision warning algorithm include: (a) *Baseline driver behaviour*: a driver behaviour car-following model is developed to evaluate the performance of the proposed RECWA ; *Older drivers*: driver age is considered; (b) *Driver reaction time*, driver reaction-time models are developed based on human factors; (c) *False alarms*, a risk factor is introduced that continuously tracks the driver actions and avoids the possibility of false alarms; and (d) *Warning message timings*: the proposed algorithm only triggers the warning when the crash potential is imminent and driver can observe the potential collision situation.

8.3 Future Research

Further development and refinement of the proposed framework can be carried out with the following future directions.

- 1) The reaction-time models used in this study were calibrated based on the data collected in a “human factors study”. These calibration parameters would

be useful at the early stage of using such a warning system. As the system is used for some time, the system can accumulate such data for the specific user(s) of the vehicle and use them to calibrate driver-specific parameters. The calibration of driver-specific parameters should be further explored in future research.

- 2) It is recommended that other human factors such as system standardization and guidelines, warning message modality and design, driver performance (driver workload), and driver control requirements (controlled parameters for system users) should be studied in the future research or when the proposed algorithm is used to design a prototype rear-end collision warning system.
- 3) Microscopic traffic simulation programs are composed of several models including car-following, lane-change, origin-destination information, and vehicle routing, etc. Like a driver-sensitive car-following model, developed in this thesis, a lane-change model should also be developed that should also incorporate the effect of driver characteristics in the lane-change driver behaviour.
- 4) Once a traffic simulation program containing driver-sensitive car-following and lane-change models is developed, it can be applied for a macroscopic traffic analysis to identify the impact of individual driver characteristics on traffic operations. A survey of age and gender of the drivers expected to use the proposed network or corridor can be conducted to develop the statistical distributions that can be used to generate driver characteristics for a macroscopic traffic analysis.

- 5) Although it is being verified that the proposed rear-end collision warning algorithm is functioning properly, before presenting a commercial product, it should be integrated with a driving simulator or into a real car, and experiments should be conducted to further evaluate its benefits.

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Appendix A

Copies of Consent Agreement and Driver Information Sheet

CONSENT AGREEMENT: DRIVER CAR-FOLLOWING BEHAVIOUR

Investigators: Atif Mehmood PhD Candidate, Department of Civil Engineering, Ryerson University, Said Easa PhD, Department of Civil Engineering, Ryerson University

Purpose of Study: In this part of the study we are examining the effect of different driving conditions on driver's behaviour.

Description of Study: In this study we will be asking you to drive in a car simulator in three driving scenarios. In the scenarios you will be asked to drive down streets and maintain a specific speed (asked at the start of each experiment) and apply brake when you feel may collide with the lead vehicle. The lead vehicle brake lights will be turned on when it will be decelerating. You have to drive and behave just like normal driving in a real world. You will be asked to complete these driving simulations under different driving speeds. Each scenario will take you about three minutes to complete. The entire study will take up to 2 hours to complete (including breaks). Remember, that while the car simulator makes you feel as if you are moving, the car is not really in motion. The data will be obtained from the simulator and will be kept confidential. However, if you are interested to know about your own results, they will be provided to you with this belief that it is not prescriptive or useful for anything other than personal curiosity or knowledge. We are seeking the help of approximately seventy-five individuals. You will also receive a copy of this consent form which contains the names and contact numbers of the study investigators.

Confidentiality: Taking part in this study is entirely your choice and you may ask to stop the session at any time. Your participation (or choice not to participate) has no affect on your status at university/college or at the Life Institute of Ryerson University. Further, when you take part in this study you will be granted total confidentiality. Your name or study results will not be shared with anyone outside of the study investigators. Once the entire study is complete, the information will be used to write a thesis and scholarly paper or for instructional purposes, after this, all the information we collect from you will be destroyed.

Risks and Benefits: The results of this study may help us to better understand driver behaviour at different driving conditions, but the results will not directly benefit you. Being involved in a study may be a new experience for you and because this is new situation you may feel uncomfortable. Recall that you do not have to participate and at any time you may discontinue participation.

Incentives to participate: You will receive \$15/hr for the time you will spend in the experiments.

You will receive this compensation even if you decide to discontinue participation at any time in the study. If your time spent in the experiment is less than an hour you will be given a minimum amount of \$15.

Voluntary nature of participation: Participation in this study is voluntary. Your choice of whether or not to participate will not influence your future relations with Ryerson University. If you decide to participate, you are free to withdraw your consent and to stop your participation at any time without penalty or loss of benefits to which you are allowed. In addition, you may withdraw your consent even after participation, up until the time of our data analysis. At any point in the study you may refuse to complete any scenarios or stop participation altogether.

Questions or Concerns about the Study: If you have any questions or concerns about the research experience feel free to ask them at any time (now, during or after the study). This research has been reviewed and received Ethical Approval by the Research Ethics Board at Ryerson University (Ethics Board contact: Office of Research Services, Ryerson University, 350 Victoria St., Toronto, ON. M5B 2K3, 416-979-5000, ext. 5042 or fax 416-979-5336). If you have any questions about this research or concerns about your treatment as a research participant you may contact Dr. Said Easa at (416) 979-5000 ext. 6451, seasa@gwemail.ryerson.ca or Ryerson's Research Ethics Board (contact information is above).

Agreement:

Your signature below indicates that you have read the information in this agreement and have had a chance to ask any questions you have about the study. Your signature also indicates that you agree to be in the study and have been told that you can change your mind and withdraw your consent to participate at any time. You have been given a copy of this agreement. You have been told that by signing this consent agreement you are not giving up any of your legal rights.

Name of Participant (please print)

Signature of Participant

Date

Signature of Investigator

Date

Table A1: Driver information check list

Scenario	<i>Normal</i>	<i>N</i>
Driver's Name		
Age		
Gender		
Driving Experience		
Average Driving Hrs. per week		
License Type		
<i>Check Mark</i>	<i>Speed (km/h)</i>	<i>Spacing (m)</i>
	100	20
	80	20
	60	20
	100	30
	80	30
	60	30
	100	40
	80	40
	60	40

Appendix B

Independent T-test for Acceleration/Deceleration Reaction Time

T-Test of Equal Means of AC.RT vs DC. R.T

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Ave.AC.RT	.79973	25	.159542	.048104
	Ave.DC R.T	.81000	25	.225954	.068128

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Ave.AC.RT & Ave.DC R.T	25	-.412	.208

Paired Samples Test

		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower				Upper
Pair 1	Ave.AC.RT - Ave.DC.R.T	-.010273	.325894	.098261	-.229211	.208666	-.105	24	.919

Appendix C

Repeated Measure ANOVA Analysis for Normal Scenario

Repeated Measure ANOVA for BRT: Normal Scenario

This appendix shows the results of repeated measure ANOVA analysis of BRT for normal scenario. The appendix includes:

- 1- Description of within and between subject factors
- 2- Descriptive statistics such as mean and standard deviation
- 3- Mauchly's test of Sphericity that examines the form of the common covariance matrix. A spherical matrix has equal variances and covariances equal to zero. The common covariance matrix of the transformed within-subject variables must be spherical, or the F tests and associated p values for the univariate approach to testing within-subjects hypotheses are invalid. If sphericity assumption is violated then SPSS performs the correct tests to check the effect of within subject factors.
- 4- Tests to show the within subject effects
- 5- Tests to show the trend of models for combination of different variables
- 6- Tests to show the between subject effects
- 7- Marginal means of BRT for all variables
- 8- Profile Plots that show the graphical representation of marginal means of BRT for each variable.

Within-Subjects Factors

Measure: brt

sphdy	Dependent Variable
1	BRT.60.20
2	BRT.60.30
3	BRT.60.40
4	BRT.80.20
5	BRT.80.30
6	BRT.80.40
7	BRT.100.20
8	BRT.100.30
9	BRT.100.40

Between-Subjects Factors

	Value Label	N
Age	middle	35
	old	16
	young	8
Gender	0	31
	1	28
Dr.Exp	Beginner	20
	M.Exp.	18
	W.Exp.	21
	Total	59
Dr.Hrs.perWeek	Ex.Dr	11
	N.Dr.	48

Descriptive Statistics

	Age	Gender	Dr.Exp	Dr.Hrs.perWeek	Mean	Std. Deviation	N
BRT.60.20	middle	Male	Beginner	Ex.Dr	1.2000	.	1
				N.Dr.	.9400	.09899	2
				Total	1.0267	.16563	3
			M.Exp.	Ex.Dr	.8000	.	1
				N.Dr.	.8700	.	1
				Total	.8350	.04950	2
			W.Exp.	Ex.Dr	.8900	.26851	3
				N.Dr.	.9310	.22223	10
				Total	.9215	.22222	13
	old	Male	Beginner	Ex.Dr	.9340	.24429	5
				N.Dr.	.9277	.19537	13
				Total	.9294	.20247	18
			M.Exp.	Ex.Dr	.6700	.	1
				N.Dr.	1.0125	.14558	8
				Total			
			W.Exp.	Ex.Dr			
				N.Dr.			
				Total			
	young	Female	Beginner	Ex.Dr			
				N.Dr.			
				Total			
			M.Exp.	Ex.Dr			
				N.Dr.			
				Total			
			W.Exp.	Ex.Dr			
				N.Dr.			
				Total			

			Total	.9744	.17770	9
		M.Exp.	Ex.Dr	1.2000	.	1
			Total	1.2000	.	1
		W.Exp.	N.Dr.	.8729	.15337	7
			Total	.8729	.15337	7
		Total	Ex.Dr	.9350	.37477	2
			N.Dr.	.9473	.16087	15
			Total	.9459	.17731	17
	Total	Beginner	Ex.Dr	.9350	.37477	2
			N.Dr.	.9980	.13604	10
			Total	.9875	.16885	12
		M.Exp.	Ex.Dr	1.0000	.28284	2
			N.Dr.	.8700	.	1
			Total	.9567	.21362	3
		W.Exp.	Ex.Dr	.8900	.26851	3
			N.Dr.	.9071	.19358	17
			Total	.9045	.19795	20
	Total		Ex.Dr	.9343	.25139	7
			N.Dr.	.9382	.17459	28
			Total	.9374	.18804	35
old	Male	M.Exp.	Ex.Dr	.6700	.	1
			N.Dr.	.8686	.13934	7
			Total	.8438	.14687	8
		W.Exp.	N.Dr.	.8100	.	1
			Total	.8100	.	1
	Total		Ex.Dr	.6700	.	1
			N.Dr.	.8613	.13065	8
			Total	.8400	.13784	9
	Female	M.Exp.	Ex.Dr	.9800	.10149	3
			N.Dr.	1.0350	.20372	4
			Total	1.0114	.15826	7
	Total		Ex.Dr	.9800	.10149	3
			N.Dr.	1.0350	.20372	4
			Total	1.0114	.15826	7
	Total	M.Exp.	Ex.Dr	.9025	.17576	4
			N.Dr.	.9291	.17649	11
			Total	.9220	.17034	15
		W.Exp.	N.Dr.	.8100	.	1
			Total	.8100	.	1
	Total		Ex.Dr	.9025	.17576	4
			N.Dr.	.9192	.17175	12
			Total	.9150	.16693	16
young	Male	Beginner	N.Dr.	.8500	.13216	4
			Total	.8500	.13216	4
	Total		N.Dr.	.8500	.13216	4
			Total	.8500	.13216	4
	Female	Beginner	N.Dr.	.9850	.22576	4
			Total	.9850	.22576	4
	Total		N.Dr.	.9850	.22576	4
			Total	.9850	.22576	4
	Total	Beginner	N.Dr.	.9175	.18584	8

BRT.60.30	Total	Male	Total	Total	.9175	.18584	8		
				N.Dr.	.9175	.18584	8		
				Total	.9175	.18584	8		
				Beginner	Ex.Dr	1.2000	.	1	
					N.Dr.	.8800	.12083	6	
			Total		.9257	.16369	7		
			M.Exp.	Ex.Dr	.7350	.09192	2		
				N.Dr.	.8688	.12900	8		
				Total	.8420	.13062	10		
			W.Exp.	Ex.Dr	.8900	.26851	3		
				N.Dr.	.9200	.21396	11		
				Total	.9136	.21557	14		
			Total	Ex.Dr	.8900	.24364	6		
				N.Dr.	.8940	.16596	25		
				Total	.8932	.17869	31		
			Female	Beginner	Ex.Dr	.6700	.	1	
					N.Dr.	1.0033	.16604	12	
					Total	.9777	.18390	13	
					M.Exp.	Ex.Dr	1.0350	.13772	4
						N.Dr.	1.0350	.20372	4
				Total		1.0350	.16098	8	
				W.Exp.	N.Dr.	.8729	.15337	7	
					Total	.8729	.15337	7	
					Total	Ex.Dr	.9620	.20216	5
				N.Dr.		.9691	.17388	23	
	Total	.9679		.17521		28			
	Total	Beginner		Ex.Dr	.9350	.37477	2		
				N.Dr.	.9622	.16035	18		
				Total	.9595	.17455	20		
		M.Exp.		Ex.Dr	.9350	.19254	6		
				N.Dr.	.9242	.16914	12		
				Total	.9278	.17159	18		
		W.Exp.		Ex.Dr	.8900	.26851	3		
				N.Dr.	.9017	.18919	18		
				Total	.9000	.19404	21		
		Total		Ex.Dr	.9227	.21781	11		
	N.Dr.			.9300	.17221	48			
	Total			.9286	.17950	59			
	middle	Male		Beginner	Ex.Dr	1.0000	.	1	
					N.Dr.	1.0900	.16971	2	
			Total		1.0600	.13077	3		
			M.Exp.	Ex.Dr	1.1300	.	1		
				N.Dr.	1.1400	.	1		
				Total	1.1350	.00707	2		
			W.Exp.	Ex.Dr	1.2267	.53529	3		
				N.Dr.	1.0700	.14414	10		
				Total	1.1062	.26088	13		
			Total	Ex.Dr	1.1620	.39143	5		
				N.Dr.	1.0785	.13558	13		
				Total	1.1017	.22474	18		
Female			Beginner	Ex.Dr	.9400	.	1		
				N.Dr.	1.2950	.17163	8		
				Total	1.2556	.19944	9		

				M.Exp.	Ex.Dr	1.4000	.	1
					Total	1.4000	.	1
				W.Exp.	N.Dr.	1.3157	.24636	7
					Total	1.3157	.24636	7
				Total	Ex.Dr	1.1700	.32527	2
					N.Dr.	1.3047	.20213	15
					Total	1.2888	.21062	17
			Total	Beginner	Ex.Dr	.9700	.04243	2
					N.Dr.	1.2540	.18325	10
					Total	1.2067	.19965	12
				M.Exp.	Ex.Dr	1.2650	.19092	2
					N.Dr.	1.1400	.	1
					Total	1.2233	.15308	3
				W.Exp.	Ex.Dr	1.2267	.53529	3
					N.Dr.	1.1712	.22358	17
					Total	1.1795	.26957	20
			Total		Ex.Dr	1.1643	.34611	7
					N.Dr.	1.1996	.20628	28
					Total	1.1926	.23481	35
	old	Male	M.Exp.	Ex.Dr	1.2000	.	.	1
				N.Dr.	1.1971	.22028	.	7
				Total	1.1975	.20394	.	8
			W.Exp.	N.Dr.	1.4100	.	.	1
				Total	1.4100	.	.	1
			Total	Ex.Dr	1.2000	.	.	1
				N.Dr.	1.2238	.21738	.	8
				Total	1.2211	.20350	.	9
		Female	M.Exp.	Ex.Dr	1.0267	.23116	.	3
				N.Dr.	1.3300	.30299	.	4
				Total	1.2000	.30000	.	7
			Total	Ex.Dr	1.0267	.23116	.	3
				N.Dr.	1.3300	.30299	.	4
				Total	1.2000	.30000	.	7
		Total	M.Exp.	Ex.Dr	1.0700	.20769	.	4
				N.Dr.	1.2455	.24728	.	11
				Total	1.1987	.24366	.	15
			W.Exp.	N.Dr.	1.4100	.	.	1
				Total	1.4100	.	.	1
			Total	Ex.Dr	1.0700	.20769	.	4
				N.Dr.	1.2592	.24051	.	12
				Total	1.2119	.24125	.	16
	young	Male	Beginner	N.Dr.	1.0850	.08347	.	4
				Total	1.0850	.08347	.	4
				Total	1.0850	.08347	.	4
		Female	Beginner	Total	1.0850	.08347	.	4
				N.Dr.	1.1175	.09946	.	4
				Total	1.1175	.09946	.	4
		Total		N.Dr.	1.1175	.09946	.	4

BRT.60.40	middle	Male	Total	Beginner	Total	1.1175	.09946	4																																																																																											
					N.Dr.	1.1013	.08676	8																																																																																											
					Total	1.1013	.08676	8																																																																																											
					N.Dr.	1.1013	.08676	8																																																																																											
					Total	1.1013	.08676	8																																																																																											
					BRT.60.40	middle	Male	Total	Male	Beginner	Ex.Dr	1.0000	.	1																																																																																					
											N.Dr.	1.0867	.09973	6																																																																																					
											Total	1.0743	.09676	7																																																																																					
											BRT.60.40	middle	Male	Total	Male	M.Exp.	Ex.Dr	1.1650	.04950	2																																																																															
																	N.Dr.	1.1900	.20494	8																																																																															
																	Total	1.1850	.18180	10																																																																															
																	BRT.60.40	middle	Male	Total	Male	W.Exp.	Ex.Dr	1.2267	.53529	3																																																																									
																							N.Dr.	1.1009	.17091	11																																																																									
																							Total	1.1279	.26347	14																																																																									
																							BRT.60.40	middle	Male	Total	Male	Total	Ex.Dr	1.1683	.35045	6																																																																			
																													N.Dr.	1.1260	.16892	25																																																																			
																													Total	1.1342	.20877	31																																																																			
																													BRT.60.40	middle	Male	Total	Female	Beginner	Ex.Dr	.9400	.	1																																																													
																																			N.Dr.	1.2358	.17053	12																																																													
																																			Total	1.2131	.18273	13																																																													
																																			BRT.60.40	middle	Male	Total	Female	M.Exp.	Ex.Dr	1.1200	.26546	4																																																							
																																									N.Dr.	1.3300	.30299	4																																																							
																																									Total	1.2250	.28661	8																																																							
																																									BRT.60.40	middle	Male	Total	Female	W.Exp.	N.Dr.	1.3157	.24636	7																																																	
																																															Total	1.3157	.24636	7																																																	
																																															BRT.60.40	middle	Male	Total	Female	Total	Ex.Dr	1.0840	.24358	5																																											
																																																					N.Dr.	1.2765	.21336	23																																											
																																																					Total	1.2421	.22698	28																																											
																																																					BRT.60.40	middle	Male	Total	Total	Beginner	Ex.Dr	.9700	.04243	2																																					
																																																											N.Dr.	1.1861	.16425	18																																					
																																																											Total	1.1645	.16929	20																																					
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																																																																	Total	1.2028	.22746	18																															
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																																																																							N.Dr.	1.1844	.22409	18																									
																																																																							Total	1.1905	.26752	21																									
																																																																							BRT.60.40	middle	Male	Total	Total	Total	Ex.Dr	1.1300	.29509	11																			
																																																																													N.Dr.	1.1981	.20409	48																			
																																																																													Total	1.1854	.22245	59																			
																																																																													BRT.60.40	middle	Male	Total	Male	Beginner	Ex.Dr	1.6000	.	1													
																																																																																			N.Dr.	2.2200	.21213	2													
																																																																																			Total	2.0133	.38812	3													
																																																																																			BRT.60.40	middle	Male	Total	Male	M.Exp.	Ex.Dr	1.9300	.	1							
																																																																																									N.Dr.	1.8000	.	1							
																																																																																									Total	1.8650	.09192	2							
																																																																																									BRT.60.40	middle	Male	Total	Male	W.Exp.	Ex.Dr	2.0267	.32470	3	
																																																																																															N.Dr.	1.9040	.31146	10	
Total	1.9323	.30532	13																																																																																																
BRT.60.40	middle	Male	Total	Total																																																																																											Total	Ex.Dr	1.9220	.29474	5
																																																																																																N.Dr.	1.9446	.30374	13

			Total	1.9383	.29270	18
	Female	Beginner	Ex.Dr	1.9400	.	1
			N.Dr.	2.2875	.35776	8
			Total	2.2489	.35413	9
		M.Exp.	Ex.Dr	1.9400	.	1
			Total	1.9400	.	1
		W.Exp.	N.Dr.	1.9200	.18735	7
			Total	1.9200	.18735	7
		Total	Ex.Dr	1.9400	.00000	2
			N.Dr.	2.1160	.33920	15
			Total	2.0953	.32263	17
	Total	Beginner	Ex.Dr	1.7700	.24042	2
			N.Dr.	2.2740	.32459	10
			Total	2.1900	.36048	12
		M.Exp.	Ex.Dr	1.9350	.00707	2
			N.Dr.	1.8000	.	1
			Total	1.8900	.07810	3
		W.Exp.	Ex.Dr	2.0267	.32470	3
			N.Dr.	1.9106	.26037	17
			Total	1.9280	.26457	20
		Total	Ex.Dr	1.9271	.24081	7
			N.Dr.	2.0364	.32900	28
			Total	2.0146	.31330	35
old	Male	M.Exp.	Ex.Dr	1.6700	.	1
			N.Dr.	2.0029	.27232	7
			Total	1.9613	.27823	8
		W.Exp.	N.Dr.	2.0000	.	1
			Total	2.0000	.	1
		Total	Ex.Dr	1.6700	.	1
			N.Dr.	2.0025	.25212	8
			Total	1.9656	.26058	9
	Female	M.Exp.	Ex.Dr	2.0700	.07000	3
			N.Dr.	1.9350	.26134	4
			Total	1.9929	.20246	7
		Total	Ex.Dr	2.0700	.07000	3
			N.Dr.	1.9350	.26134	4
			Total	1.9929	.20246	7
	Total	M.Exp.	Ex.Dr	1.9700	.20801	4
			N.Dr.	1.9782	.25721	11
			Total	1.9760	.23778	15
		W.Exp.	N.Dr.	2.0000	.	1
			Total	2.0000	.	1
		Total	Ex.Dr	1.9700	.20801	4
			N.Dr.	1.9800	.24532	12
			Total	1.9775	.22980	16
young	Male	Beginner	N.Dr.	1.6500	.11518	4
			Total	1.6500	.11518	4
		Total	N.Dr.	1.6500	.11518	4
			Total	1.6500	.11518	4
	Female	Beginner	N.Dr.	1.7200	.31570	4
			Total	1.7200	.31570	4
		Total	N.Dr.	1.7200	.31570	4
			Total	1.7200	.31570	4

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				Total	Ex.Dr	.8280	.19305	5
					N.Dr.	.9162	.16480	13
					Total	.8917	.17202	18
		Female	Beginner	Ex.Dr	.6700	.	.	1
				N.Dr.	1.0138	.13553	.	8
				Total	.9756	.17089	.	9
			M.Exp.	Ex.Dr	.8700	.	.	1
				Total	.8700	.	.	1
			W.Exp.	N.Dr.	.8971	.12867	.	7
				Total	.8971	.12867	.	7
			Total	Ex.Dr	.7700	.14142	.	2
				N.Dr.	.9593	.14109	.	15
				Total	.9371	.15041	.	17
		Total	Beginner	Ex.Dr	.8700	.28284	.	2
				N.Dr.	.9910	.13715	.	10
				Total	.9708	.15774	.	12
			M.Exp.	Ex.Dr	.8650	.00707	.	2
				N.Dr.	1.1300	.	.	1
				Total	.9533	.15308	.	3
			W.Exp.	Ex.Dr	.7367	.17954	.	3
				N.Dr.	.8976	.14910	.	17
				Total	.8735	.15998	.	20
			Total	Ex.Dr	.8114	.17024	.	7
				N.Dr.	.9393	.15124	.	28
				Total	.9137	.16116	.	35
	old	Male	M.Exp.	Ex.Dr	.8000	.	.	1
				N.Dr.	.8971	.15074	.	7
				Total	.8850	.14373	.	8
			W.Exp.	N.Dr.	1.0000	.	.	1
				Total	1.0000	.	.	1
			Total	Ex.Dr	.8000	.	.	1
				N.Dr.	.9100	.14422	.	8
				Total	.8978	.13980	.	9
		Female	M.Exp.	Ex.Dr	.7567	.10263	.	3
				N.Dr.	.8825	.17840	.	4
				Total	.8286	.15475	.	7
			Total	Ex.Dr	.7567	.10263	.	3
				N.Dr.	.8825	.17840	.	4
				Total	.8286	.15475	.	7
		Total	M.Exp.	Ex.Dr	.7675	.08655	.	4
				N.Dr.	.8918	.15243	.	11
				Total	.8587	.14643	.	15
			W.Exp.	N.Dr.	1.0000	.	.	1
				Total	1.0000	.	.	1
			Total	Ex.Dr	.7675	.08655	.	4
				N.Dr.	.9008	.14866	.	12
				Total	.8675	.14581	.	16
young	Male	Beginner	N.Dr.	.8825	.09946	.	.	4
			Total	.8825	.09946	.	.	4
			N.Dr.	.8825	.09946	.	.	4
		Total	N.Dr.	.8825	.09946	.	.	4
			Total	.8825	.09946	.	.	4
			N.Dr.	.9050	.16823	.	.	4
	Female	Beginner	N.Dr.					

			Total	Total	.9050	.16823	4
			Total	N.Dr.	.9050	.16823	4
			Total	Total	.9050	.16823	4
		Total	Beginner	N.Dr.	.8938	.12850	8
			Total	Total	.8938	.12850	8
		Total	Total	N.Dr.	.8938	.12850	8
			Total	Total	.8938	.12850	8
	Total	Male	Beginner	Ex.Dr	1.0700	.	1
				N.Dr.	.8883	.10008	6
			Total	Total	.9143	.11429	7
			M.Exp.	Ex.Dr	.8300	.04243	2
				N.Dr.	.9263	.16204	8
			Total	Total	.9070	.14922	10
			W.Exp.	Ex.Dr	.7367	.17954	3
				N.Dr.	.9073	.16304	11
			Total	Total	.8707	.17517	14
			Total	Ex.Dr	.8233	.17305	6
				N.Dr.	.9088	.14501	25
			Total	Total	.8923	.15163	31
		Female	Beginner	Ex.Dr	.6700	.	1
				N.Dr.	.9775	.14925	12
			Total	Total	.9538	.16641	13
			M.Exp.	Ex.Dr	.7850	.10116	4
				N.Dr.	.8825	.17840	4
			Total	Total	.8338	.14402	8
			W.Exp.	N.Dr.	.8971	.12867	7
			Total	Total	.8971	.12867	7
			Total	Ex.Dr	.7620	.10159	5
				N.Dr.	.9365	.14810	23
			Total	Total	.9054	.15503	28
		Total	Beginner	Ex.Dr	.8700	.28284	2
				N.Dr.	.9478	.13867	18
			Total	Total	.9400	.14829	20
			M.Exp.	Ex.Dr	.8000	.08390	6
				N.Dr.	.9117	.16078	12
			Total	Total	.8744	.14742	18
			W.Exp.	Ex.Dr	.7367	.17954	3
				N.Dr.	.9033	.14665	18
			Total	Total	.8795	.15835	21
			Total	Ex.Dr	.7955	.14187	11
				N.Dr.	.9221	.14560	48
			Total	Total	.8985	.15206	59
BRT.80.30	middle	Male	Beginner	Ex.Dr	1.0700	.	1
				N.Dr.	1.0800	.21213	2
			Total	Total	1.0767	.15011	3
			M.Exp.	Ex.Dr	1.0600	.	1
				N.Dr.	1.4700	.	1
			Total	Total	1.2650	.28991	2
			W.Exp.	Ex.Dr	.8667	.20502	3
				N.Dr.	1.1160	.31384	10
			Total	Total	1.0585	.30468	13

				Total	Ex.Dr	.9460	.18119	5
					N.Dr.	1.1377	.29626	13
					Total	1.0844	.27836	18
		Female	Beginner		Ex.Dr	.8000	.	1
					N.Dr.	1.3338	.17196	8
					Total	1.2744	.23985	9
			M.Exp.		Ex.Dr	1.1400	.	1
					Total	1.1400	.	1
					N.Dr.	1.0971	.15681	7
			W.Exp.		Total	1.0971	.15681	7
					Ex.Dr	.9700	.24042	2
					N.Dr.	1.2233	.20063	15
		Total	Beginner		Total	1.1935	.21427	17
					Ex.Dr	.9350	.19092	2
					N.Dr.	1.2830	.19861	10
			M.Exp.		Total	1.2250	.23224	12
					Ex.Dr	1.1000	.05657	2
					N.Dr.	1.4700	.	1
			W.Exp.		Total	1.2233	.21733	3
					Ex.Dr	.8667	.20502	3
					N.Dr.	1.1082	.25439	17
		Total			Total	1.0720	.25837	20
					Ex.Dr	.9529	.17792	7
					N.Dr.	1.1836	.24854	28
		old	Male		Total	1.1374	.25181	35
					Ex.Dr	1.6400	.	1
					N.Dr.	1.1414	.16708	7
			W.Exp.		Total	1.2038	.23452	8
					N.Dr.	1.2000	.	1
					Total	1.2000	.	1
			M.Exp.		Ex.Dr	1.6400	.	1
					N.Dr.	1.1488	.15606	8
					Total	1.2033	.21937	9
		Female	M.Exp.		Ex.Dr	1.2233	.16623	3
					N.Dr.	1.2325	.20855	4
					Total	1.2286	.17601	7
		Total			Ex.Dr	1.2233	.16623	3
					N.Dr.	1.2325	.20855	4
					Total	1.2286	.17601	7
		Total	M.Exp.		Ex.Dr	1.3275	.24865	4
					N.Dr.	1.1745	.17863	11
					Total	1.2153	.20234	15
			W.Exp.		N.Dr.	1.2000	.	1
					Total	1.2000	.	1
		Total			Ex.Dr	1.3275	.24865	4
					N.Dr.	1.1767	.17047	12
					Total	1.2144	.19552	16
		young	Male	Beginner	N.Dr.	1.1425	.15174	4

			Total	Total	1.1425	.15174	4
			Total	N.Dr.	1.1425	.15174	4
			Total	Total	1.1425	.15174	4
		Female	Beginner	N.Dr.	1.0625	.10243	4
			Total	Total	1.0625	.10243	4
			Total	N.Dr.	1.0625	.10243	4
			Total	Total	1.0625	.10243	4
		Total	Beginner	N.Dr.	1.1025	.12725	8
			Total	Total	1.1025	.12725	8
			Total	N.Dr.	1.1025	.12725	8
			Total	Total	1.1025	.12725	8
	Total	Male	Beginner	Ex.Dr	1.0700	.	1
				N.Dr.	1.1217	.15446	6
				Total	1.1143	.14234	7
			M.Exp.	Ex.Dr	1.3500	.41012	2
				N.Dr.	1.1825	.19345	8
				Total	1.2160	.22974	10
			W.Exp.	Ex.Dr	.8667	.20502	3
				N.Dr.	1.1236	.29881	11
				Total	1.0686	.29516	14
			Total	Ex.Dr	1.0617	.32640	6
				N.Dr.	1.1420	.23215	25
				Total	1.1265	.24882	31
		Female	Beginner	Ex.Dr	.8000	.	1
				N.Dr.	1.2433	.19878	12
				Total	1.2092	.22659	13
			M.Exp.	Ex.Dr	1.2025	.14198	4
				N.Dr.	1.2325	.20855	4
				Total	1.2175	.16594	8
			W.Exp.	N.Dr.	1.0971	.15681	7
				Total	1.0971	.15681	7
			Total	Ex.Dr	1.1220	.21799	5
				N.Dr.	1.1970	.19227	23
				Total	1.1836	.19498	28
		Total	Beginner	Ex.Dr	.9350	.19092	2
				N.Dr.	1.2028	.18992	18
				Total	1.1760	.20244	20
			M.Exp.	Ex.Dr	1.2517	.22702	6
				N.Dr.	1.1992	.19048	12
				Total	1.2167	.19820	18
			W.Exp.	Ex.Dr	.8667	.20502	3
				N.Dr.	1.1133	.24774	18
				Total	1.0781	.25337	21
			Total	Ex.Dr	1.0891	.27068	11
				N.Dr.	1.1683	.21352	48
				Total	1.1536	.22483	59
BRT.80.40	middle	Male	Beginner	Ex.Dr	1.6700	.	1
				N.Dr.	1.9000	.14142	2
				Total	1.8233	.16623	3
			M.Exp.	Ex.Dr	1.9400	.	1
				N.Dr.	1.8700	.	1
				Total	1.9050	.04950	2
			W.Exp.	Ex.Dr	1.8200	.17088	3

			N.Dr.	1.8850	.22392	10
			Total	1.8700	.20805	13
		Total	Ex.Dr	1.8140	.15421	5
			N.Dr.	1.8862	.19831	13
			Total	1.8661	.18564	18
	Female	Beginner	Ex.Dr	1.9300	.	1
			N.Dr.	2.0600	.31857	8
			Total	2.0456	.30113	9
		M.Exp.	Ex.Dr	1.9300	.	1
			Total	1.9300	.	1
		W.Exp.	N.Dr.	1.9157	.27628	7
			Total	1.9157	.27628	7
		Total	Ex.Dr	1.9300	.00000	2
			N.Dr.	1.9927	.29834	15
			Total	1.9853	.27985	17
	Total	Beginner	Ex.Dr	1.8000	.18385	2
			N.Dr.	2.0280	.29276	10
			Total	1.9900	.28473	12
		M.Exp.	Ex.Dr	1.9350	.00707	2
			N.Dr.	1.8700	.	1
			Total	1.9133	.03786	3
		W.Exp.	Ex.Dr	1.8200	.17088	3
			N.Dr.	1.8976	.23889	17
			Total	1.8860	.22791	20
		Total	Ex.Dr	1.8471	.13805	7
			N.Dr.	1.9432	.25798	28
			Total	1.9240	.24028	35
old	Male	M.Exp.	Ex.Dr	1.9000	.	1
			N.Dr.	1.8029	.25650	7
			Total	1.8150	.23994	8
		W.Exp.	N.Dr.	1.8000	.	1
			Total	1.8000	.	1
		Total	Ex.Dr	1.9000	.	1
			N.Dr.	1.8025	.23747	8
			Total	1.8133	.22450	9
	Female	M.Exp.	Ex.Dr	2.1800	.20298	3
			N.Dr.	1.9525	.14997	4
			Total	2.0500	.19942	7
		Total	Ex.Dr	2.1800	.20298	3
			N.Dr.	1.9525	.14997	4
			Total	2.0500	.19942	7
	Total	M.Exp.	Ex.Dr	2.1100	.21695	4
			N.Dr.	1.8573	.22786	11
			Total	1.9247	.24608	15
		W.Exp.	N.Dr.	1.8000	.	1
			Total	1.8000	.	1
		Total	Ex.Dr	2.1100	.21695	4
			N.Dr.	1.8525	.21789	12
			Total	1.9169	.23977	16
young	Male	Beginner	N.Dr.	1.7500	.07958	4

			Total	1.7500	.07958	4
		Total	N.Dr.	1.7500	.07958	4
			Total	1.7500	.07958	4
	Female	Beginner	N.Dr.	1.7850	.13503	4
			Total	1.7850	.13503	4
		Total	N.Dr.	1.7850	.13503	4
			Total	1.7850	.13503	4
	Total	Beginner	N.Dr.	1.7675	.10430	8
			Total	1.7675	.10430	8
		Total	N.Dr.	1.7675	.10430	8
			Total	1.7675	.10430	8
Total	Male	Beginner	Ex.Dr	1.6700	.	1
			N.Dr.	1.8000	.11747	6
			Total	1.7814	.11796	7
		M.Exp.	Ex.Dr	1.9200	.02828	2
			N.Dr.	1.8113	.23865	8
			Total	1.8330	.21562	10
		W.Exp.	Ex.Dr	1.8200	.17088	3
			N.Dr.	1.8773	.21397	11
			Total	1.8650	.20076	14
		Total	Ex.Dr	1.8283	.14233	6
			N.Dr.	1.8376	.19967	25
			Total	1.8358	.18784	31
	Female	Beginner	Ex.Dr	1.9300	.	1
			N.Dr.	1.9683	.29646	12
			Total	1.9654	.28404	13
		M.Exp.	Ex.Dr	2.1175	.20759	4
			N.Dr.	1.9525	.14997	4
			Total	2.0350	.18944	8
		W.Exp.	N.Dr.	1.9157	.27628	7
			Total	1.9157	.27628	7
		Total	Ex.Dr	2.0800	.19837	5
			N.Dr.	1.9496	.26151	23
			Total	1.9729	.25326	28
	Total	Beginner	Ex.Dr	1.8000	.18385	2
			N.Dr.	1.9122	.25999	18
			Total	1.9010	.25190	20
		M.Exp.	Ex.Dr	2.0517	.19083	6
			N.Dr.	1.8583	.21729	12
			Total	1.9228	.22373	18
		W.Exp.	Ex.Dr	1.8200	.17088	3
			N.Dr.	1.8922	.23290	18
			Total	1.8819	.22293	21
		Total	Ex.Dr	1.9427	.20771	11
			N.Dr.	1.8913	.23572	48
			Total	1.9008	.22994	59
BRT.100.20	middle	Male	Beginner	Ex.Dr	1.1400	1
			N.Dr.	1.0700	.09899	2

			Total	1.0933	.08083	3
		M.Exp.	Ex.Dr	.8000	.	1
			N.Dr.	.8700	.	1
			Total	.8350	.04950	2
		W.Exp.	Ex.Dr	.8467	.08083	3
			N.Dr.	.8220	.25099	10
			Total	.8277	.22012	13
		Total	Ex.Dr	.8960	.14926	5
			N.Dr.	.8638	.23793	13
			Total	.8728	.21312	18
	Female	Beginner	Ex.Dr	1.0100	.	1
			N.Dr.	.9675	.18453	8
			Total	.9722	.17319	9
		M.Exp.	Ex.Dr	1.2100	.	1
			Total	1.2100	.	1
		W.Exp.	N.Dr.	.8429	.13326	7
			Total	.8429	.13326	7
		Total	Ex.Dr	1.1100	.14142	2
			N.Dr.	.9093	.16964	15
			Total	.9329	.17570	17
	Total	Beginner	Ex.Dr	1.0750	.09192	2
			N.Dr.	.9880	.17158	10
			Total	1.0025	.16125	12
		M.Exp.	Ex.Dr	1.0050	.28991	2
			N.Dr.	.8700	.	1
			Total	.9600	.21932	3
		W.Exp.	Ex.Dr	.8467	.08083	3
			N.Dr.	.8306	.20544	17
			Total	.8330	.19043	20
		Total	Ex.Dr	.9571	.17056	7
			N.Dr.	.8882	.20153	28
			Total	.9020	.19537	35
old	Male	M.Exp.	Ex.Dr	1.2000	.	1
			N.Dr.	.7914	.13969	7
			Total	.8425	.19389	8
		W.Exp.	N.Dr.	.9300	.	1
			Total	.9300	.	1
		Total	Ex.Dr	1.2000	.	1
			N.Dr.	.8088	.13830	8
			Total	.8522	.18370	9
	Female	M.Exp.	Ex.Dr	.9567	.32470	3
			N.Dr.	.8850	.30989	4
			Total	.9157	.29091	7
		Total	Ex.Dr	.9567	.32470	3
			N.Dr.	.8850	.30989	4
			Total	.9157	.29091	7
	Total	M.Exp.	Ex.Dr	1.0175	.29170	4
			N.Dr.	.8255	.20675	11
			Total	.8767	.23769	15
		W.Exp.	N.Dr.	.9300	.	1
			Total	.9300	.	1
		Total	Ex.Dr	1.0175	.29170	4
			N.Dr.	.8342	.19943	12
			Total	.8800	.23001	16

	young	Male	Beginner	N.Dr.	.7650	.15546	4
				Total	.7650	.15546	4
			Total	N.Dr.	.7650	.15546	4
			Total		.7650	.15546	4
		Female	Beginner	N.Dr.	.9850	.13988	4
				Total	.9850	.13988	4
			Total	N.Dr.	.9850	.13988	4
			Total		.9850	.13988	4
		Total	Beginner	N.Dr.	.8750	.18048	8
				Total	.8750	.18048	8
			Total	N.Dr.	.8750	.18048	8
			Total		.8750	.18048	8
	Total	Male	Beginner	Ex.Dr	1.1400	.	1
				N.Dr.	.8667	.20314	6
				Total	.9057	.21228	7
			M.Exp.	Ex.Dr	1.0000	.28284	2
				N.Dr.	.8013	.13228	8
				Total	.8410	.17182	10
			W.Exp.	Ex.Dr	.8467	.08083	3
				N.Dr.	.8318	.24033	11
				Total	.8350	.21324	14
			Total	Ex.Dr	.9467	.18228	6
				N.Dr.	.8304	.19591	25
				Total	.8529	.19601	31
		Female	Beginner	Ex.Dr	1.0100	.	1
				N.Dr.	.9733	.16456	12
				Total	.9762	.15788	13
			M.Exp.	Ex.Dr	1.0200	.29383	4
				N.Dr.	.8850	.30989	4
				Total	.9525	.28873	8
			W.Exp.	N.Dr.	.8429	.13326	7
				Total	.8429	.13326	7
			Total	Ex.Dr	1.0180	.25450	5
				N.Dr.	.9183	.18746	23
				Total	.9361	.19936	28
		Total	Beginner	Ex.Dr	1.0750	.09192	2
				N.Dr.	.9378	.17982	18
				Total	.9515	.17652	20
			M.Exp.	Ex.Dr	1.0133	.26059	6
				N.Dr.	.8292	.19755	12
				Total	.8906	.23066	18
			W.Exp.	Ex.Dr	.8467	.08083	3
				N.Dr.	.8361	.20068	18
				Total	.8376	.18681	21
			Total	Ex.Dr	.9791	.20954	11
				N.Dr.	.8725	.19497	48
				Total	.8924	.20032	59
BRT.100.30	middle	Male	Beginner	Ex.Dr	1.1400	.	1
				N.Dr.	1.3000	.14142	2

			Total	1.2467	.13614	3
		M.Exp.	Ex.Dr	1.1400	.	1
			N.Dr.	1.5400	.	1
			Total	1.3400	.28284	2
		W.Exp.	Ex.Dr	1.1733	.06658	3
			N.Dr.	1.0430	.13663	10
			Total	1.0731	.13419	13
		Total	Ex.Dr	1.1600	.05050	5
			N.Dr.	1.1208	.20176	13
			Total	1.1317	.17223	18
	Female	Beginner	Ex.Dr	1.8400	.	1
			N.Dr.	1.3438	.23543	8
			Total	1.3989	.27543	9
		M.Exp.	Ex.Dr	1.7000	.	1
			Total	1.7000	.	1
		W.Exp.	N.Dr.	1.1957	.24738	7
			Total	1.1957	.24738	7
		Total	Ex.Dr	1.7700	.09899	2
			N.Dr.	1.2747	.24451	15
			Total	1.3329	.28282	17
	Total	Beginner	Ex.Dr	1.4900	.49497	2
			N.Dr.	1.3350	.21371	10
			Total	1.3608	.25156	12
		M.Exp.	Ex.Dr	1.4200	.39598	2
			N.Dr.	1.5400	.	1
			Total	1.4600	.28844	3
		W.Exp.	Ex.Dr	1.1733	.06658	3
			N.Dr.	1.1059	.19862	17
			Total	1.1160	.18520	20
		Total	Ex.Dr	1.3343	.30320	7
			N.Dr.	1.2032	.23495	28
			Total	1.2294	.25077	35
old	Male	M.Exp.	Ex.Dr	1.4100	.	1
			N.Dr.	1.1143	.26682	7
			Total	1.1513	.26824	8
		W.Exp.	N.Dr.	1.5100	.	1
			Total	1.5100	.	1
		Total	Ex.Dr	1.4100	.	1
			N.Dr.	1.1638	.28390	8
			Total	1.1911	.27796	9
	Female	M.Exp.	Ex.Dr	1.4467	.43547	3
			N.Dr.	1.2125	.17970	4
			Total	1.3129	.30826	7
		Total	Ex.Dr	1.4467	.43547	3
			N.Dr.	1.2125	.17970	4
			Total	1.3129	.30826	7
	Total	M.Exp.	Ex.Dr	1.4375	.35603	4
			N.Dr.	1.1500	.23422	11
			Total	1.2267	.28925	15

			W.Exp.	N.Dr.	1.5100	.	1
				Total	1.5100	.	1
			Total	Ex.Dr	1.4375	.35603	4
				N.Dr.	1.1800	.24632	12
				Total	1.2444	.28828	16
	young	Male	Beginner	N.Dr.	1.1000	.07071	4
				Total	1.1000	.07071	4
			Total	N.Dr.	1.1000	.07071	4
				Total	1.1000	.07071	4
		Female	Beginner	N.Dr.	1.2200	.06272	4
				Total	1.2200	.06272	4
			Total	N.Dr.	1.2200	.06272	4
				Total	1.2200	.06272	4
		Total	Beginner	N.Dr.	1.1600	.08912	8
				Total	1.1600	.08912	8
			Total	N.Dr.	1.1600	.08912	8
				Total	1.1600	.08912	8
	Total	Male	Beginner	Ex.Dr	1.1400	.	1
				N.Dr.	1.1667	.13292	6
				Total	1.1629	.12175	7
			M.Exp.	Ex.Dr	1.2750	.19092	2
				N.Dr.	1.1675	.28927	8
				Total	1.1890	.26681	10
			W.Exp.	Ex.Dr	1.1733	.06658	3
				N.Dr.	1.0855	.19138	11
				Total	1.1043	.17395	14
			Total	Ex.Dr	1.2017	.11161	6
				N.Dr.	1.1312	.21228	25
				Total	1.1448	.19730	31
		Female	Beginner	Ex.Dr	1.8400	.	1
				N.Dr.	1.3025	.20014	12
				Total	1.3438	.24278	13
			M.Exp.	Ex.Dr	1.5100	.37745	4
				N.Dr.	1.2125	.17970	4
				Total	1.3613	.31652	8
			W.Exp.	N.Dr.	1.1957	.24738	7
				Total	1.1957	.24738	7
			Total	Ex.Dr	1.5760	.35865	5
				N.Dr.	1.2543	.20928	23
				Total	1.3118	.26548	28
		Total	Beginner	Ex.Dr	1.4900	.49497	2
				N.Dr.	1.2572	.18830	18
				Total	1.2805	.22305	20
			M.Exp.	Ex.Dr	1.4317	.32787	6
				N.Dr.	1.1825	.25010	12
				Total	1.2656	.29444	18
			W.Exp.	Ex.Dr	1.1733	.06658	3
				N.Dr.	1.1283	.21495	18
				Total	1.1348	.19994	21
			Total	Ex.Dr	1.3718	.30967	11
				N.Dr.	1.1902	.21766	48
				Total	1.2241	.24498	59
BRT.100.40	middle	Male	Beginner	Ex.Dr	1.9300	.	1
				N.Dr.	2.3000	.52326	2

			Total	2.1767	.42724	3
		M.Exp.	Ex.Dr	1.8700	.	1
			N.Dr.	1.8100	.	1
			Total	1.8400	.04243	2
		W.Exp.	Ex.Dr	1.8500	.15588	3
			N.Dr.	1.7760	.26328	10
			Total	1.7931	.23893	13
		Total	Ex.Dr	1.8700	.11554	5
			N.Dr.	1.8592	.33639	13
			Total	1.8622	.28817	18
	Female	Beginner	Ex.Dr	2.1400	.	1
			N.Dr.	2.0038	.21810	8
			Total	2.0189	.20901	9
		M.Exp.	Ex.Dr	2.3200	.	1
			Total	2.3200	.	1
		W.Exp.	N.Dr.	2.0014	.29430	7
			Total	2.0014	.29430	7
		Total	Ex.Dr	2.2300	.12728	2
			N.Dr.	2.0027	.24679	15
			Total	2.0294	.24496	17
	Total	Beginner	Ex.Dr	2.0350	.14849	2
			N.Dr.	2.0630	.28814	10
			Total	2.0583	.26467	12
		M.Exp.	Ex.Dr	2.0950	.31820	2
			N.Dr.	1.8100	.	1
			Total	2.0000	.27875	3
		W.Exp.	Ex.Dr	1.8500	.15588	3
			N.Dr.	1.8688	.29077	17
			Total	1.8660	.27167	20
		Total	Ex.Dr	1.9729	.20605	7
			N.Dr.	1.9361	.29526	28
			Total	1.9434	.27739	35
old	Male	M.Exp.	Ex.Dr	1.8000	.	1
			N.Dr.	1.8586	.10367	7
			Total	1.8513	.09819	8
		W.Exp.	N.Dr.	1.7400	.	1
			Total	1.7400	.	1
		Total	Ex.Dr	1.8000	.	1
			N.Dr.	1.8438	.10474	8
			Total	1.8389	.09905	9
	Female	M.Exp.	Ex.Dr	2.1367	.17954	3
			N.Dr.	1.8675	.28756	4
			Total	1.9829	.26980	7
		Total	Ex.Dr	2.1367	.17954	3
			N.Dr.	1.8675	.28756	4
			Total	1.9829	.26980	7
	Total	M.Exp.	Ex.Dr	2.0525	.22322	4

			N.Dr.	1.8618	.17685	11
			Total	1.9127	.20158	15
		W.Exp.	N.Dr.	1.7400	.	1
			Total	1.7400	.	1
		Total	Ex.Dr	2.0525	.22322	4
			N.Dr.	1.8517	.17225	12
			Total	1.9019	.19947	16
young	Male	Beginner	N.Dr.	1.7350	.11504	4
			Total	1.7350	.11504	4
		Total	N.Dr.	1.7350	.11504	4
			Total	1.7350	.11504	4
	Female	Beginner	N.Dr.	1.7475	.16701	4
			Total	1.7475	.16701	4
		Total	N.Dr.	1.7475	.16701	4
			Total	1.7475	.16701	4
	Total	Beginner	N.Dr.	1.7413	.13293	8
			Total	1.7413	.13293	8
		Total	N.Dr.	1.7413	.13293	8
			Total	1.7413	.13293	8
Total	Male	Beginner	Ex.Dr	1.9300	.	1
			N.Dr.	1.9233	.38448	6
			Total	1.9243	.35099	7
		M.Exp.	Ex.Dr	1.8350	.04950	2
			N.Dr.	1.8525	.09750	8
			Total	1.8490	.08787	10
		W.Exp.	Ex.Dr	1.8500	.15588	3
			N.Dr.	1.7727	.25000	11
			Total	1.7893	.23000	14
		Total	Ex.Dr	1.8583	.10722	6
			N.Dr.	1.8344	.25188	25
			Total	1.8390	.22970	31
	Female	Beginner	Ex.Dr	2.1400	.	1
			N.Dr.	1.9183	.23194	12
			Total	1.9354	.23042	13
		M.Exp.	Ex.Dr	2.1825	.17289	4
			N.Dr.	1.8675	.28756	4
			Total	2.0250	.27677	8
		W.Exp.	N.Dr.	2.0014	.29430	7
			Total	2.0014	.29430	7
		Total	Ex.Dr	2.1740	.15093	5
			N.Dr.	1.9348	.25334	23
			Total	1.9775	.25372	28
	Total	Beginner	Ex.Dr	2.0350	.14849	2
			N.Dr.	1.9200	.27981	18
			Total	1.9315	.26920	20
		M.Exp.	Ex.Dr	2.0667	.22500	6
			N.Dr.	1.8575	.16928	12
			Total	1.9272	.20911	18
		W.Exp.	Ex.Dr	1.8500	.15588	3
			N.Dr.	1.8617	.28372	18

	Total	1.8600	.26621	21
Total	Ex.Dr	2.0018	.20503	11
	N.Dr.	1.8825	.25496	48
	Total	1.9047	.24924	59

Multivariate Tests(c)

Effect		Value	F	Hypothesis df	Error df	Sig.
sphdy	Pillai's Trace	.926	54.802(a)	8.000	35.000	.000
	Wilks' Lambda	.074	54.802(a)	8.000	35.000	.000
	Hotelling's Trace	12.526	54.802(a)	8.000	35.000	.000
	Roy's Largest Root	12.526	54.802(a)	8.000	35.000	.000
sphdy * Age	Pillai's Trace	.403	1.135	16.000	72.000	.341
	Wilks' Lambda	.623	1.169(a)	16.000	70.000	.314
	Hotelling's Trace	.564	1.199	16.000	68.000	.292
	Roy's Largest Root	.478	2.151(b)	8.000	36.000	.056
sphdy * Gender	Pillai's Trace	.382	2.699(a)	8.000	35.000	.020
	Wilks' Lambda	.618	2.699(a)	8.000	35.000	.020
	Hotelling's Trace	.617	2.699(a)	8.000	35.000	.020
	Roy's Largest Root	.617	2.699(a)	8.000	35.000	.020
sphdy * Dr.Exp	Pillai's Trace	.387	1.079	16.000	72.000	.391
	Wilks' Lambda	.649	1.055(a)	16.000	70.000	.414
	Hotelling's Trace	.485	1.030	16.000	68.000	.438
	Roy's Largest Root	.300	1.350(b)	8.000	36.000	.251
sphdy * Dr.Hrs.perWeek	Pillai's Trace	.479	4.028(a)	8.000	35.000	.002
	Wilks' Lambda	.521	4.028(a)	8.000	35.000	.002
	Hotelling's Trace	.921	4.028(a)	8.000	35.000	.002
	Roy's Largest Root	.921	4.028(a)	8.000	35.000	.002
sphdy * Age * Gender	Pillai's Trace	.444	1.285	16.000	72.000	.231
	Wilks' Lambda	.599	1.279(a)	16.000	70.000	.235
	Hotelling's Trace	.599	1.272	16.000	68.000	.240
	Roy's Largest Root	.434	1.952(b)	8.000	36.000	.082
sphdy * Age * Dr.Exp	Pillai's Trace	.195	1.062(a)	8.000	35.000	.411
	Wilks' Lambda	.805	1.062(a)	8.000	35.000	.411
	Hotelling's Trace	.243	1.062(a)	8.000	35.000	.411
	Roy's Largest Root	.243	1.062(a)	8.000	35.000	.411
sphdy * Gender * Dr.Exp	Pillai's Trace	.498	1.493	16.000	72.000	.126
	Wilks' Lambda	.554	1.502(a)	16.000	70.000	.124
	Hotelling's Trace	.710	1.509	16.000	68.000	.122
	Roy's Largest Root	.532	2.394(b)	8.000	36.000	.035
sphdy * Age * Gender * Dr.Exp	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
sphdy * Age * Dr.Hrs.perWeek	Pillai's Trace	.208	1.152(a)	8.000	35.000	.355
	Wilks' Lambda	.792	1.152(a)	8.000	35.000	.355

sphdy * Gender * Dr.Hrs.perWeek	Hotelling's Trace	.263	1.152(a)	8.000	35.000	.355
	Roy's Largest Root	.263	1.152(a)	8.000	35.000	.355
	Pillai's Trace	.348	2.333(a)	8.000	35.000	.070
	Wilks' Lambda	.652	2.333(a)	8.000	35.000	.060
	Hotelling's Trace	.533	2.333(a)	8.000	35.000	.080
sphdy * Age * Gender * Dr.Hrs.perWeek	Roy's Largest Root	.533	2.333(a)	8.000	35.000	.060
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
sphdy * Dr.Exp * Dr.Hrs.perWeek	Pillai's Trace	.363	.998	16.000	72.000	.468
	Wilks' Lambda	.657	1.022(a)	16.000	70.000	.445
	Hotelling's Trace	.491	1.043	16.000	68.000	.426
	Roy's Largest Root	.416	1.873(b)	8.000	36.000	.095
	Pillai's Trace	.000	.(a)	.000	.000	.
sphdy * Age * Dr.Exp * Dr.Hrs.perWeek	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
sphdy * Gender * Dr.Exp * Dr.Hrs.perWeek	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
sphdy * Age * Gender * Dr.Exp * Dr.Hrs.perWeek	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000

a Exact statistic

b The statistic is an upper bound on F that yields a lower bound on the significance level.

c Design: Intercept+Age+Gender+Dr.Exp+Dr.Hrs.perWeek+Age * Gender+Age * Dr.Exp+Gender * Dr.Exp+Age * Gender * Dr.Exp+Age * Dr.Hrs.perWeek+Gender * Dr.Hrs.perWeek+Age * Gender * Dr.Hrs.perWeek+Dr.Exp * Dr.Hrs.perWeek+Age * Dr.Exp * Dr.Hrs.perWeek+Gender * Dr.Exp * Dr.Hrs.perWeek+Age * Gender * Dr.Exp * Dr.Hrs.perWeek

Within Subjects Design: sphdy

Mauchly's Test of Sphericity^b

Measure: brt

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
sphdy	.119	83.283	35	.000	.658	1.000	.125

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept+Age+Gender+Dr.Exp+Dr.Hrs.perWeek+Age * Gender+Age * Dr.Exp+Gender * Dr.Exp+Age * Gender * Dr.Exp+Age * Dr.Hrs.perWeek+Gender * Dr.Hrs.perWeek+Age * Gender * Dr.Hrs.perWeek+Dr.Exp * Dr.Hrs.perWeek+Age * Dr.Exp * Dr.Hrs.perWeek+Gender * Dr.Exp * Dr.Hrs.perWeek+Age * Gender * Dr.Exp * Dr.Hrs.perWeek

Within Subjects Design: sphdy

Tests of Within-Subjects Effects

Measure: brt

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
sphdy	Sphericity Assumed	32.045	8	4.006	109.507	.000
	Greenhouse-Geisser	32.045	5.268	6.083	109.507	.000
	Huynh-Feldt	32.045	8.000	4.006	109.507	.000
	Lower-bound	32.045	1.000	32.045	109.507	.000
sphdy * Age	Sphericity Assumed	1.084	16	.068	1.851	.064
	Greenhouse-Geisser	1.084	10.536	.103	1.851	.070
	Huynh-Feldt	1.084	16.000	.068	1.851	.067
	Lower-bound	1.084	2.000	.542	1.851	.170
sphdy * Gender	Sphericity Assumed	.678	8	.085	2.318	.020
	Greenhouse-Geisser	.678	5.268	.129	2.318	.041
	Huynh-Feldt	.678	8.000	.085	2.318	.020
	Lower-bound	.678	1.000	.678	2.318	.014
sphdy * Dr.Exp	Sphericity Assumed	.495	16	.031	.846	.632
	Greenhouse-Geisser	.495	10.536	.047	.846	.590
	Huynh-Feldt	.495	16.000	.031	.846	.632
	Lower-bound	.495	2.000	.248	.846	.436
sphdy * Dr.Hrs.perWeek	Sphericity Assumed	.797	8	.100	2.723	.076
	Greenhouse-Geisser	.797	5.268	.151	2.723	.089
	Huynh-Feldt	.797	8.000	.100	2.723	.066
	Lower-bound	.797	1.000	.797	2.723	.106
sphdy * Age * Gender	Sphericity Assumed	.658	16	.041	1.124	.331
	Greenhouse-Geisser	.658	10.536	.062	1.124	.344
	Huynh-Feldt	.658	16.000	.041	1.124	.331
	Lower-bound	.658	2.000	.329	1.124	.335
sphdy * Age * Dr.Exp	Sphericity Assumed	.390	8	.049	1.333	.226
	Greenhouse-Geisser	.390	5.268	.074	1.333	.249
	Huynh-Feldt	.390	8.000	.049	1.333	.226
	Lower-bound	.390	1.000	.390	1.333	.255
sphdy * Gender * Dr.Exp	Sphericity Assumed	.824	16	.052	1.408	.135
	Greenhouse-Geisser	.824	10.536	.078	1.408	.174
	Huynh-Feldt	.824	16.000	.052	1.408	.135
	Lower-bound	.824	2.000	.412	1.408	.256
sphdy * Age * Gender * Dr.Exp	Sphericity Assumed	.000	0	.	.	.
	Greenhouse-Geisser	.000	.000	.	.	.
	Huynh-Feldt	.000	.000	.	.	.
	Lower-bound	.000	.000	.	.	.
sphdy * Age * Dr.Hrs.perWeek	Sphericity Assumed	.488	8	.061	1.669	.105
	Greenhouse-Geisser	.488	5.268	.093	1.669	.139
	Huynh-Feldt	.488	8.000	.061	1.669	.105
	Lower-bound	.488	1.000	.488	1.669	.203
sphdy * Gender * Dr.Hrs.perWeek	Sphericity Assumed	.837	8	.105	2.861	.004

	Greenhouse-Geisser	.837	5.268	.159	2.861	.014
	Huynh-Feldt	.837	8.000	.105	2.861	.004
	Lower-bound	.837	1.000	.837	2.861	.098
sphdy * Age * Gender *	Sphericity Assumed	.000	0	.	.	.
Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
	Huynh-Feldt	.000	.000	.	.	.
	Lower-bound	.000	.000	.	.	.
sphdy * Dr.Exp *	Sphericity Assumed	.700	16	.044	1.195	.270
Dr.Hrs.perWeek	Greenhouse-Geisser	.700	10.536	.066	1.195	.293
	Huynh-Feldt	.700	16.000	.044	1.195	.270
	Lower-bound	.700	2.000	.350	1.195	.313
sphdy * Age * Dr.Exp *	Sphericity Assumed	.000	0	.	.	.
Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
	Huynh-Feldt	.000	.000	.	.	.
	Lower-bound	.000	.000	.	.	.
sphdy * Gender * Dr.Exp	Sphericity Assumed	.000	0	.	.	.
* Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
	Huynh-Feldt	.000	.000	.	.	.
	Lower-bound	.000	.000	.	.	.
sphdy * Age * Gender *	Sphericity Assumed	.000	0	.	.	.
Dr.Exp * Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
	Huynh-Feldt	.000	.000	.	.	.
	Lower-bound	.000	.000	.	.	.
Error(sphdy)	Sphericity Assumed	12.291	336	.037		
	Greenhouse-Geisser	12.291	221.247	.056		
	Huynh-Feldt	12.291	336.000	.037		
	Lower-bound	12.291	42.000	.293		

Tests of Within-Subjects Contrasts

Measure: brt

Source	sphdy	Type III Sum of Squares	df	Mean Square	F	Sig.
sphdy	Linear	4.907	1	4.907	147.010	.000
	Quadratic	.114	1	.114	2.797	.102
	Cubic	5.438	1	5.438	101.697	.000
	Order 4	.002	1	.002	.062	.804
	Order 5	2.525	1	2.525	106.230	.000
	Order 6	1.011	1	1.011	27.178	.000
	Order 7	17.821	1	17.821	316.470	.000
	Order 8	.227	1	.227	10.751	.002
sphdy * Age	Linear	.033	2	.016	.489	.617
	Quadratic	.075	2	.037	.912	.410
	Cubic	.318	2	.159	2.970	.062

sphdy * Gender	Order 4	.036	2	.018	.689	.508
	Order 5	.003	2	.002	.065	.938
	Order 6	.302	2	.151	4.053	.062
	Order 7	.288	2	.144	2.556	.090
	Order 8	.030	2	.015	.705	.500
	Linear	.133	1	.133	3.988	.035
	Quadratic	.170	1	.170	4.160	.048
	Cubic	1.23E-005	1	1.23E-005	.000	.988
	Order 4	.153	1	.153	5.797	.021
sphdy * Dr.Exp	Order 5	7.82E-005	1	7.82E-005	.003	.955
	Order 6	.009	1	.009	.244	.624
	Order 7	.179	1	.179	3.172	.082
	Order 8	.034	1	.034	1.609	.212
	Linear	.072	2	.036	1.086	.347
	Quadratic	.008	2	.004	.104	.902
	Cubic	.006	2	.003	.058	.943
	Order 4	.200	2	.100	3.782	.033
	Order 5	.035	2	.017	.733	.486
sphdy * Dr.Hrs.perWeek	Order 6	.133	2	.066	1.784	.180
	Order 7	.024	2	.012	.209	.812
	Order 8	.017	2	.008	.395	.676
	Linear	.541	1	.541	16.197	.170
	Quadratic	.044	1	.044	1.064	.308
	Cubic	.115	1	.115	2.142	.151
	Order 4	.090	1	.090	3.402	.072
	Order 5	.002	1	.002	.100	.753
	Order 6	.000	1	.000	.003	.954
sphdy * Age * Gender	Order 7	.005	1	.005	.086	.770
	Order 8	.001	1	.001	.043	.837
	Linear	.103	2	.051	1.536	.227
	Quadratic	.100	2	.050	1.222	.305
	Cubic	.039	2	.019	.364	.697
	Order 4	.036	2	.018	.675	.515
	Order 5	.001	2	.001	.025	.975
	Order 6	.186	2	.093	2.503	.094
	Order 7	.140	2	.070	1.242	.299
sphdy * Age * Dr.Exp	Order 8	.053	2	.027	1.265	.293
	Linear	.036	1	.036	1.081	.304
	Quadratic	.022	1	.022	.544	.465
	Cubic	.009	1	.009	.164	.687
	Order 4	.073	1	.073	2.771	.103
	Order 5	.070	1	.070	2.943	.094
	Order 6	.164	1	.164	4.407	.054
	Order 7	.015	1	.015	.271	.605
	Order 8	.000	1	.000	.023	.880
sphdy * Gender * Dr.Exp	Linear	.231	2	.115	3.456	.041
	Quadratic	.232	2	.116	2.829	.070

	Cubic	.083	2	.042	.777	.466
	Order 4	.057	2	.028	1.071	.352
	Order 5	.015	2	.007	.305	.738
	Order 6	.020	2	.010	.265	.768
	Order 7	.177	2	.088	1.569	.220
	Order 8	.011	2	.006	.264	.769
	sphdy * Age * Gender * Dr.Exp	Linear	0	.	.	.
		Quadratic	0	.	.	.
		Cubic	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
	sphdy * Age * Dr.Hrs.perWeek	Linear	1	.078	2.325	.135
		Quadratic	1	.064	1.570	.217
		Cubic	1	.078	1.457	.234
	Order 4	2.04E-005	1	2.04E-005	.001	.978
	Order 5	.017	1	.017	.720	.401
	Order 6	.151	1	.151	4.061	.065
	Order 7	.046	1	.046	.816	.371
	Order 8	.054	1	.054	2.576	.116
	sphdy * Gender * Dr.Hrs.perWeek	Linear	1	.200	6.003	.019
		Quadratic	1	.094	2.287	.138
		Cubic	1	.070	1.306	.260
	Order 4	.049	1	.049	1.869	.179
	Order 5	.013	1	.013	.541	.466
	Order 6	.102	1	.102	2.750	.105
	Order 7	.274	1	.274	4.867	.033
	Order 8	.035	1	.035	1.637	.208
	sphdy * Age * Gender * Dr.Hrs.perWeek	Linear	0	.	.	.
		Quadratic	0	.	.	.
		Cubic	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
	sphdy * Dr.Exp * Dr.Hrs.perWeek	Linear	2	.019	.564	.573
		Quadratic	2	.009	.219	.804
		Cubic	2	.072	1.355	.269
	Order 4	.145	2	.072	2.740	.076
	Order 5	.057	2	.029	1.202	.311
	Order 6	.086	2	.043	1.159	.324

sphdy * Age * Dr.Exp * Dr.Hrs.perWeek	Order 7	.206	2	.103	1.830	.173
	Order 8	.005	2	.002	.108	.898
	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
sphdy * Gender * Dr.Exp * Dr.Hrs.perWeek	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
sphdy * Age * Gender * Dr.Exp * Dr.Hrs.perWeek	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
Error(sphdy)	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
	Linear	1.402	42	.033		
	Quadratic	1.718	42	.041		
	Cubic	2.246	42	.053		
	Order 4	1.111	42	.026		
	Order 5	.998	42	.024		
	Order 6	1.562	42	.037		
	Order 7	2.365	42	.056		
	Order 8	.888	42	.021		

Tests of Between-Subjects Effects

Measure: brt

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	346.818	1	346.818	2737.389	.000
Age	1.111	2	.555	4.384	.019
Gender	.331	1	.331	2.616	.011
Dr.Exp	.115	2	.057	.453	.639
Dr.Hrs.perWeek	.051	1	.051	.400	.530

Age * Gender	.096	2	.048	.378	.047
Age * Dr.Exp	.157	1	.157	1.240	.272
Gender * Dr.Exp	.119	2	.060	.470	.628
Age * Gender * Dr.Exp	.000	0	.	.	.
Age * Dr.Hrs.perWeek	.089	1	.089	.702	.407
Gender * Dr.Hrs.perWeek	.008	1	.008	.065	.800
Age * Gender * Dr.Hrs.perWeek	.000	0	.	.	.
Dr.Exp * Dr.Hrs.perWeek	.081	2	.040	.318	.729
Age * Dr.Exp * Dr.Hrs.perWeek	.000	0	.	.	.
Gender * Dr.Exp * Dr.Hrs.perWeek	.000	0	.	.	.
Age * Gender * Dr.Exp * Dr.Hrs.perWeek	.000	0	.	.	.
Error	5.321	42	.127		

Estimated Marginal Means

1. Age

Measure: brt

Age	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
middle	1.362(a)	.030	1.302	1.421
old	1.366(a)	.039	1.287	1.445
young	1.249(a)	.042	1.165	1.334

a Based on modified population marginal mean.

2. Gender

Measure: brt

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Male	1.321(a)	.030	1.260	1.381
Female	1.391(a)	.030	1.331	1.452

a Based on modified population marginal mean.

3. Dr.Exp

Measure: brt

Dr.Exp	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Beginner	1.340(a)	.035	1.270	1.411
M.Exp.	1.378(a)	.037	1.304	1.452
W.Exp.	1.315(a)	.037	1.240	1.390

a Based on modified population marginal mean.

4. Dr.Hrs.perWeek

Measure: brt

Dr.Hrs.perWeek	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Ex.Dr	1.357(a)	.040	1.276	1.439
N.Dr.	1.345(a)	.023	1.298	1.391

a Based on modified population marginal mean.

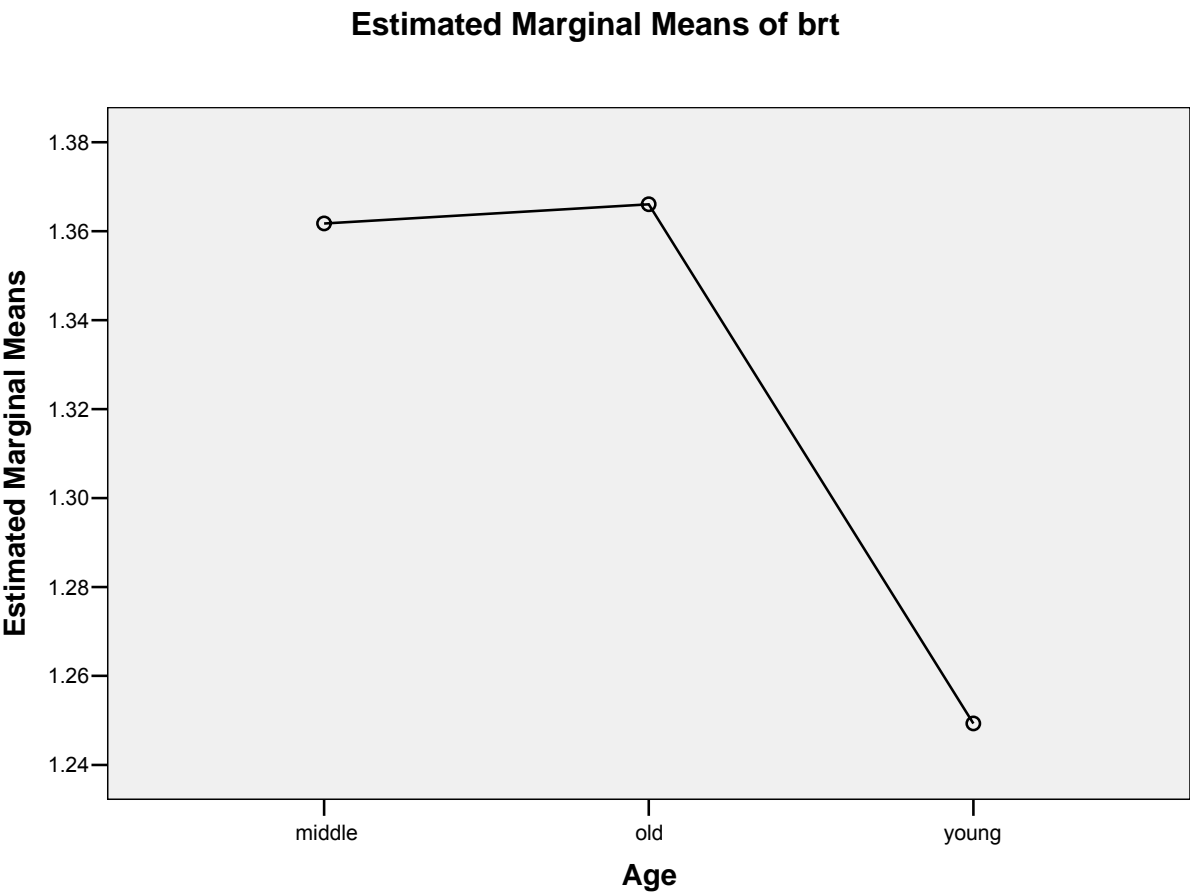
5. sphdy

Measure: brt

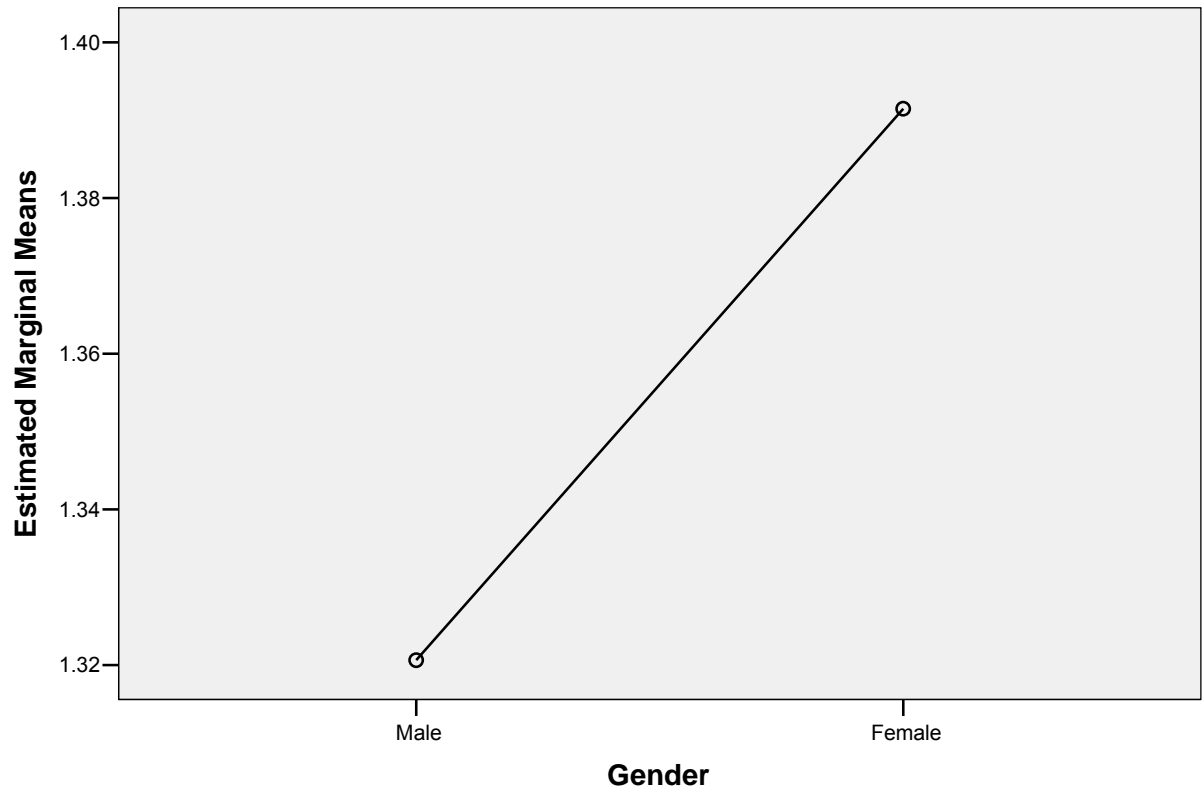
sphdy	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	.917(a)	.032	.851	.982
2	1.175(a)	.040	1.094	1.256
3	1.919(a)	.050	1.817	2.020
4	.892(a)	.027	.838	.947
5	1.157(a)	.038	1.081	1.233
6	1.888(a)	.042	1.802	1.973
7	.947(a)	.036	.874	1.020
8	1.319(a)	.038	1.242	1.397
9	1.934(a)	.042	1.849	2.020

a Based on modified population marginal mean.

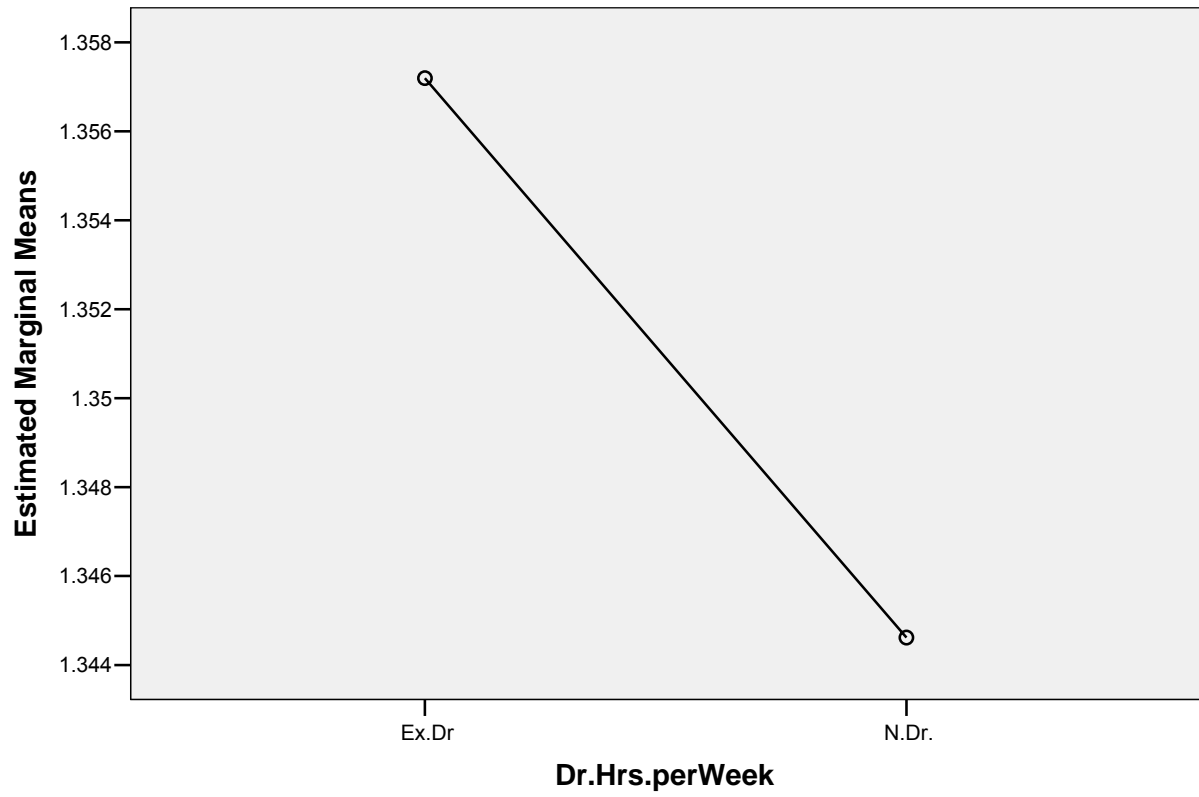
Profile Plots



Estimated Marginal Means of brt



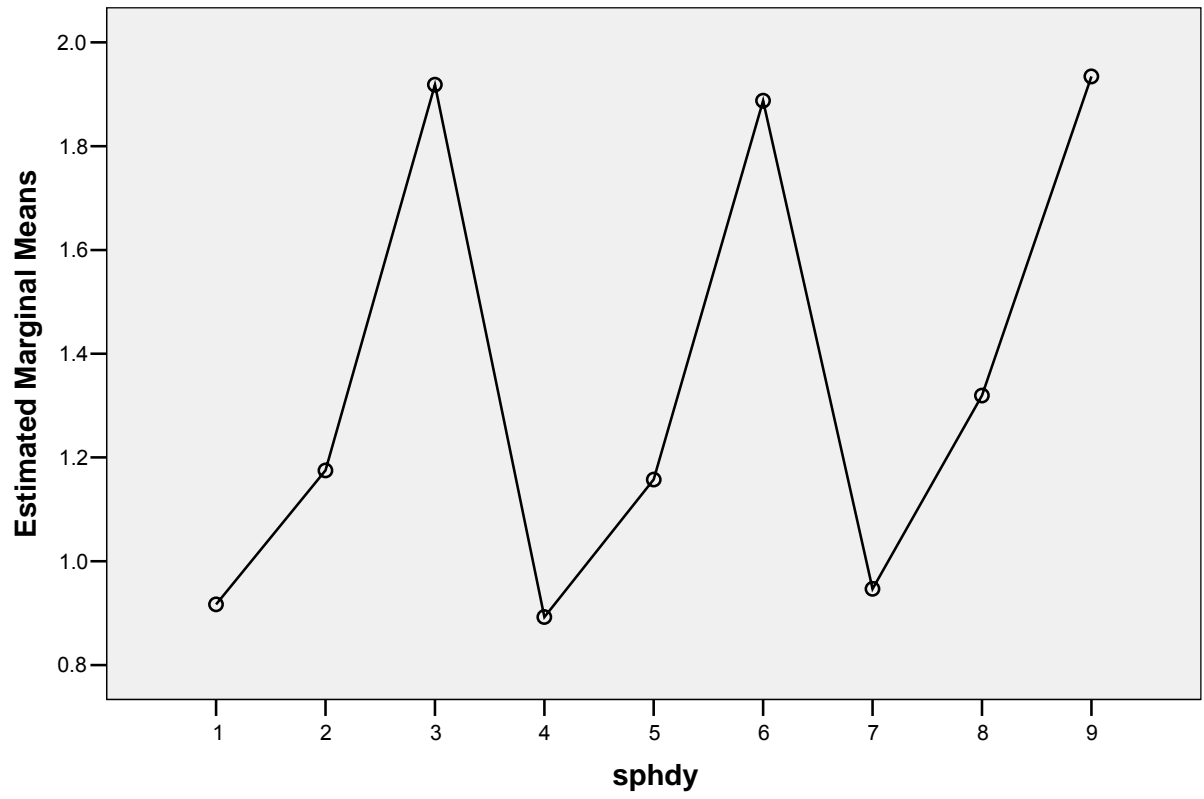
Estimated Marginal Means of brt



Estimated Marginal Means of brt



Estimated Marginal Means of brt



Appendix D

Repeated Measure ANOVA Analysis for Surprised Scenario

Repeated Measure ANOVA for BRT: Surprised Scenario

This appendix shows the results of repeated measure ANOVA analysis of BRT for surprised scenario. The appendix includes:

- 1- Description of within and between subject factors
- 2- Descriptive statistics such as mean and standard deviation
- 3- Mauchly's test of Sphericity that examines the form of the common covariance matrix. A spherical matrix has equal variances and covariances equal to zero. The common covariance matrix of the transformed within-subject variables must be spherical, or the F tests and associated p values for the univariate approach to testing within-subjects hypotheses are invalid. If sphericity assumption is violated then SPSS performs the correct tests to check the effect of within subject factors.
- 4- Tests to show the within subject effects
- 5- Tests to show the trend of models for combination of different variables
- 6- Tests to show the between subject effects
- 7- Marginal means of BRT for all variables
- 8- Profile Plots that show the graphical representation of marginal means of BRT for each variable.

Within-Subjects Factors

Measure: brt

sphdy	Dependent Variable
1	BRT.60.10
2	BRT.60.20
3	BRT.60.30
4	BRT.80.10
5	BRT.80.20
6	BRT.80.30
7	BRT.100.10
8	BRT.100.20
9	BRT.100.30

Between-Subjects Factors

	N
Age middle	35
old	16
young	8
Gender 0	31
1	28
Dr.Exp Beginner	20
M.Exp.	18
W.Exp.	21
Dr.Hrs.perWeek Ex.Dr	11
N.Dr.	48

Descriptive Statistics

	Age	Gender	Dr.Exp	Dr.Hrs.perWeek	Mean	Std. Deviation	N
BRT.60.10	middle	0	Beginner	Ex.Dr	.640	.	1
				N.Dr.	.715	.0212	2
				Total	.690	.0458	3
			M.Exp.	Ex.Dr	.500	.	1
				N.Dr.	.730	.	1
				Total	.615	.1626	2
			W.Exp.	Ex.Dr	.560	.0721	3
				N.Dr.	.607	.0665	10
				Total	.596	.0679	13
			Total	Ex.Dr	.564	.0713	5
				N.Dr.	.633	.0763	13
				Total	.614	.0795	18
	1		Beginner	Ex.Dr	.600	.	1
				N.Dr.	.660	.0532	8

			Total	.653	.0536	9
		M.Exp.	Ex.Dr	.670	.	1
			Total	.670	.	1
		W.Exp.	N.Dr.	.599	.0724	7
			Total	.599	.0724	7
		Total	Ex.Dr	.635	.0495	2
			N.Dr.	.631	.0683	15
			Total	.632	.0651	17
	Total	Beginner	Ex.Dr	.620	.0283	2
			N.Dr.	.671	.0528	10
			Total	.663	.0524	12
		M.Exp.	Ex.Dr	.585	.1202	2
			N.Dr.	.730	.	1
			Total	.633	.1193	3
		W.Exp.	Ex.Dr	.560	.0721	3
			N.Dr.	.604	.0669	17
			Total	.597	.0676	20
		Total	Ex.Dr	.584	.0707	7
			N.Dr.	.632	.0708	28
			Total	.623	.0724	35
old	0	M.Exp.	Ex.Dr	.600	.	1
			N.Dr.	.590	.0480	7
			Total	.591	.0445	8
		W.Exp.	N.Dr.	.670	.	1
			Total	.670	.	1
		Total	Ex.Dr	.600	.	1
			N.Dr.	.600	.0526	8
			Total	.600	.0492	9
	1	M.Exp.	Ex.Dr	.723	.0764	3
			N.Dr.	.693	.0830	4
			Total	.706	.0752	7
		Total	Ex.Dr	.723	.0764	3
			N.Dr.	.693	.0830	4
			Total	.706	.0752	7
	Total	M.Exp.	Ex.Dr	.693	.0877	4
			N.Dr.	.627	.0782	11
			Total	.645	.0831	15
		W.Exp.	N.Dr.	.670	.	1
			Total	.670	.	1
		Total	Ex.Dr	.693	.0877	4
			N.Dr.	.631	.0756	12
			Total	.646	.0806	16
young	0	Beginner	N.Dr.	.583	.0918	4
			Total	.583	.0918	4
		Total	N.Dr.	.583	.0918	4
			Total	.583	.0918	4
	1	Beginner	N.Dr.	.730	.1800	4
			Total	.730	.1800	4
		Total	N.Dr.	.730	.1800	4
			Total	.730	.1800	4
	Total	Beginner	N.Dr.	.656	.1540	8

				Total	.656	.1540	8
			Total	N.Dr.	.656	.1540	8
				Total	.656	.1540	8
	Total	0	Beginner	Ex.Dr	.640	.	1
				N.Dr.	.627	.0991	6
				Total	.629	.0906	7
			M.Exp.	Ex.Dr	.550	.0707	2
				N.Dr.	.608	.0665	8
				Total	.596	.0677	10
			W.Exp.	Ex.Dr	.560	.0721	3
				N.Dr.	.613	.0659	11
				Total	.601	.0681	14
			Total	Ex.Dr	.570	.0654	6
				N.Dr.	.614	.0721	25
				Total	.606	.0721	31
		1	Beginner	Ex.Dr	.600	.	1
				N.Dr.	.683	.1087	12
				Total	.677	.1066	13
			M.Exp.	Ex.Dr	.710	.0678	4
				N.Dr.	.693	.0830	4
				Total	.701	.0708	8
			W.Exp.	N.Dr.	.599	.0724	7
				Total	.599	.0724	7
			Total	Ex.Dr	.688	.0766	5
				N.Dr.	.659	.0999	23
				Total	.664	.0955	28
		Total	Beginner	Ex.Dr	.620	.0283	2
				N.Dr.	.664	.1063	18
				Total	.660	.1017	20
			M.Exp.	Ex.Dr	.657	.1029	6
				N.Dr.	.636	.0803	12
				Total	.643	.0859	18
			W.Exp.	Ex.Dr	.560	.0721	3
				N.Dr.	.607	.0668	18
				Total	.600	.0678	21
			Total	Ex.Dr	.624	.0910	11
				N.Dr.	.636	.0885	48
				Total	.634	.0883	59
BRT.60.20	middle	0	Beginner	Ex.Dr	.740	.	1
				N.Dr.	.915	.0212	2
				Total	.857	.1021	3
			M.Exp.	Ex.Dr	.700	.	1
				N.Dr.	.810	.	1
				Total	.755	.0778	2
			W.Exp.	Ex.Dr	.660	.0954	3
				N.Dr.	.712	.0851	10
				Total	.700	.0864	13
			Total	Ex.Dr	.684	.0764	5
				N.Dr.	.751	.1073	13
				Total	.732	.1022	18
		1	Beginner	Ex.Dr	.900	.	1
				N.Dr.	.836	.1165	8
				Total	.843	.1110	9

			M.Exp.	Ex.Dr	.750	.	1
				Total	.750	.	1
			W.Exp.	N.Dr.	.759	.0969	7
				Total	.759	.0969	7
			Total	Ex.Dr	.825	.1061	2
				N.Dr.	.800	.1114	15
				Total	.803	.1079	17
		Total	Beginner	Ex.Dr	.820	.1131	2
				N.Dr.	.852	.1082	10
				Total	.847	.1044	12
			M.Exp.	Ex.Dr	.725	.0354	2
				N.Dr.	.810	.	1
				Total	.753	.0551	3
			W.Exp.	Ex.Dr	.660	.0954	3
				N.Dr.	.731	.0903	17
				Total	.721	.0922	20
		Total		Ex.Dr	.724	.1024	7
				N.Dr.	.777	.1103	28
				Total	.767	.1095	35
old	0		M.Exp.	Ex.Dr	.700	.	1
				N.Dr.	.746	.0787	7
				Total	.740	.0746	8
			W.Exp.	N.Dr.	.800	.	1
				Total	.800	.	1
		Total		Ex.Dr	.700	.	1
				N.Dr.	.753	.0754	8
				Total	.747	.0726	9
	1		M.Exp.	Ex.Dr	.820	.1114	3
				N.Dr.	.838	.1884	4
				Total	.830	.1482	7
		Total		Ex.Dr	.820	.1114	3
				N.Dr.	.838	.1884	4
				Total	.830	.1482	7
		Total	M.Exp.	Ex.Dr	.790	.1089	4
				N.Dr.	.779	.1285	11
				Total	.782	.1198	15
			W.Exp.	N.Dr.	.800	.	1
				Total	.800	.	1
		Total		Ex.Dr	.790	.1089	4
				N.Dr.	.781	.1227	12
				Total	.783	.1159	16
young	0		Beginner	N.Dr.	.718	.1287	4
				Total	.718	.1287	4
		Total		N.Dr.	.718	.1287	4
				Total	.718	.1287	4
	1		Beginner	N.Dr.	.860	.2304	4
				Total	.860	.2304	4
		Total		N.Dr.	.860	.2304	4

				Total	.860	.2304	4	
		Total	Beginner	N.Dr.	.789	.1888	8	
				Total	.789	.1888	8	
			Total	N.Dr.	.789	.1888	8	
				Total	.789	.1888	8	
	Total	0	Beginner	Ex.Dr	.740	.	1	
				N.Dr.	.783	.1429	6	
				Total	.777	.1315	7	
			M.Exp.	Ex.Dr	.700	.0000	2	
				N.Dr.	.754	.0763	8	
				Total	.743	.0710	10	
			W.Exp.	Ex.Dr	.660	.0954	3	
				N.Dr.	.720	.0850	11	
				Total	.707	.0872	14	
			Total	Ex.Dr	.687	.0686	6	
				N.Dr.	.746	.0982	25	
				Total	.735	.0952	31	
		1	Beginner	Ex.Dr	.900	.	1	
				N.Dr.	.844	.1525	12	
				Total	.848	.1468	13	
			M.Exp.	Ex.Dr	.803	.0974	4	
				N.Dr.	.838	.1884	4	
				Total	.820	.1401	8	
			W.Exp.	N.Dr.	.759	.0969	7	
				Total	.759	.0969	7	
			Total	Ex.Dr	.822	.0950	5	
				N.Dr.	.817	.1435	23	
				Total	.818	.1346	28	
			Total	Beginner	Ex.Dr	.820	.1131	2
				N.Dr.	.824	.1481	18	
				Total	.824	.1424	20	
			M.Exp.	Ex.Dr	.768	.0922	6	
				N.Dr.	.782	.1228	12	
				Total	.777	.1109	18	
			W.Exp.	Ex.Dr	.660	.0954	3	
				N.Dr.	.735	.0891	18	
				Total	.724	.0915	21	
			Total	Ex.Dr	.748	.1047	11	
				N.Dr.	.780	.1259	48	
				Total	.774	.1220	59	
BRT.60.30	middle	0	Beginner	Ex.Dr	.870	.	1	
				N.Dr.	.985	.1202	2	
				Total	.947	.1079	3	
			M.Exp.	Ex.Dr	.700	.	1	
				N.Dr.	1.000	.	1	
				Total	.850	.2121	2	
			W.Exp.	Ex.Dr	.827	.3338	3	
				N.Dr.	.987	.2035	10	
				Total	.950	.2336	13	
			Total	Ex.Dr	.810	.2446	5	
				N.Dr.	.988	.1797	13	

			Total	.938	.2088	18
	1	Beginner	Ex.Dr	1.000	.	1
			N.Dr.	1.196	.2192	8
			Total	1.174	.2152	9
		M.Exp.	Ex.Dr	.800	.	1
			Total	.800	.	1
		W.Exp.	N.Dr.	1.156	.3803	7
			Total	1.156	.3803	7
		Total	Ex.Dr	.900	.1414	2
			N.Dr.	1.177	.2940	15
			Total	1.145	.2922	17
	Total	Beginner	Ex.Dr	.935	.0919	2
			N.Dr.	1.154	.2165	10
			Total	1.118	.2154	12
		M.Exp.	Ex.Dr	.750	.0707	2
			N.Dr.	1.000	.	1
			Total	.833	.1528	3
		W.Exp.	Ex.Dr	.827	.3338	3
			N.Dr.	1.056	.2913	17
			Total	1.022	.3005	20
		Total	Ex.Dr	.836	.2125	7
			N.Dr.	1.089	.2616	28
			Total	1.039	.2700	35
old	0	M.Exp.	Ex.Dr	.810	.	1
			N.Dr.	.993	.2342	7
			Total	.970	.2263	8
		W.Exp.	N.Dr.	1.070	.	1
			Total	1.070	.	1
		Total	Ex.Dr	.810	.	1
			N.Dr.	1.003	.2186	8
			Total	.981	.2143	9
	1	M.Exp.	Ex.Dr	1.073	.2650	3
			N.Dr.	1.038	.3090	4
			Total	1.053	.2674	7
		Total	Ex.Dr	1.073	.2650	3
			N.Dr.	1.038	.3090	4
			Total	1.053	.2674	7
	Total	M.Exp.	Ex.Dr	1.008	.2533	4
			N.Dr.	1.009	.2491	11
			Total	1.009	.2410	15
		W.Exp.	N.Dr.	1.070	.	1
			Total	1.070	.	1
		Total	Ex.Dr	1.008	.2533	4
			N.Dr.	1.014	.2382	12
			Total	1.013	.2333	16
young	0	Beginner	N.Dr.	.853	.1118	4
			Total	.853	.1118	4
		Total	N.Dr.	.853	.1118	4
			Total	.853	.1118	4
	1	Beginner	N.Dr.	1.118	.3414	4
			Total	1.118	.3414	4
		Total	N.Dr.	1.118	.3414	4
			Total	1.118	.3414	4

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			Total	Total	.710	.2093	4
			Total	N.Dr.	.710	.2093	4
			Total		.710	.2093	4
		Total	Beginner	N.Dr.	.643	.1583	8
			Total		.643	.1583	8
			Total	N.Dr.	.643	.1583	8
			Total		.643	.1583	8
	Total	0	Beginner	Ex.Dr	.640	.	1
				N.Dr.	.595	.0543	6
			Total		.601	.0524	7
			M.Exp.	Ex.Dr	.605	.0071	2
				N.Dr.	.644	.0727	8
			Total		.636	.0662	10
			W.Exp.	Ex.Dr	.707	.2684	3
				N.Dr.	.607	.1010	11
			Total		.629	.1439	14
			Total	Ex.Dr	.662	.1772	6
				N.Dr.	.616	.0825	25
			Total		.625	.1050	31
		1	Beginner	Ex.Dr	.630	.	1
				N.Dr.	.683	.1221	12
			Total		.678	.1178	13
			M.Exp.	Ex.Dr	.770	.1610	4
				N.Dr.	.635	.0635	4
			Total		.703	.1344	8
			W.Exp.	N.Dr.	.606	.1015	7
			Total		.606	.1015	7
			Total	Ex.Dr	.742	.1529	5
				N.Dr.	.651	.1098	23
			Total		.667	.1206	28
		Total	Beginner	Ex.Dr	.635	.0071	2
				N.Dr.	.653	.1110	18
			Total		.652	.1051	20
			M.Exp.	Ex.Dr	.715	.1511	6
				N.Dr.	.641	.0669	12
			Total		.666	.1044	18
			W.Exp.	Ex.Dr	.707	.2684	3
				N.Dr.	.607	.0982	18
			Total		.621	.1291	21
			Total	Ex.Dr	.698	.1638	11
				N.Dr.	.633	.0971	48
			Total		.645	.1137	59
BRT.80.20	middle	0	Beginner	Ex.Dr	.710	.	1
				N.Dr.	.720	.0283	2
			Total		.717	.0208	3
			M.Exp.	Ex.Dr	.700	.	1
				N.Dr.	.900	.	1
			Total		.800	.1414	2
			W.Exp.	Ex.Dr	.680	.1852	3
				N.Dr.	.724	.1133	10
			Total		.714	.1253	13

		Total	Ex.Dr	.690	.1317	5
			N.Dr.	.737	.1100	13
		Total		.724	.1144	18
	1	Beginner	Ex.Dr	.740	.	1
			N.Dr.	.863	.0944	8
		Total		.849	.0973	9
		M.Exp.	Ex.Dr	.750	.	1
			Total	.750	.	1
		W.Exp.	N.Dr.	.770	.1457	7
		Total		.770	.1457	7
		Total	Ex.Dr	.745	.0071	2
			N.Dr.	.819	.1258	15
		Total		.811	.1203	17
	Total	Beginner	Ex.Dr	.725	.0212	2
			N.Dr.	.834	.1031	10
		Total		.816	.1026	12
		M.Exp.	Ex.Dr	.725	.0354	2
			N.Dr.	.900	.	1
		Total		.783	.1041	3
		W.Exp.	Ex.Dr	.680	.1852	3
			N.Dr.	.743	.1254	17
		Total		.734	.1318	20
		Total	Ex.Dr	.706	.1109	7
			N.Dr.	.781	.1238	28
		Total		.766	.1236	35
old	0	M.Exp.	Ex.Dr	.770	.	1
			N.Dr.	.727	.0407	7
		Total		.733	.0406	8
		W.Exp.	N.Dr.	1.070	.	1
		Total		1.070	.	1
		Total	Ex.Dr	.770	.	1
			N.Dr.	.770	.1269	8
		Total		.770	.1187	9
	1	M.Exp.	Ex.Dr	.830	.1015	3
			N.Dr.	.823	.2133	4
		Total		.826	.1618	7
		Total	Ex.Dr	.830	.1015	3
			N.Dr.	.823	.2133	4
		Total		.826	.1618	7
	Total	M.Exp.	Ex.Dr	.815	.0881	4
			N.Dr.	.762	.1302	11
		Total		.776	.1199	15
		W.Exp.	N.Dr.	1.070	.	1
		Total		1.070	.	1
		Total	Ex.Dr	.815	.0881	4
			N.Dr.	.788	.1527	12
		Total		.794	.1372	16
young	0	Beginner	N.Dr.	.685	.0705	4

			Total	Total	.685	.0705	4
			Total	N.Dr.	.685	.0705	4
			Total	Total	.685	.0705	4
	1		Beginner	N.Dr.	.810	.2107	4
			Total	Total	.810	.2107	4
			Total	N.Dr.	.810	.2107	4
			Total	Total	.810	.2107	4
	Total		Beginner	N.Dr.	.748	.1601	8
			Total	Total	.748	.1601	8
			Total	N.Dr.	.748	.1601	8
			Total	Total	.748	.1601	8
Total	0		Beginner	Ex.Dr	.710	.	1
				N.Dr.	.697	.0589	6
			Total	Total	.699	.0540	7
			M.Exp.	Ex.Dr	.735	.0495	2
				N.Dr.	.749	.0718	8
			Total	Total	.746	.0657	10
			W.Exp.	Ex.Dr	.680	.1852	3
				N.Dr.	.755	.1498	11
			Total	Total	.739	.1535	14
			Total	Ex.Dr	.703	.1223	6
				N.Dr.	.739	.1103	25
			Total	Total	.732	.1115	31
	1		Beginner	Ex.Dr	.740	.	1
				N.Dr.	.845	.1358	12
			Total	Total	.837	.1333	13
			M.Exp.	Ex.Dr	.810	.0920	4
				N.Dr.	.823	.2133	4
			Total	Total	.816	.1522	8
			W.Exp.	N.Dr.	.770	.1457	7
			Total	Total	.770	.1457	7
			Total	Ex.Dr	.796	.0856	5
				N.Dr.	.818	.1495	23
			Total	Total	.814	.1392	28
	Total		Beginner	Ex.Dr	.725	.0212	2
				N.Dr.	.796	.1347	18
			Total	Total	.789	.1293	20
			M.Exp.	Ex.Dr	.785	.0841	6
				N.Dr.	.773	.1304	12
			Total	Total	.777	.1145	18
			W.Exp.	Ex.Dr	.680	.1852	3
				N.Dr.	.761	.1440	18
			Total	Total	.750	.1480	21
			Total	Ex.Dr	.745	.1129	11
				N.Dr.	.777	.1352	48
			Total	Total	.771	.1310	59
BRT.80.30	middle	0	Beginner	Ex.Dr	.800	.	1
				N.Dr.	.970	.0424	2
			Total	Total	.913	.1026	3
			M.Exp.	Ex.Dr	.800	.	1
				N.Dr.	1.000	.	1
			Total	Total	.900	.1414	2
			W.Exp.	Ex.Dr	.857	.2376	3

			N.Dr.	.970	.3260	10
			Total	.944	.3026	13
		Total	Ex.Dr	.834	.1708	5
			N.Dr.	.972	.2827	13
			Total	.934	.2595	18
	1	Beginner	Ex.Dr	1.270	.	1
			N.Dr.	1.220	.1817	8
			Total	1.226	.1708	9
		M.Exp.	Ex.Dr	.870	.	1
			Total	.870	.	1
		W.Exp.	N.Dr.	1.121	.3761	7
			Total	1.121	.3761	7
		Total	Ex.Dr	1.070	.2828	2
			N.Dr.	1.174	.2823	15
			Total	1.162	.2756	17
	Total	Beginner	Ex.Dr	1.035	.3323	2
			N.Dr.	1.170	.1924	10
			Total	1.148	.2075	12
		M.Exp.	Ex.Dr	.835	.0495	2
			N.Dr.	1.000	.	1
			Total	.890	.1015	3
		W.Exp.	Ex.Dr	.857	.2376	3
			N.Dr.	1.032	.3446	17
			Total	1.006	.3317	20
		Total	Ex.Dr	.901	.2146	7
			N.Dr.	1.080	.2956	28
			Total	1.045	.2877	35
old	0	M.Exp.	Ex.Dr	.870	.	1
			N.Dr.	.980	.2529	7
			Total	.966	.2374	8
		W.Exp.	N.Dr.	1.330	.	1
			Total	1.330	.	1
		Total	Ex.Dr	.870	.	1
			N.Dr.	1.024	.2648	8
			Total	1.007	.2530	9
	1	M.Exp.	Ex.Dr	.993	.2003	3
			N.Dr.	.995	.2138	4
			Total	.994	.1903	7
		Total	Ex.Dr	.993	.2003	3
			N.Dr.	.995	.2138	4
			Total	.994	.1903	7
	Total	M.Exp.	Ex.Dr	.963	.1748	4
			N.Dr.	.985	.2284	11
			Total	.979	.2095	15
		W.Exp.	N.Dr.	1.330	.	1
			Total	1.330	.	1
		Total	Ex.Dr	.963	.1748	4
			N.Dr.	1.014	.2394	12
			Total	1.001	.2206	16
young	0	Beginner	N.Dr.	.810	.0804	4

			Total	.810	.0804	4
		Total	N.Dr.	.810	.0804	4
			Total	.810	.0804	4
	1	Beginner	N.Dr.	1.220	.6239	4
			Total	1.220	.6239	4
		Total	N.Dr.	1.220	.6239	4
			Total	1.220	.6239	4
	Total	Beginner	N.Dr.	1.015	.4665	8
			Total	1.015	.4665	8
		Total	N.Dr.	1.015	.4665	8
			Total	1.015	.4665	8
Total	0	Beginner	Ex.Dr	.800	.	1
			N.Dr.	.863	.1052	6
			Total	.854	.0990	7
		M.Exp.	Ex.Dr	.835	.0495	2
			N.Dr.	.983	.2343	8
			Total	.953	.2164	10
		W.Exp.	Ex.Dr	.857	.2376	3
			N.Dr.	1.003	.3278	11
			Total	.971	.3085	14
		Total	Ex.Dr	.840	.1535	6
			N.Dr.	.963	.2577	25
			Total	.939	.2439	31
	1	Beginner	Ex.Dr	1.270	.	1
			N.Dr.	1.220	.3566	12
			Total	1.224	.3417	13
		M.Exp.	Ex.Dr	.963	.1748	4
			N.Dr.	.995	.2138	4
			Total	.979	.1816	8
		W.Exp.	N.Dr.	1.121	.3761	7
			Total	1.121	.3761	7
		Total	Ex.Dr	1.024	.2045	5
			N.Dr.	1.151	.3401	23
			Total	1.128	.3208	28
	Total	Beginner	Ex.Dr	1.035	.3323	2
			N.Dr.	1.101	.3398	18
			Total	1.095	.3310	20
		M.Exp.	Ex.Dr	.920	.1522	6
			N.Dr.	.987	.2178	12
			Total	.964	.1963	18
		W.Exp.	Ex.Dr	.857	.2376	3
			N.Dr.	1.049	.3416	18
			Total	1.021	.3310	21
		Total	Ex.Dr	.924	.1943	11
			N.Dr.	1.053	.3116	48
			Total	1.029	.2962	59
BRT.100.10	middle	0	Beginner	Ex.Dr	.670	1
			N.Dr.	.700	.1414	2

			Total	.690	.1015	3
		M.Exp.	Ex.Dr	.500	.	1
			N.Dr.	.740	.	1
			Total	.620	.1697	2
		W.Exp.	Ex.Dr	.600	.0000	3
			N.Dr.	.597	.0678	10
			Total	.598	.0588	13
		Total	Ex.Dr	.594	.0607	5
			N.Dr.	.624	.0884	13
			Total	.616	.0810	18
	1	Beginner	Ex.Dr	.670	.	1
			N.Dr.	.695	.1321	8
			Total	.692	.1239	9
		M.Exp.	Ex.Dr	.600	.	1
			Total	.600	.	1
		W.Exp.	N.Dr.	.634	.1039	7
			Total	.634	.1039	7
		Total	Ex.Dr	.635	.0495	2
			N.Dr.	.667	.1197	15
			Total	.663	.1132	17
	Total	Beginner	Ex.Dr	.670	.0000	2
			N.Dr.	.696	.1257	10
			Total	.692	.1142	12
		M.Exp.	Ex.Dr	.550	.0707	2
			N.Dr.	.740	.	1
			Total	.613	.1206	3
		W.Exp.	Ex.Dr	.600	.0000	3
			N.Dr.	.612	.0836	17
			Total	.611	.0769	20
		Total	Ex.Dr	.606	.0571	7
			N.Dr.	.647	.1067	28
			Total	.639	.0994	35
old	0	M.Exp.	Ex.Dr	.600	.	1
			N.Dr.	.604	.0503	7
			Total	.604	.0466	8
		W.Exp.	N.Dr.	.600	.	1
			Total	.600	.	1
		Total	Ex.Dr	.600	.	1
			N.Dr.	.604	.0466	8
			Total	.603	.0436	9
	1	M.Exp.	Ex.Dr	.647	.0404	3
			N.Dr.	.648	.0450	4
			Total	.647	.0395	7
		Total	Ex.Dr	.647	.0404	3
			N.Dr.	.648	.0450	4
			Total	.647	.0395	7
	Total	M.Exp.	Ex.Dr	.635	.0404	4
			N.Dr.	.620	.0510	11
			Total	.624	.0475	15
		W.Exp.	N.Dr.	.600	.	1
			Total	.600	.	1
		Total	Ex.Dr	.635	.0404	4
			N.Dr.	.618	.0490	12
			Total	.623	.0463	16

	young	0	Beginner	N.Dr.	.578	.0741	4
				Total	.578	.0741	4
			Total	N.Dr.	.578	.0741	4
			Total		.578	.0741	4
		1	Beginner	N.Dr.	.670	.0990	4
				Total	.670	.0990	4
			Total	N.Dr.	.670	.0990	4
			Total		.670	.0990	4
		Total	Beginner	N.Dr.	.624	.0949	8
				Total	.624	.0949	8
			Total	N.Dr.	.624	.0949	8
			Total		.624	.0949	8
	Total	0	Beginner	Ex.Dr	.670	.	1
				N.Dr.	.618	.1063	6
				Total	.626	.0990	7
			M.Exp.	Ex.Dr	.550	.0707	2
				N.Dr.	.621	.0669	8
				Total	.607	.0702	10
			W.Exp.	Ex.Dr	.600	.0000	3
				N.Dr.	.597	.0644	11
				Total	.598	.0565	14
			Total	Ex.Dr	.595	.0543	6
				N.Dr.	.610	.0743	25
				Total	.607	.0703	31
		1	Beginner	Ex.Dr	.670	.	1
				N.Dr.	.687	.1180	12
				Total	.685	.1131	13
			M.Exp.	Ex.Dr	.635	.0404	4
				N.Dr.	.648	.0450	4
				Total	.641	.0402	8
			W.Exp.	N.Dr.	.634	.1039	7
				Total	.634	.1039	7
			Total	Ex.Dr	.642	.0383	5
				N.Dr.	.664	.1039	23
				Total	.660	.0953	28
		Total	Beginner	Ex.Dr	.670	.0000	2
				N.Dr.	.664	.1159	18
				Total	.665	.1097	20
			M.Exp.	Ex.Dr	.607	.0625	6
				N.Dr.	.630	.0597	12
				Total	.622	.0599	18
			W.Exp.	Ex.Dr	.600	.0000	3
				N.Dr.	.612	.0812	18
				Total	.610	.0750	21
			Total	Ex.Dr	.616	.0516	11
				N.Dr.	.636	.0928	48
				Total	.632	.0866	59
BRT.100.20	middle	0	Beginner	Ex.Dr	.800	.	1
				N.Dr.	.900	.1414	2

		Total	.867	.1155	3	
	M.Exp.	Ex.Dr	.700	.	1	
		N.Dr.	.830	.	1	
		Total	.765	.0919	2	
	W.Exp.	Ex.Dr	.693	.0404	3	
		N.Dr.	.695	.1101	10	
		Total	.695	.0967	13	
	Total	Ex.Dr	.716	.0550	5	
		N.Dr.	.737	.1318	13	
		Total	.731	.1143	18	
1	Beginner	Ex.Dr	1.340	.	1	
		N.Dr.	.915	.1144	8	
		Total	.962	.1775	9	
	M.Exp.	Ex.Dr	.750	.	1	
		Total	.750	.	1	
	W.Exp.	N.Dr.	.736	.1056	7	
		Total	.736	.1056	7	
	Total	Ex.Dr	1.045	.4172	2	
		N.Dr.	.831	.1411	15	
		Total	.856	.1825	17	
	Total	Beginner	Ex.Dr	1.070	.3818	2
		N.Dr.	.912	.1115	10	
		Total	.938	.1650	12	
	M.Exp.	Ex.Dr	.725	.0354	2	
		N.Dr.	.830	.	1	
		Total	.760	.0656	3	
	W.Exp.	Ex.Dr	.693	.0404	3	
		N.Dr.	.712	.1069	17	
		Total	.709	.0992	20	
	Total	Ex.Dr	.810	.2383	7	
		N.Dr.	.788	.1426	28	
		Total	.792	.1620	35	
old	0	M.Exp.	Ex.Dr	.670	.	1
		N.Dr.	.740	.0852	7	
		Total	.731	.0827	8	
	W.Exp.	N.Dr.	.810	.	1	
		Total	.810	.	1	
	Total	Ex.Dr	.670	.	1	
		N.Dr.	.749	.0827	8	
		Total	.740	.0817	9	
	1	M.Exp.	Ex.Dr	.820	.2193	3
		N.Dr.	.883	.1895	4	
		Total	.856	.1873	7	
	Total	Ex.Dr	.820	.2193	3	
		N.Dr.	.883	.1895	4	
		Total	.856	.1873	7	
	Total	M.Exp.	Ex.Dr	.783	.1941	4
		N.Dr.	.792	.1425	11	
		Total	.789	.1503	15	

			W.Exp.	N.Dr.	.810	.	1
				Total	.810	.	1
			Total	Ex.Dr	.783	.1941	4
				N.Dr.	.793	.1359	12
				Total	.791	.1453	16
	young	0	Beginner	N.Dr.	.730	.0678	4
				Total	.730	.0678	4
			Total	N.Dr.	.730	.0678	4
				Total	.730	.0678	4
		1	Beginner	N.Dr.	.805	.1756	4
				Total	.805	.1756	4
			Total	N.Dr.	.805	.1756	4
				Total	.805	.1756	4
		Total	Beginner	N.Dr.	.768	.1296	8
				Total	.768	.1296	8
			Total	N.Dr.	.768	.1296	8
				Total	.768	.1296	8
	Total	0	Beginner	Ex.Dr	.800	.	1
				N.Dr.	.787	.1203	6
				Total	.789	.1099	7
			M.Exp.	Ex.Dr	.685	.0212	2
				N.Dr.	.751	.0851	8
				Total	.738	.0804	10
			W.Exp.	Ex.Dr	.693	.0404	3
				N.Dr.	.705	.1100	11
				Total	.703	.0979	14
			Total	Ex.Dr	.708	.0527	6
				N.Dr.	.740	.1063	25
				Total	.734	.0983	31
		1	Beginner	Ex.Dr	1.340	.	1
				N.Dr.	.878	.1402	12
				Total	.914	.1855	13
			M.Exp.	Ex.Dr	.803	.1825	4
				N.Dr.	.883	.1895	4
				Total	.843	.1774	8
			W.Exp.	N.Dr.	.736	.1056	7
				Total	.736	.1056	7
			Total	Ex.Dr	.910	.2877	5
				N.Dr.	.836	.1495	23
				Total	.849	.1769	28
		Total	Beginner	Ex.Dr	1.070	.3818	2
				N.Dr.	.848	.1377	18
				Total	.870	.1712	20
			M.Exp.	Ex.Dr	.763	.1541	6
				N.Dr.	.795	.1363	12
				Total	.784	.1387	18
			W.Exp.	Ex.Dr	.693	.0404	3
				N.Dr.	.717	.1063	18
				Total	.714	.0992	21
			Total	Ex.Dr	.800	.2135	11
				N.Dr.	.786	.1363	48
				Total	.788	.1515	59
BRT.100.30	middle	0	Beginner	Ex.Dr	.900	.	1
				N.Dr.	1.065	.0919	2

			Total	1.010	.1153	3
		M.Exp.	Ex.Dr	1.100	.	1
			N.Dr.	.940	.	1
			Total	1.020	.1131	2
		W.Exp.	Ex.Dr	.870	.1758	3
			N.Dr.	1.057	.3995	10
			Total	1.014	.3627	13
		Total	Ex.Dr	.922	.1597	5
			N.Dr.	1.049	.3486	13
			Total	1.014	.3085	18
	1	Beginner	Ex.Dr	1.000	.	1
			N.Dr.	1.164	.1103	8
			Total	1.146	.1167	9
		M.Exp.	Ex.Dr	.800	.	1
			Total	.800	.	1
		W.Exp.	N.Dr.	.901	.1157	7
			Total	.901	.1157	7
		Total	Ex.Dr	.900	.1414	2
			N.Dr.	1.041	.1737	15
			Total	1.025	.1728	17
	Total	Beginner	Ex.Dr	.950	.0707	2
			N.Dr.	1.144	.1102	10
			Total	1.112	.1268	12
		M.Exp.	Ex.Dr	.950	.2121	2
			N.Dr.	.940	.	1
			Total	.947	.1501	3
		W.Exp.	Ex.Dr	.870	.1758	3
			N.Dr.	.993	.3178	17
			Total	.975	.3006	20
		Total	Ex.Dr	.916	.1430	7
			N.Dr.	1.045	.2639	28
			Total	1.019	.2484	35
old	0	M.Exp.	Ex.Dr	.870	.	1
			N.Dr.	1.051	.1858	7
			Total	1.029	.1836	8
		W.Exp.	N.Dr.	1.410	.	1
			Total	1.410	.	1
		Total	Ex.Dr	.870	.	1
			N.Dr.	1.096	.2137	8
			Total	1.071	.2136	9
	1	M.Exp.	Ex.Dr	1.013	.2940	3
			N.Dr.	1.035	.2689	4
			Total	1.026	.2551	7
		Total	Ex.Dr	1.013	.2940	3
			N.Dr.	1.035	.2689	4
			Total	1.026	.2551	7
	Total	M.Exp.	Ex.Dr	.978	.2505	4

			N.Dr.	1.045	.2061	11
			Total	1.027	.2115	15
		W.Exp.	N.Dr.	1.410	.	1
			Total	1.410	.	1
		Total	Ex.Dr	.978	.2505	4
			N.Dr.	1.076	.2229	12
			Total	1.051	.2257	16
young	0	Beginner	N.Dr.	.895	.2113	4
			Total	.895	.2113	4
		Total	N.Dr.	.895	.2113	4
			Total	.895	.2113	4
	1	Beginner	N.Dr.	.995	.2390	4
			Total	.995	.2390	4
		Total	N.Dr.	.995	.2390	4
			Total	.995	.2390	4
	Total	Beginner	N.Dr.	.945	.2155	8
			Total	.945	.2155	8
		Total	N.Dr.	.945	.2155	8
			Total	.945	.2155	8
Total	0	Beginner	Ex.Dr	.900	.	1
			N.Dr.	.952	.1902	6
			Total	.944	.1747	7
		M.Exp.	Ex.Dr	.985	.1626	2
			N.Dr.	1.038	.1765	8
			Total	1.027	.1663	10
		W.Exp.	Ex.Dr	.870	.1758	3
			N.Dr.	1.089	.3937	11
			Total	1.042	.3642	14
		Total	Ex.Dr	.913	.1445	6
			N.Dr.	1.040	.2903	25
			Total	1.015	.2710	31
	1	Beginner	Ex.Dr	1.000	.	1
			N.Dr.	1.108	.1738	12
			Total	1.099	.1691	13
		M.Exp.	Ex.Dr	.960	.2627	4
			N.Dr.	1.035	.2689	4
			Total	.998	.2493	8
		W.Exp.	N.Dr.	.901	.1157	7
			Total	.901	.1157	7
		Total	Ex.Dr	.968	.2282	5
			N.Dr.	1.032	.1928	23
			Total	1.021	.1965	28
	Total	Beginner	Ex.Dr	.950	.0707	2
			N.Dr.	1.056	.1895	18
			Total	1.045	.1829	20
		M.Exp.	Ex.Dr	.968	.2165	6
			N.Dr.	1.037	.1988	12
			Total	1.014	.2011	18
		W.Exp.	Ex.Dr	.870	.1758	3
			N.Dr.	1.016	.3236	18

	Total	.995	.3080	21
Total	Ex.Dr	.938	.1791	11
	N.Dr.	1.036	.2458	48
	Total	1.018	.2366	59

Multivariate Tests(c)

Effect		Value	F	Hypothesis df	Error df	Sig.
sphdy	Pillai's Trace	.797	17.175(a)	8.000	35.000	.000
	Wilks' Lambda	.203	17.175(a)	8.000	35.000	.000
	Hotelling's Trace	3.926	17.175(a)	8.000	35.000	.000
	Roy's Largest Root	3.926	17.175(a)	8.000	35.000	.000
sphdy * Age	Pillai's Trace	.256	.662	16.000	72.000	.038
	Wilks' Lambda	.759	.647(a)	16.000	70.000	.038
	Hotelling's Trace	.297	.632	16.000	68.000	.038
	Roy's Largest Root	.193	.866(b)	8.000	36.000	.036
sphdy * Gender	Pillai's Trace	.273	1.644(a)	8.000	35.000	.015
	Wilks' Lambda	.727	1.644(a)	8.000	35.000	.015
	Hotelling's Trace	.376	1.644(a)	8.000	35.000	.015
	Roy's Largest Root	.376	1.644(a)	8.000	35.000	.015
sphdy * Dr.Exp	Pillai's Trace	.446	1.292	16.000	72.000	.226
	Wilks' Lambda	.581	1.365(a)	16.000	70.000	.185
	Hotelling's Trace	.675	1.434	16.000	68.000	.152
	Roy's Largest Root	.597	2.687(b)	8.000	36.000	.072
sphdy * Dr.Hrs.perWeek	Pillai's Trace	.201	1.099(a)	8.000	35.000	.387
	Wilks' Lambda	.799	1.099(a)	8.000	35.000	.387
	Hotelling's Trace	.251	1.099(a)	8.000	35.000	.387
	Roy's Largest Root	.251	1.099(a)	8.000	35.000	.387
sphdy * Age * Gender	Pillai's Trace	.311	.827	16.000	72.000	.037
	Wilks' Lambda	.710	.817(a)	16.000	70.000	.047
	Hotelling's Trace	.380	.807	16.000	68.000	.047
	Roy's Largest Root	.275	1.238(b)	8.000	36.000	.043
sphdy * Age * Dr.Exp	Pillai's Trace	.233	1.331(a)	8.000	35.000	.261
	Wilks' Lambda	.767	1.331(a)	8.000	35.000	.261
	Hotelling's Trace	.304	1.331(a)	8.000	35.000	.261
	Roy's Largest Root	.304	1.331(a)	8.000	35.000	.261
sphdy * Gender * Dr.Exp	Pillai's Trace	.463	1.356	16.000	72.000	.189
	Wilks' Lambda	.590	1.321(a)	16.000	70.000	.210
	Hotelling's Trace	.605	1.286	16.000	68.000	.232
	Roy's Largest Root	.345	1.551(b)	8.000	36.000	.174
sphdy * Age * Gender * Dr.Exp	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
sphdy * Age * Dr.Hrs.perWeek	Pillai's Trace	.118	.587(a)	8.000	35.000	.781
	Wilks' Lambda	.882	.587(a)	8.000	35.000	.781

sphdy * Gender * Dr.Hrs.perWeek	Hotelling's Trace	.134	.587(a)	8.000	35.000	.781
	Roy's Largest Root	.134	.587(a)	8.000	35.000	.781
	Pillai's Trace	.254	1.490(a)	8.000	35.000	.196
	Wilks' Lambda	.746	1.490(a)	8.000	35.000	.196
	Hotelling's Trace	.341	1.490(a)	8.000	35.000	.196
sphdy * Age * Gender * Dr.Hrs.perWeek	Roy's Largest Root	.341	1.490(a)	8.000	35.000	.196
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
sphdy * Dr.Exp * Dr.Hrs.perWeek	Pillai's Trace	.167	.409	16.000	72.000	.976
	Wilks' Lambda	.840	.399(a)	16.000	70.000	.978
	Hotelling's Trace	.183	.390	16.000	68.000	.981
	Roy's Largest Root	.121	.543(b)	8.000	36.000	.816
	Pillai's Trace	.000	.(a)	.000	.000	.
sphdy * Age * Dr.Exp * Dr.Hrs.perWeek	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
sphdy * Gender * Dr.Exp * * Dr.Hrs.perWeek	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
sphdy * Age * Gender * Dr.Exp * Dr.Hrs.perWeek	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000

a Exact statistic

b The statistic is an upper bound on F that yields a lower bound on the significance level.

c Design: Intercept+Age+Gender+Dr.Exp+Dr.Hrs.perWeek+Age * Gender+Age * Dr.Exp+Gender * Dr.Exp+Age * Gender * Dr.Exp+Age * Dr.Hrs.perWeek+Gender * Dr.Hrs.perWeek+Age * Gender * Dr.Hrs.perWeek+Dr.Exp * Dr.Hrs.perWeek+Age * Dr.Exp * Dr.Hrs.perWeek+Gender * Dr.Exp * Dr.Hrs.perWeek+Age * Gender * Dr.Exp * Dr.Hrs.perWeek

Within Subjects Design: sphdy

Mauchly's Test of Sphericity(b)

Measure: brt

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon(a)		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
sphdy	.005	207.786	35	.000	.476	.729	.125

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables

is proportional to an identity matrix.

a May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in

the Tests of Within-Subjects Effects table.

b Design: Intercept+Age+Gender+Dr.Exp+Dr.Hrs.perWeek+Age * Gender+Age * Dr.Exp+Gender * Dr.Exp+Age * Gender * Dr.Exp+Age * Dr.Hrs.perWeek+Gender * Dr.Hrs.perWeek+Age * Gender * Dr.Hrs.perWeek+Dr.Exp * Dr.Hrs.perWeek+Age * Dr.Exp * Dr.Hrs.perWeek+Gender * Dr.Exp * Dr.Hrs.perWeek+Age * Gender * Dr.Exp * Dr.Hrs.perWeek

Within Subjects Design: sphdy

Tests of Within-Subjects Effects

Measure: brt

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
sphdy	Sphericity Assumed	3.933	8	.492	24.250	.000
	Greenhouse-Geisser	3.933	3.810	1.032	24.250	.000
	Huynh-Feldt	3.933	5.834	.674	24.250	.000
	Lower-bound	3.933	1.000	3.933	24.250	.000
sphdy * Age	Sphericity Assumed	.186	16	.012	1.573	.035
	Greenhouse-Geisser	.186	7.621	.024	.573	.038
	Huynh-Feldt	.186	11.669	.016	.573	.039
	Lower-bound	.186	2.000	.093	.573	.036
sphdy * Gender	Sphericity Assumed	.268	8	.034	1.653	.043
	Greenhouse-Geisser	.268	3.810	.070	1.653	.042
	Huynh-Feldt	.268	5.834	.046	1.653	.041
	Lower-bound	.268	1.000	.268	1.653	.042
sphdy * Dr.Exp	Sphericity Assumed	.253	16	.016	.780	.708
	Greenhouse-Geisser	.253	7.621	.033	.780	.615
	Huynh-Feldt	.253	11.669	.022	.780	.667
	Lower-bound	.253	2.000	.127	.780	.465
sphdy * Dr.Hrs.perWeek	Sphericity Assumed	.181	8	.023	1.117	.351
	Greenhouse-Geisser	.181	3.810	.048	1.117	.350
	Huynh-Feldt	.181	5.834	.031	1.117	.353
	Lower-bound	.181	1.000	.181	1.117	.297
sphdy * Age * Gender	Sphericity Assumed	.103	16	.006	1.319	.033
	Greenhouse-Geisser	.103	7.621	.014	.319	.040
	Huynh-Feldt	.103	11.669	.009	.319	.040
	Lower-bound	.103	2.000	.052	.319	.027
sphdy * Age * Dr.Exp	Sphericity Assumed	.065	8	.008	.399	.921
	Greenhouse-Geisser	.065	3.810	.017	.399	.800
	Huynh-Feldt	.065	5.834	.011	.399	.875
	Lower-bound	.065	1.000	.065	.399	.531
sphdy * Gender * Dr.Exp	Sphericity Assumed	.242	16	.015	.747	.744
	Greenhouse-Geisser	.242	7.621	.032	.747	.643
	Huynh-Feldt	.242	11.669	.021	.747	.700
	Lower-bound	.242	2.000	.121	.747	.480
sphdy * Age * Gender * Dr.Exp	Sphericity Assumed	.000	0	.	.	.

		Greenhouse-Geisser	Huynh-Feldt	Sphericity Assumed	Lower-bound	Upper-bound	Epsilon
sphdy * Age *	Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
		Huynh-Feldt	.000	.000	.	.	.
		Lower-bound	.000	.000	.	.	.
		Sphericity Assumed	.084	8	.011	.519	.842
sphdy * Gender *	Dr.Hrs.perWeek	Greenhouse-Geisser	.084	3.810	.022	.519	.713
		Huynh-Feldt	.084	5.834	.014	.519	.789
		Lower-bound	.084	1.000	.084	.519	.475
		Sphericity Assumed	.072	8	.009	.443	.895
sphdy * Age * Gender *	Dr.Hrs.perWeek	Greenhouse-Geisser	.072	3.810	.019	.443	.768
		Huynh-Feldt	.072	5.834	.012	.443	.845
		Lower-bound	.072	1.000	.072	.443	.509
		Sphericity Assumed	.000	0	.	.	.
sphdy * Dr.Exp *	Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
		Huynh-Feldt	.000	.000	.	.	.
		Lower-bound	.000	.000	.	.	.
		Sphericity Assumed	.131	16	.008	.403	.981
sphdy * Age * Dr.Exp *	Dr.Hrs.perWeek	Greenhouse-Geisser	.131	7.621	.017	.403	.911
		Huynh-Feldt	.131	11.669	.011	.403	.959
		Lower-bound	.131	2.000	.065	.403	.671
		Sphericity Assumed	.000	0	.	.	.
sphdy * Gender * Dr.Exp *	Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
		Huynh-Feldt	.000	.000	.	.	.
		Lower-bound	.000	.000	.	.	.
		Sphericity Assumed	.000	0	.	.	.
sphdy * Age * Gender * Dr.Exp *	Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
		Huynh-Feldt	.000	.000	.	.	.
		Lower-bound	.000	.000	.	.	.
		Sphericity Assumed	.000	0	.	.	.
Error(sphdy)		Greenhouse-Geisser	6.813	336	.020		
		Greenhouse-Geisser	6.813	160.038	.043		
		Huynh-Feldt	6.813	245.046	.028		
		Lower-bound	6.813	42.000	.162		

Measure: brt

sphdy * Age	Cubic	.719	1	.719	38.323	.000
	Order 4	.016	1	.016	1.316	.258
	Order 5	.350	1	.350	21.181	.000
	Order 6	.003	1	.003	.270	.606
	Order 7	2.327	1	2.327	57.458	.000
	Order 8	.049	1	.049	2.757	.104
	Linear	.051	2	.026	1.177	.032
	Quadratic	.025	2	.012	.564	.573
	Cubic	.028	2	.014	.756	.476
	Order 4	.025	2	.012	.991	.380
sphdy * Gender	Order 5	.012	2	.006	.367	.695
	Order 6	.000	2	.000	.010	.990
	Order 7	.045	2	.022	.550	.581
	Order 8	.000	2	.000	.011	.989
	Linear	.005	1	.005	.253	.618
	Quadratic	.046	1	.046	2.092	.156
	Cubic	.012	1	.012	.631	.432
	Order 4	.031	1	.031	2.524	.120
	Order 5	2.89E-005	1	2.89E-005	.002	.967
	Order 6	.001	1	.001	.044	.835
sphdy * Dr.Exp	Order 7	.145	1	.145	3.581	.065
	Order 8	.028	1	.028	1.578	.216
	Linear	.046	2	.023	1.058	.356
	Quadratic	.048	2	.024	1.091	.345
	Cubic	.001	2	.001	.032	.968
	Order 4	.073	2	.037	2.954	.063
	Order 5	.004	2	.002	.108	.898
	Order 6	.008	2	.004	.304	.740
	Order 7	.064	2	.032	.791	.460
	Order 8	.010	2	.005	.275	.761
sphdy * Dr.Hrs.perWeek	Linear	.000	1	.000	.013	.910
	Quadratic	.006	1	.006	.282	.598
	Cubic	.030	1	.030	1.578	.216
	Order 4	.010	1	.010	.788	.380
	Order 5	.038	1	.038	2.297	.137
	Order 6	.040	1	.040	3.153	.083
	Order 7	.038	1	.038	.951	.335
	Order 8	.019	1	.019	1.070	.307
	Linear	.031	2	.016	.721	.035
	Quadratic	.009	2	.005	.209	.812
sphdy * Age * Gender	Cubic	.038	2	.019	1.009	.373
	Order 4	.004	2	.002	.168	.846
	Order 5	.005	2	.003	.161	.852
	Order 6	.000	2	9.07E-005	.007	.993
	Order 7	.001	2	.001	.017	.983
	Order 8	.014	2	.007	.392	.678
	Linear	.002	1	.002	.078	.782
sphdy * Age * Dr.Exp						

sphdy * Gender * Dr.Exp	Quadratic	.013	1	.013	.604	.441
	Cubic	.001	1	.001	.027	.871
	Order 4	.031	1	.031	2.494	.122
	Order 5	.000	1	.000	.008	.930
	Order 6	.018	1	.018	1.433	.238
	Order 7	.000	1	.000	.004	.953
	Order 8	7.53E-005	1	7.53E-005	.004	.949
	Linear	.098	2	.049	2.264	.116
	Quadratic	.003	2	.001	.058	.944
	Cubic	.021	2	.010	.552	.580
	Order 4	.051	2	.026	2.064	.140
	Order 5	.003	2	.001	.084	.920
	Order 6	.015	2	.007	.587	.560
	Order 7	.039	2	.020	.482	.621
	Order 8	.013	2	.007	.368	.695
sphdy * Age * Gender * Dr.Exp	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
	Linear	.026	1	.026	1.183	.283
	Quadratic	.024	1	.024	1.090	.302
	Cubic	.025	1	.025	1.316	.258
	Order 4	.000	1	.000	.014	.907
	Order 5	.005	1	.005	.298	.588
	Order 6	7.12E-005	1	7.12E-005	.006	.940
	Order 7	.002	1	.002	.057	.813
	Order 8	.003	1	.003	.143	.707
sphdy * Gender * Dr.Hrs.perWeek	Linear	.006	1	.006	.268	.608
	Quadratic	.002	1	.002	.095	.759
	Cubic	5.97E-006	1	5.97E-006	.000	.986
	Order 4	.023	1	.023	1.845	.182
	Order 5	.001	1	.001	.043	.836
	Order 6	.004	1	.004	.352	.556
	Order 7	.010	1	.010	.235	.630
	Order 8	.026	1	.026	1.473	.232
	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
sphdy * Age * Gender * Dr.Hrs.perWeek	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.

sphdy * Dr.Exp * Dr.Hrs.perWeek	Linear	.026	2	.013	.593	.557
	Quadratic	.040	2	.020	.927	.404
	Cubic	.022	2	.011	.579	.565
	Order 4	.006	2	.003	.222	.802
	Order 5	.018	2	.009	.558	.577
	Order 6	.004	2	.002	.162	.851
	Order 7	.007	2	.004	.091	.914
	Order 8	.007	2	.004	.209	.812
sphdy * Age * Dr.Exp * Dr.Hrs.perWeek	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
sphdy * Gender * Dr.Exp * Dr.Hrs.perWeek	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
sphdy * Age * Gender * Dr.Exp * Dr.Hrs.perWeek	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
Error(sphdy)	Linear	.911	42	.022		
	Quadratic	.915	42	.022		
	Cubic	.788	42	.019		
	Order 4	.521	42	.012		
	Order 5	.694	42	.017		
	Order 6	.528	42	.013		
	Order 7	1.701	42	.040		
	Order 8	.753	42	.018		

Tests of Between-Subjects Effects

Measure: brt

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	128.608	1	128.608	940.868	.000
Age	.389	2	.195	1.423	.025
Gender	.643	1	.643	4.708	.036
Dr.Exp	.210	2	.105	.767	.471
Dr.Hrs.perWeek	.091	1	.091	.665	.419
Age * Gender	.101	2	.051	.371	.039
Age * Dr.Exp	.249	1	.249	1.824	.184
Gender * Dr.Exp	.039	2	.019	.141	.869
Age * Gender * Dr.Exp	.000	0	.	.	.
Age * Dr.Hrs.perWeek	.028	1	.028	.208	.651
Gender * Dr.Hrs.perWeek	.054	1	.054	.397	.532
Age * Gender * Dr.Hrs.perWeek	.000	0	.	.	.
Dr.Exp * Dr.Hrs.perWeek	.044	2	.022	.160	.852
Age * Dr.Exp * Dr.Hrs.perWeek	.000	0	.	.	.
Gender * Dr.Exp * Dr.Hrs.perWeek	.000	0	.	.	.
Age * Gender * Dr.Exp * Dr.Hrs.perWeek	.000	0	.	.	.
Error	5.741	42	.137		

Estimated Marginal Means

1. Age

Measure: brt

Age	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
middle	.801(a)	.031	.740	.863
old	.830(a)	.041	.748	.912
young	.797(a)	.044	.709	.885

a Based on modified population marginal mean.

2. Gender

Measure: brt

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
0	.781(a)	.031	.718	.844
1	.850(a)	.031	.787	.912

a Based on modified population marginal mean.

3. Dr.Exp

Measure: brt

Dr.Exp	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Beginner	.835(a)	.036	.762	.908
M.Exp.	.787(a)	.038	.710	.864
W.Exp.	.810(a)	.039	.732	.888

a Based on modified population marginal mean.

4. Dr.Hrs.perWeek

Measure: brt

Dr.Hrs.perWeek	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Ex.Dr	.771(a)	.042	.686	.855
N.Dr.	.836(a)	.024	.788	.885

a Based on modified population marginal mean.

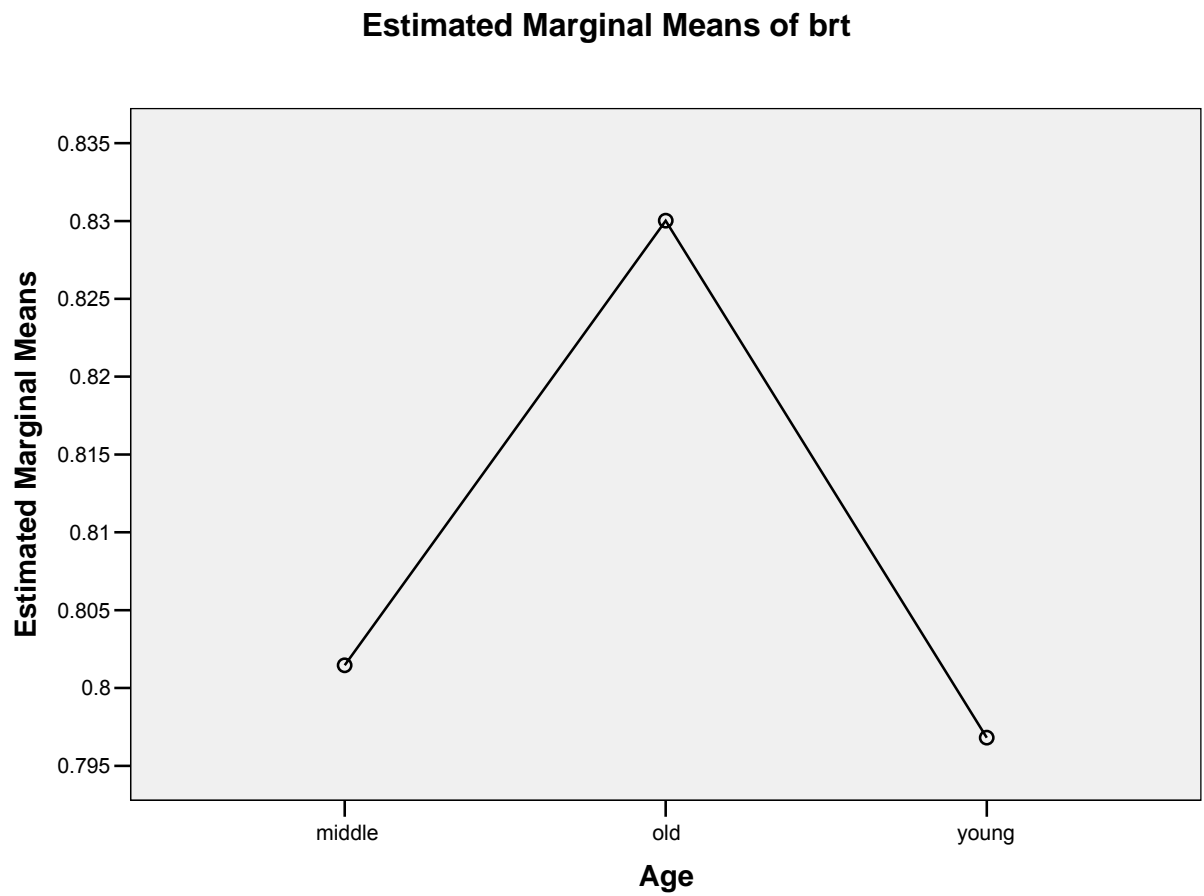
5. sphdy

Measure: brt

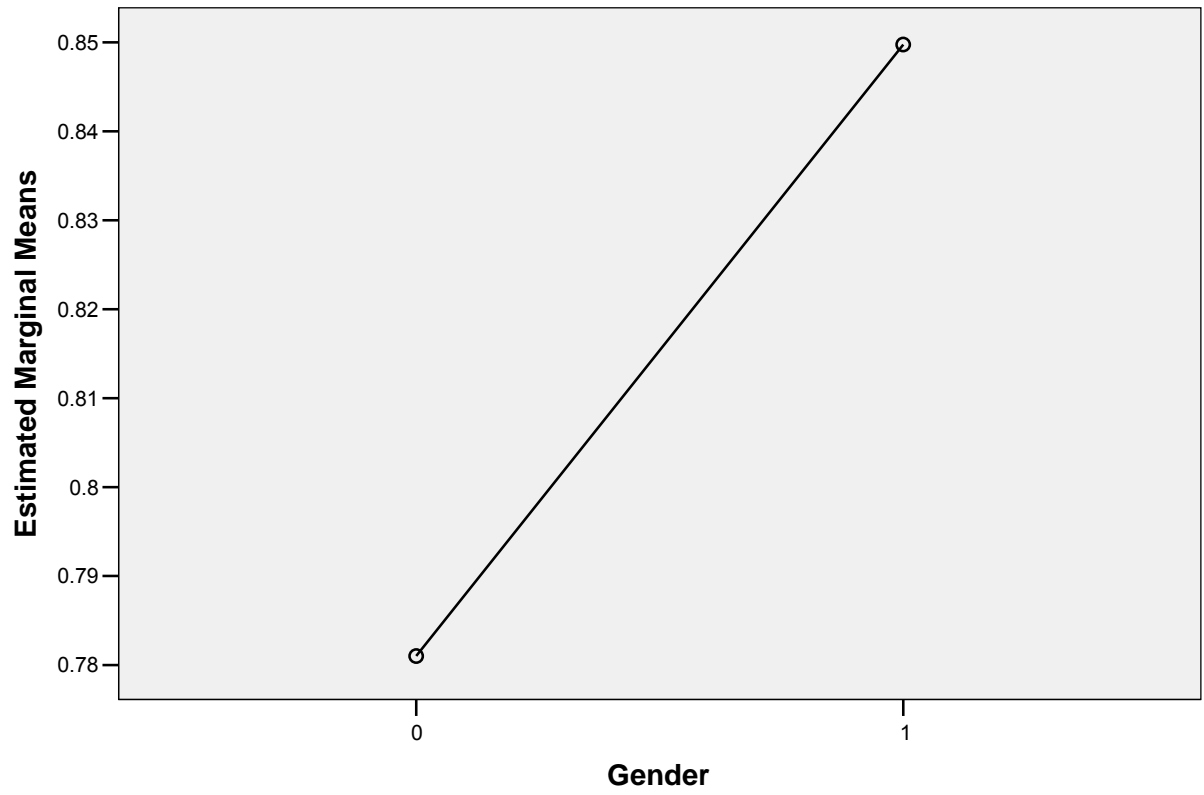
sphdy	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	.639(a)	.014	.610	.669
2	.780(a)	.022	.736	.824
3	.969(a)	.048	.872	1.066
4	.661(a)	.021	.619	.703
5	.781(a)	.023	.734	.827
6	1.004(a)	.055	.893	1.116
7	.632(a)	.016	.601	.664
8	.813(a)	.022	.768	.858
9	1.004(a)	.045	.914	1.094

a Based on modified population marginal mean.

Profile Plots



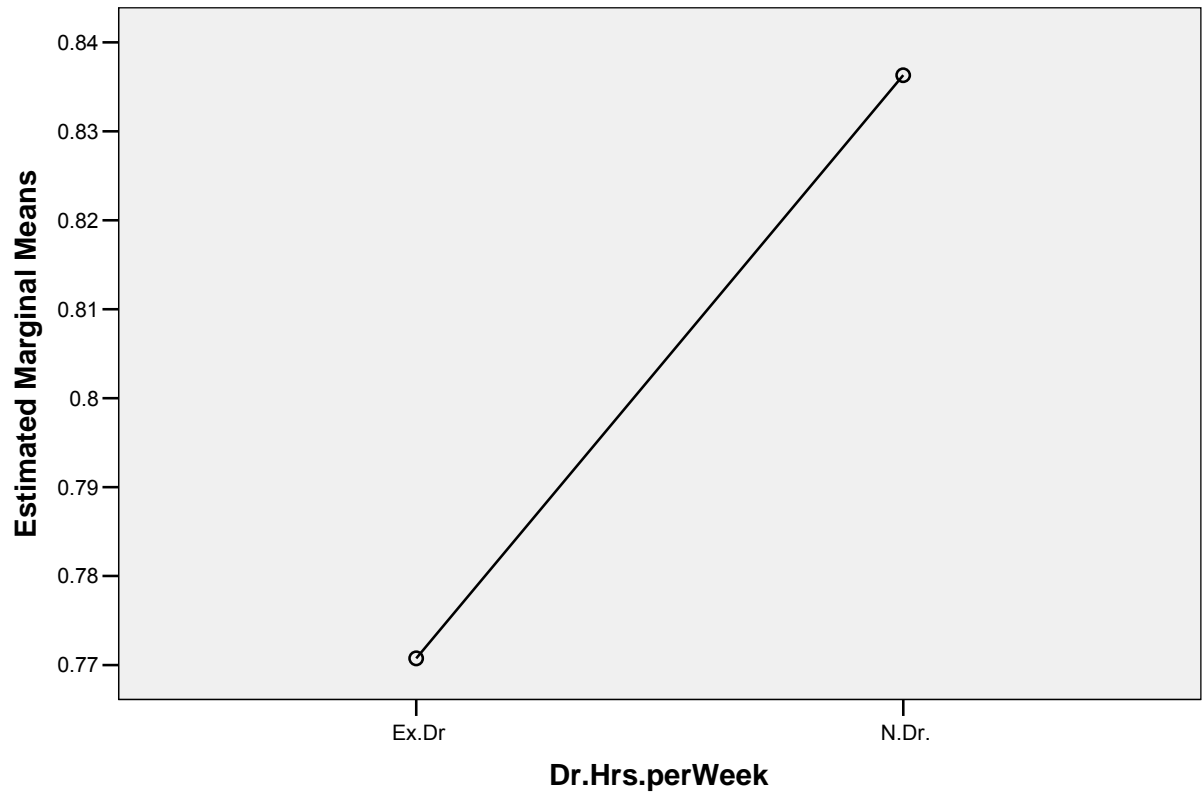
Estimated Marginal Means of brt



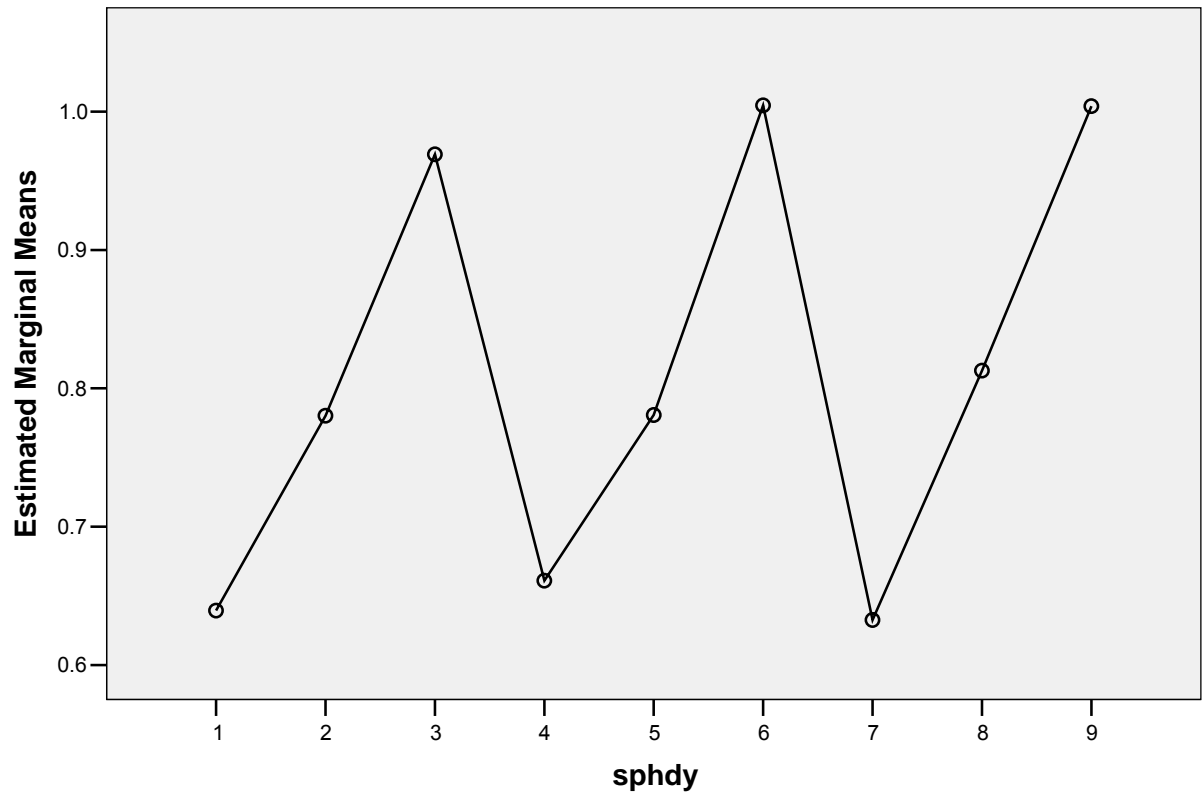
Estimated Marginal Means of brt



Estimated Marginal Means of brt



Estimated Marginal Means of brt



Appendix E

Repeated Measure ANOVA Analysis for Stationary Scenario

Repeated Measure ANOVA for BRT: Stationary Scenario

This appendix shows the results of repeated measure ANOVA analysis of BRT for stationary scenario. The appendix includes:

- 1- Description of within and between subject factors
- 2- Descriptive statistics such as mean and standard deviation
- 3- Mauchly's test of Sphericity that examines the form of the common covariance matrix. A spherical matrix has equal variances and covariances equal to zero. The common covariance matrix of the transformed within-subject variables must be spherical, or the F tests and associated p values for the univariate approach to testing within-subjects hypotheses are invalid. If sphericity assumption is violated then SPSS performs the correct tests to check the effect of within subject factors.
- 4- Tests to show the within subject effects
- 5- Tests to show the trend of models for combination of different variables
- 6- Tests to show the between subject effects
- 7- Marginal means of BRT for all variables
- 8- Profile Plots that show the graphical representation of marginal means of BRT for each variable.

Within-Subjects Factors

Measure: brt

sphdy	Dependent Variable
1	BRT.60.20
2	BRT.60.30
3	BRT.60.40
4	BRT.80.20
5	BRT.80.30
6	BRT.80.40
7	BRT.100.20
8	BRT.100.30
9	BRT.100.40

Between-Subjects Factors

		N
Age	middle	35
	old	16
	young	8
Gender	0	31
	1	28
Dr.Exp	Beginner	20
	M.Exp.	18
	W.Exp.	21
Dr.Hrs.perWeek	Ex.Dr	11
	N.Dr.	48

Descriptive Statistics

	Age	Gender	Dr.Exp	Dr.Hrs.perWeek	Mean	Std. Deviation	N
BRT.60.20	middle	0	Beginner	Ex.Dr	.5400	.	1
				N.Dr.	.6500	.07071	2
				Total	.6133	.08083	3
			M.Exp.	Ex.Dr	.5000	.	1
				N.Dr.	.6100	.	1
				Total	.5550	.07778	2
			W.Exp.	Ex.Dr	.5233	.06807	3
				N.Dr.	.5230	.08680	10
				Total	.5231	.08014	13
			Total	Ex.Dr	.5220	.05020	5
				N.Dr.	.5492	.09296	13
				Total	.5417	.08276	18
	old	1	Beginner	Ex.Dr	.4700	.	1
				N.Dr.	.5275	.05445	8

			Total	.5211	.05442	9
		M.Exp.	Ex.Dr	.5300	.	1
			Total	.5300	.	1
		W.Exp.	N.Dr.	.5671	.09013	7
			Total	.5671	.09013	7
		Total	Ex.Dr	.5000	.04243	2
			N.Dr.	.5460	.07337	15
			Total	.5406	.07110	17
	Total	Beginner	Ex.Dr	.5050	.04950	2
			N.Dr.	.5520	.07436	10
			Total	.5442	.07128	12
		M.Exp.	Ex.Dr	.5150	.02121	2
			N.Dr.	.6100	.	1
			Total	.5467	.05686	3
		W.Exp.	Ex.Dr	.5233	.06807	3
			N.Dr.	.5412	.08824	17
			Total	.5385	.08418	20
		Total	Ex.Dr	.5157	.04577	7
			N.Dr.	.5475	.08145	28
			Total	.5411	.07619	35
old	0	M.Exp.	Ex.Dr	.5400	.	1
			N.Dr.	.5686	.03579	7
			Total	.5650	.03464	8
		W.Exp.	N.Dr.	.5100	.	1
			Total	.5100	.	1
		Total	Ex.Dr	.5400	.	1
			N.Dr.	.5613	.03907	8
			Total	.5589	.03723	9
	1	M.Exp.	Ex.Dr	.6900	.13454	3
			N.Dr.	.5550	.11619	4
			Total	.6129	.13413	7
		Total	Ex.Dr	.6900	.13454	3
			N.Dr.	.5550	.11619	4
			Total	.6129	.13413	7
	Total	M.Exp.	Ex.Dr	.6525	.13301	4
			N.Dr.	.5636	.06975	11
			Total	.5873	.09445	15
		W.Exp.	N.Dr.	.5100	.	1
			Total	.5100	.	1
		Total	Ex.Dr	.6525	.13301	4
			N.Dr.	.5592	.06829	12
			Total	.5825	.09327	16
young	0	Beginner	N.Dr.	.5700	.03464	4
			Total	.5700	.03464	4
		Total	N.Dr.	.5700	.03464	4
			Total	.5700	.03464	4
	1	Beginner	N.Dr.	.6125	.13301	4
			Total	.6125	.13301	4
		Total	N.Dr.	.6125	.13301	4
			Total	.6125	.13301	4
	Total	Beginner	N.Dr.	.5913	.09280	8

				Total	.5913	.09280	8
			Total	N.Dr.	.5913	.09280	8
				Total	.5913	.09280	8
	Total	0	Beginner	Ex.Dr	.5400	.	1
				N.Dr.	.5967	.05854	6
				Total	.5886	.05757	7
			M.Exp.	Ex.Dr	.5200	.02828	2
				N.Dr.	.5738	.03623	8
				Total	.5630	.04029	10
			W.Exp.	Ex.Dr	.5233	.06807	3
				N.Dr.	.5218	.08244	11
				Total	.5221	.07708	14
			Total	Ex.Dr	.5250	.04550	6
				N.Dr.	.5564	.07059	25
				Total	.5503	.06701	31
		1	Beginner	Ex.Dr	.4700	.	1
				N.Dr.	.5558	.09199	12
				Total	.5492	.09124	13
			M.Exp.	Ex.Dr	.6500	.13589	4
				N.Dr.	.5550	.11619	4
				Total	.6025	.12759	8
			W.Exp.	N.Dr.	.5671	.09013	7
				Total	.5671	.09013	7
			Total	Ex.Dr	.6140	.14258	5
				N.Dr.	.5591	.09120	23
				Total	.5689	.10123	28
		Total	Beginner	Ex.Dr	.5050	.04950	2
				N.Dr.	.5694	.08292	18
				Total	.5630	.08170	20
			M.Exp.	Ex.Dr	.6067	.12549	6
				N.Dr.	.5675	.06784	12
				Total	.5806	.08928	18
			W.Exp.	Ex.Dr	.5233	.06807	3
				N.Dr.	.5394	.08592	18
				Total	.5371	.08229	21
			Total	Ex.Dr	.5655	.10643	11
				N.Dr.	.5577	.08025	48
				Total	.5592	.08474	59
BRT.60.30	middle	0	Beginner	Ex.Dr	.5400	.	1
				N.Dr.	.7200	.02828	2
				Total	.6600	.10583	3
			M.Exp.	Ex.Dr	.6000	.	1
				N.Dr.	.7300	.	1
				Total	.6650	.09192	2
			W.Exp.	Ex.Dr	.6700	.05196	3
				N.Dr.	.6360	.10522	10
				Total	.6438	.09474	13
			Total	Ex.Dr	.6300	.06928	5
				N.Dr.	.6562	.09921	13
				Total	.6489	.09068	18
		1	Beginner	Ex.Dr	.5700	.	1
				N.Dr.	.6675	.06585	8
				Total	.6567	.06964	9

		M.Exp.	Ex.Dr	.8000	.	1
			Total	.8000	.	1
		W.Exp.	N.Dr.	.7129	.13913	7
			Total	.7129	.13913	7
		Total	Ex.Dr	.6850	.16263	2
			N.Dr.	.6887	.10494	15
			Total	.6882	.10626	17
	Total	Beginner	Ex.Dr	.5550	.02121	2
			N.Dr.	.6780	.06286	10
			Total	.6575	.07461	12
		M.Exp.	Ex.Dr	.7000	.14142	2
			N.Dr.	.7300	.	1
			Total	.7100	.10149	3
		W.Exp.	Ex.Dr	.6700	.05196	3
			N.Dr.	.6676	.12250	17
			Total	.6680	.11368	20
	Total		Ex.Dr	.6457	.09126	7
			N.Dr.	.6736	.10177	28
			Total	.6680	.09911	35
old	0	M.Exp.	Ex.Dr	.6300	.	1
			N.Dr.	.7000	.08327	7
			Total	.6913	.08097	8
		W.Exp.	N.Dr.	.6000	.	1
			Total	.6000	.	1
		Total	Ex.Dr	.6300	.	1
			N.Dr.	.6875	.08481	8
			Total	.6811	.08162	9
	1	M.Exp.	Ex.Dr	.6467	.13614	3
			N.Dr.	.6850	.16197	4
			Total	.6686	.14041	7
		Total	Ex.Dr	.6467	.13614	3
			N.Dr.	.6850	.16197	4
			Total	.6686	.14041	7
	Total	M.Exp.	Ex.Dr	.6425	.11147	4
			N.Dr.	.6945	.10994	11
			Total	.6807	.10892	15
		W.Exp.	N.Dr.	.6000	.	1
			Total	.6000	.	1
		Total	Ex.Dr	.6425	.11147	4
			N.Dr.	.6867	.10832	12
			Total	.6756	.10714	16
young	0	Beginner	N.Dr.	.6850	.01732	4
			Total	.6850	.01732	4
		Total	N.Dr.	.6850	.01732	4
			Total	.6850	.01732	4
	1	Beginner	N.Dr.	.6950	.16031	4
			Total	.6950	.16031	4
		Total	N.Dr.	.6950	.16031	4

			Total		.6950	.16031	4
		Total	Beginner	N.Dr.	.6900	.10569	8
				Total	.6900	.10569	8
			Total	N.Dr.	.6900	.10569	8
				Total	.6900	.10569	8
Total	0		Beginner	Ex.Dr	.5400	.	1
				N.Dr.	.6967	.02582	6
				Total	.6743	.06373	7
			M.Exp.	Ex.Dr	.6150	.02121	2
				N.Dr.	.7038	.07782	8
				Total	.6860	.07849	10
			W.Exp.	Ex.Dr	.6700	.05196	3
				N.Dr.	.6327	.10041	11
				Total	.6407	.09177	14
			Total	Ex.Dr	.6300	.06197	6
				N.Dr.	.6708	.08544	25
				Total	.6629	.08215	31
	1		Beginner	Ex.Dr	.5700	.	1
				N.Dr.	.6767	.09976	12
				Total	.6685	.09999	13
			M.Exp.	Ex.Dr	.6850	.13503	4
				N.Dr.	.6850	.16197	4
				Total	.6850	.13805	8
			W.Exp.	N.Dr.	.7129	.13913	7
				Total	.7129	.13913	7
			Total	Ex.Dr	.6620	.12775	5
				N.Dr.	.6891	.11874	23
				Total	.6843	.11840	28
		Total	Beginner	Ex.Dr	.5550	.02121	2
				N.Dr.	.6833	.08203	18
				Total	.6705	.08721	20
			M.Exp.	Ex.Dr	.6617	.11107	6
				N.Dr.	.6975	.10532	12
				Total	.6856	.10540	18
			W.Exp.	Ex.Dr	.6700	.05196	3
				N.Dr.	.6639	.11991	18
				Total	.6648	.11179	21
			Total	Ex.Dr	.6445	.09342	11
				N.Dr.	.6796	.10204	48
				Total	.6731	.10066	59
BRT.60.40	middle	0	Beginner	Ex.Dr	1.0700	.	1
				N.Dr.	1.1200	.02828	2
				Total	1.1033	.03512	3
			M.Exp.	Ex.Dr	.8000	.	1
				N.Dr.	.8700	.	1
				Total	.8350	.04950	2
			W.Exp.	Ex.Dr	.9500	.17059	3
				N.Dr.	.8880	.07969	10
				Total	.9023	.10175	13
			Total	Ex.Dr	.9440	.15405	5
				N.Dr.	.9223	.11204	13

			Total	.9283	.12060	18
	1	Beginner	Ex.Dr	.6700	.	1
			N.Dr.	.8338	.10391	8
			Total	.8156	.11148	9
		M.Exp.	Ex.Dr	1.4000	.	1
			Total	1.4000	.	1
		W.Exp.	N.Dr.	.9971	.32541	7
			Total	.9971	.32541	7
		Total	Ex.Dr	1.0350	.51619	2
			N.Dr.	.9100	.24062	15
			Total	.9247	.26275	17
	Total	Beginner	Ex.Dr	.8700	.28284	2
			N.Dr.	.8910	.15184	10
			Total	.8875	.16187	12
		M.Exp.	Ex.Dr	1.1000	.42426	2
			N.Dr.	.8700	.	1
			Total	1.0233	.32808	3
		W.Exp.	Ex.Dr	.9500	.17059	3
			N.Dr.	.9329	.21528	17
			Total	.9355	.20526	20
		Total	Ex.Dr	.9700	.24940	7
			N.Dr.	.9157	.18879	28
			Total	.9266	.19941	35
old	0	M.Exp.	Ex.Dr	.7100	.	1
			N.Dr.	.8214	.10221	7
			Total	.8075	.10250	8
		W.Exp.	N.Dr.	.8100	.	1
			Total	.8100	.	1
		Total	Ex.Dr	.7100	.	1
			N.Dr.	.8200	.09472	8
			Total	.8078	.09589	9
	1	M.Exp.	Ex.Dr	1.0000	.13528	3
			N.Dr.	1.1350	.32889	4
			Total	1.0771	.25572	7
		Total	Ex.Dr	1.0000	.13528	3
			N.Dr.	1.1350	.32889	4
			Total	1.0771	.25572	7
	Total	M.Exp.	Ex.Dr	.9275	.18228	4
			N.Dr.	.9355	.25248	11
			Total	.9333	.22949	15
		W.Exp.	N.Dr.	.8100	.	1
			Total	.8100	.	1
		Total	Ex.Dr	.9275	.18228	4
			N.Dr.	.9250	.24344	12
			Total	.9256	.22384	16
young	0	Beginner	N.Dr.	.8450	.04796	4
			Total	.8450	.04796	4
		Total	N.Dr.	.8450	.04796	4
			Total	.8450	.04796	4
	1	Beginner	N.Dr.	.9775	.15543	4
			Total	.9775	.15543	4
		Total	N.Dr.	.9775	.15543	4
			Total	.9775	.15543	4

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			Total	Ex.Dr	.5160	.08905	5
				N.Dr.	.5754	.10767	13
				Total	.5589	.10392	18
	1	Beginner	Ex.Dr	.6700	.	.	1
			N.Dr.	.5125	.03536	.	8
			Total	.5300	.06205	.	9
		M.Exp.	Ex.Dr	.6000	.	.	1
			Total	.6000	.	.	1
		W.Exp.	N.Dr.	.5571	.08281	.	7
			Total	.5571	.08281	.	7
		Total	Ex.Dr	.6350	.04950	.	2
			N.Dr.	.5333	.06399	.	15
			Total	.5453	.06983	.	17
	Total	Beginner	Ex.Dr	.6350	.04950	.	2
			N.Dr.	.5390	.06903	.	10
			Total	.5550	.07428	.	12
		M.Exp.	Ex.Dr	.5000	.14142	.	2
			N.Dr.	.7900	.	.	1
			Total	.5967	.19502	.	3
		W.Exp.	Ex.Dr	.5267	.07371	.	3
			N.Dr.	.5471	.08184	.	17
			Total	.5440	.07917	.	20
		Total	Ex.Dr	.5500	.09522	.	7
			N.Dr.	.5529	.08793	.	28
			Total	.5523	.08799	.	35
	old	0	M.Exp.	Ex.Dr	.4700	.	1
			N.Dr.	.5471	.03251	.	7
			Total	.5375	.04062	.	8
		W.Exp.	N.Dr.	.5500	.	.	1
			Total	.5500	.	.	1
		Total	Ex.Dr	.4700	.	.	1
			N.Dr.	.5475	.03012	.	8
			Total	.5389	.03822	.	9
		1	M.Exp.	Ex.Dr	.6867	.15011	3
			N.Dr.	.6050	.05323	.	4
			Total	.6400	.10408	.	7
		Total	Ex.Dr	.6867	.15011	.	3
			N.Dr.	.6050	.05323	.	4
			Total	.6400	.10408	.	7
	young	0	M.Exp.	Ex.Dr	.6325	.16358	4
			N.Dr.	.5682	.04834	.	11
			Total	.5853	.09094	.	15
		W.Exp.	N.Dr.	.5500	.	.	1
			Total	.5500	.	.	1
		Total	Ex.Dr	.6325	.16358	.	4
			N.Dr.	.5667	.04638	.	12
			Total	.5831	.08830	.	16
		Beginner	N.Dr.	.4600	.04243	.	4
			Total	.4600	.04243	.	4
			Total	.4600	.04243	.	4
		Total	N.Dr.	.4600	.04243	.	4
			Total	.4600	.04243	.	4
	1	Beginner	N.Dr.	.6175	.03500	.	4

				Total	.6175	.03500	4
			Total	N.Dr.	.6175	.03500	4
			Total		.6175	.03500	4
		Total	Beginner	N.Dr.	.5388	.09156	8
			Total		.5388	.09156	8
			Total	N.Dr.	.5388	.09156	8
			Total		.5388	.09156	8
Total	0		Beginner	Ex.Dr	.6000	.	1
				N.Dr.	.5217	.10685	6
			Total		.5329	.10193	7
			M.Exp.	Ex.Dr	.4350	.04950	2
				N.Dr.	.5775	.09099	8
			Total		.5490	.10159	10
			W.Exp.	Ex.Dr	.5267	.07371	3
				N.Dr.	.5409	.08055	11
			Total		.5379	.07658	14
			Total	Ex.Dr	.5083	.08183	6
				N.Dr.	.5480	.08935	25
			Total		.5403	.08807	31
	1		Beginner	Ex.Dr	.6700	.	1
				N.Dr.	.5475	.06166	12
			Total		.5569	.06812	13
			M.Exp.	Ex.Dr	.6650	.13000	4
				N.Dr.	.6050	.05323	4
			Total		.6350	.09739	8
			W.Exp.	N.Dr.	.5571	.08281	7
			Total		.5571	.08281	7
			Total	Ex.Dr	.6660	.11261	5
				N.Dr.	.5604	.06792	23
			Total		.5793	.08563	28
		Total	Beginner	Ex.Dr	.6350	.04950	2
				N.Dr.	.5389	.07730	18
			Total		.5485	.07969	20
			M.Exp.	Ex.Dr	.5883	.15728	6
				N.Dr.	.5867	.07889	12
			Total		.5872	.10632	18
			W.Exp.	Ex.Dr	.5267	.07371	3
				N.Dr.	.5472	.07940	18
			Total		.5443	.07717	21
			Total	Ex.Dr	.5800	.12329	11
				N.Dr.	.5540	.07922	48
			Total		.5588	.08838	59
BRT.80.30	middle	0	Beginner	Ex.Dr	.8000	.	1
				N.Dr.	.7850	.12021	2
			Total		.7900	.08544	3
			M.Exp.	Ex.Dr	.8000	.	1
				N.Dr.	.8500	.	1
			Total		.8250	.03536	2
			W.Exp.	Ex.Dr	.6833	.06658	3
				N.Dr.	.6870	.08179	10
			Total		.6862	.07589	13

			Total	Ex.Dr	.7300	.07937	5
				N.Dr.	.7146	.09597	13
				Total	.7189	.08963	18
	1	Beginner	Ex.Dr	.7500	.	.	1
			N.Dr.	.6088	.04824	.	8
			Total	.6244	.06521	.	9
		M.Exp.	Ex.Dr	.8000	.	.	1
			Total	.8000	.	.	1
		W.Exp.	N.Dr.	.6186	.08435	.	7
			Total	.6186	.08435	.	7
		Total	Ex.Dr	.7750	.03536	.	2
			N.Dr.	.6133	.06510	.	15
			Total	.6324	.08166	.	17
	Total	Beginner	Ex.Dr	.7750	.03536	.	2
			N.Dr.	.6440	.09454	.	10
			Total	.6658	.10013	.	12
		M.Exp.	Ex.Dr	.8000	.00000	.	2
			N.Dr.	.8500	.	.	1
			Total	.8167	.02887	.	3
		W.Exp.	Ex.Dr	.6833	.06658	.	3
			N.Dr.	.6588	.08738	.	17
			Total	.6625	.08353	.	20
		Total	Ex.Dr	.7429	.06993	.	7
			N.Dr.	.6604	.09454	.	28
			Total	.6769	.09529	.	35
old	0	M.Exp.	Ex.Dr	.6400	.	.	1
			N.Dr.	.6343	.04077	.	7
			Total	.6350	.03780	.	8
		W.Exp.	N.Dr.	.5700	.	.	1
			Total	.5700	.	.	1
		Total	Ex.Dr	.6400	.	.	1
			N.Dr.	.6263	.04406	.	8
			Total	.6278	.04147	.	9
	1	M.Exp.	Ex.Dr	.8900	.21932	.	3
			N.Dr.	.8100	.18203	.	4
			Total	.8443	.18555	.	7
		Total	Ex.Dr	.8900	.21932	.	3
			N.Dr.	.8100	.18203	.	4
			Total	.8443	.18555	.	7
	Total	M.Exp.	Ex.Dr	.8275	.21838	.	4
			N.Dr.	.6982	.13710	.	11
			Total	.7327	.16477	.	15
		W.Exp.	N.Dr.	.5700	.	.	1
			Total	.5700	.	.	1
		Total	Ex.Dr	.8275	.21838	.	4
			N.Dr.	.6875	.13586	.	12
			Total	.7225	.16430	.	16
	young	0	Beginner	N.Dr.	.6525	.06702	4

			Total	Total	.6525	.06702	4
			Total	N.Dr.	.6525	.06702	4
			Total	Total	.6525	.06702	4
	1	Beginner	N.Dr.		.8100	.13317	4
			Total	Total	.8100	.13317	4
		Total	N.Dr.		.8100	.13317	4
		Total	Total	Total	.8100	.13317	4
	Total	Beginner	N.Dr.		.7313	.12889	8
			Total	Total	.7313	.12889	8
		Total	N.Dr.		.7313	.12889	8
		Total	Total	Total	.7313	.12889	8
Total	0	Beginner	Ex.Dr		.8000	.	1
			N.Dr.		.6967	.10132	6
			Total		.7114	.10040	7
		M.Exp.	Ex.Dr		.7200	.11314	2
			N.Dr.		.6613	.08509	8
			Total		.6730	.08757	10
		W.Exp.	Ex.Dr		.6833	.06658	3
			N.Dr.		.6764	.08524	11
			Total		.6779	.07924	14
		Total	Ex.Dr		.7150	.07994	6
			N.Dr.		.6764	.08636	25
			Total		.6839	.08527	31
	1	Beginner	Ex.Dr		.7500	.	1
			N.Dr.		.6758	.12703	12
			Total		.6815	.12335	13
		M.Exp.	Ex.Dr		.8675	.18464	4
			N.Dr.		.8100	.18203	4
			Total		.8388	.17250	8
		W.Exp.	N.Dr.		.6186	.08435	7
			Total		.6186	.08435	7
		Total	Ex.Dr		.8440	.16832	5
			N.Dr.		.6817	.13713	23
			Total		.7107	.15338	28
	Total	Beginner	Ex.Dr		.7750	.03536	2
			N.Dr.		.6828	.11646	18
			Total		.6920	.11405	20
		M.Exp.	Ex.Dr		.8183	.16975	6
			N.Dr.		.7108	.13787	12
			Total		.7467	.15328	18
		W.Exp.	Ex.Dr		.6833	.06658	3
			N.Dr.		.6539	.08732	18
			Total		.6581	.08388	21
		Total	Ex.Dr		.7736	.13808	11
			N.Dr.		.6790	.11233	48
			Total		.6966	.12205	59
BRT.80.40	middle	0	Beginner	Ex.Dr	.5400	.	1
			N.Dr.		1.1000	.28284	2
			Total		.9133	.38018	3
		M.Exp.	Ex.Dr		.9000	.	1
			N.Dr.		.9000	.	1
			Total		.9000	.00000	2
		W.Exp.	Ex.Dr		.7267	.07371	3

			N.Dr.	.8050	.06223	10
			Total	.7869	.07064	13
		Total	Ex.Dr	.7240	.13759	5
			N.Dr.	.8577	.14771	13
			Total	.8206	.15379	18
	1	Beginner	Ex.Dr	.8100	.	1
			N.Dr.	.7150	.05155	8
			Total	.7256	.05769	9
		M.Exp.	Ex.Dr	1.0000	.	1
			Total	1.0000	.	1
		W.Exp.	N.Dr.	.7186	.09371	7
			Total	.7186	.09371	7
		Total	Ex.Dr	.9050	.13435	2
			N.Dr.	.7167	.07138	15
			Total	.7388	.09746	17
	Total	Beginner	Ex.Dr	.6750	.19092	2
			N.Dr.	.7920	.19315	10
			Total	.7725	.18950	12
		M.Exp.	Ex.Dr	.9500	.07071	2
			N.Dr.	.9000	.	1
			Total	.9333	.05774	3
		W.Exp.	Ex.Dr	.7267	.07371	3
			N.Dr.	.7694	.08598	17
			Total	.7630	.08392	20
		Total	Ex.Dr	.7757	.15306	7
			N.Dr.	.7821	.13217	28
			Total	.7809	.13422	35
old	0	M.Exp.	Ex.Dr	1.0100	.	1
			N.Dr.	.7529	.05090	7
			Total	.7850	.10240	8
		W.Exp.	N.Dr.	.7000	.	1
			Total	.7000	.	1
		Total	Ex.Dr	1.0100	.	1
			N.Dr.	.7463	.05069	8
			Total	.7756	.09989	9
	1	M.Exp.	Ex.Dr	1.0000	.28792	3
			N.Dr.	.8925	.01500	4
			Total	.9386	.17620	7
		Total	Ex.Dr	1.0000	.28792	3
			N.Dr.	.8925	.01500	4
			Total	.9386	.17620	7
	Total	M.Exp.	Ex.Dr	1.0025	.23514	4
			N.Dr.	.8036	.08115	11
			Total	.8567	.15760	15
		W.Exp.	N.Dr.	.7000	.	1
			Total	.7000	.	1
		Total	Ex.Dr	1.0025	.23514	4
			N.Dr.	.7950	.08296	12
			Total	.8469	.15721	16
young	0	Beginner	N.Dr.	.7950	.07047	4

			Total	.7950	.07047	4
		Total	N.Dr.	.7950	.07047	4
			Total	.7950	.07047	4
	1	Beginner	N.Dr.	.7850	.23573	4
			Total	.7850	.23573	4
		Total	N.Dr.	.7850	.23573	4
			Total	.7850	.23573	4
	Total	Beginner	N.Dr.	.7900	.16116	8
			Total	.7900	.16116	8
		Total	N.Dr.	.7900	.16116	8
			Total	.7900	.16116	8
Total	0	Beginner	Ex.Dr	.5400	.	1
			N.Dr.	.8967	.20925	6
			Total	.8457	.23380	7
		M.Exp.	Ex.Dr	.9550	.07778	2
			N.Dr.	.7713	.07019	8
			Total	.8080	.10250	10
		W.Exp.	Ex.Dr	.7267	.07371	3
			N.Dr.	.7955	.06699	11
			Total	.7807	.07173	14
		Total	Ex.Dr	.7717	.16964	6
			N.Dr.	.8120	.12207	25
			Total	.8042	.13030	31
	1	Beginner	Ex.Dr	.8100	.	1
			N.Dr.	.7383	.13429	12
			Total	.7438	.13010	13
		M.Exp.	Ex.Dr	1.0000	.23509	4
			N.Dr.	.8925	.01500	4
			Total	.9463	.16457	8
		W.Exp.	N.Dr.	.7186	.09371	7
			Total	.7186	.09371	7
		Total	Ex.Dr	.9620	.22061	5
			N.Dr.	.7591	.12424	23
			Total	.7954	.16139	28
	Total	Beginner	Ex.Dr	.6750	.19092	2
			N.Dr.	.7911	.17449	18
			Total	.7795	.17446	20
		M.Exp.	Ex.Dr	.9850	.18684	6
			N.Dr.	.8117	.08222	12
			Total	.8694	.14735	18
		W.Exp.	Ex.Dr	.7267	.07371	3
			N.Dr.	.7656	.08501	18
			Total	.7600	.08295	21
		Total	Ex.Dr	.8582	.20913	11
			N.Dr.	.7867	.12468	48
			Total	.8000	.14466	59
BRT.100.20	middle	0	Beginner	Ex.Dr	1.2400	1
			N.Dr.	.6500	.07071	2

			Total	.8467	.34429	3
		M.Exp.	Ex.Dr	.5000	.	1
			N.Dr.	.6700	.	1
			Total	.5850	.12021	2
		W.Exp.	Ex.Dr	.6600	.06000	3
			N.Dr.	.5590	.03446	10
			Total	.5823	.05876	13
		Total	Ex.Dr	.7440	.28893	5
			N.Dr.	.5815	.05625	13
			Total	.6267	.16578	18
	1	Beginner	Ex.Dr	.4700	.	1
			N.Dr.	.5163	.03378	8
			Total	.5111	.03516	9
		M.Exp.	Ex.Dr	.6500	.	1
			Total	.6500	.	1
		W.Exp.	N.Dr.	.5700	.08602	7
			Total	.5700	.08602	7
		Total	Ex.Dr	.5600	.12728	2
			N.Dr.	.5413	.06717	15
			Total	.5435	.07071	17
	Total	Beginner	Ex.Dr	.8550	.54447	2
			N.Dr.	.5430	.06800	10
			Total	.5950	.21326	12
		M.Exp.	Ex.Dr	.5750	.10607	2
			N.Dr.	.6700	.	1
			Total	.6067	.09292	3
		W.Exp.	Ex.Dr	.6600	.06000	3
			N.Dr.	.5635	.05894	17
			Total	.5780	.06748	20
		Total	Ex.Dr	.6914	.25771	7
			N.Dr.	.5600	.06452	28
			Total	.5863	.13368	35
old	0	M.Exp.	Ex.Dr	.6100	.	1
			N.Dr.	.5514	.06149	7
			Total	.5588	.06058	8
		W.Exp.	N.Dr.	.5400	.	1
			Total	.5400	.	1
		Total	Ex.Dr	.6100	.	1
			N.Dr.	.5500	.05707	8
			Total	.5567	.05701	9
	1	M.Exp.	Ex.Dr	.6267	.11372	3
			N.Dr.	.5975	.08617	4
			Total	.6100	.09092	7
		Total	Ex.Dr	.6267	.11372	3
			N.Dr.	.5975	.08617	4
			Total	.6100	.09092	7
	Total	M.Exp.	Ex.Dr	.6225	.09323	4
			N.Dr.	.5682	.07097	11
			Total	.5827	.07796	15
		W.Exp.	N.Dr.	.5400	.	1
			Total	.5400	.	1
		Total	Ex.Dr	.6225	.09323	4
			N.Dr.	.5658	.06815	12
			Total	.5800	.07607	16

	young	0	Beginner	N.Dr.	.4900	.13115	4
				Total	.4900	.13115	4
			Total	N.Dr.	.4900	.13115	4
		1	Beginner	Total	.4900	.13115	4
				N.Dr.	.7825	.32786	4
				Total	.7825	.32786	4
		Total	Beginner	N.Dr.	.7825	.32786	4
				Total	.7825	.32786	4
				N.Dr.	.6363	.27908	8
		Total	Beginner	Total	.6363	.27908	8
				N.Dr.	.6363	.27908	8
				Total	.6363	.27908	8
	Total	0	Beginner	Ex.Dr	1.2400	.	1
				N.Dr.	.5433	.13471	6
				Total	.6429	.29062	7
		M.Exp.	Ex.Dr	Ex.Dr	.5550	.07778	2
				N.Dr.	.5663	.07070	8
				Total	.5640	.06769	10
		W.Exp.	Ex.Dr	Ex.Dr	.6600	.06000	3
				N.Dr.	.5573	.03319	11
				Total	.5793	.05757	14
		Total	Ex.Dr	Ex.Dr	.7217	.26415	6
				N.Dr.	.5568	.07598	25
				Total	.5887	.14364	31
		1	Beginner	Ex.Dr	.4700	.	1
				N.Dr.	.6050	.21732	12
				Total	.5946	.21141	13
		M.Exp.	Ex.Dr	Ex.Dr	.6325	.09359	4
				N.Dr.	.5975	.08617	4
				Total	.6150	.08536	8
		W.Exp.	N.Dr.	N.Dr.	.5700	.08602	7
				Total	.5700	.08602	7
		Total	Ex.Dr	Ex.Dr	.6000	.10886	5
				N.Dr.	.5930	.16400	23
				Total	.5943	.15387	28
		Total	Beginner	Ex.Dr	.8550	.54447	2
				N.Dr.	.5844	.19181	18
				Total	.6115	.23549	20
		M.Exp.	Ex.Dr	Ex.Dr	.6067	.08981	6
				N.Dr.	.5767	.07377	12
				Total	.5867	.07814	18
		W.Exp.	Ex.Dr	Ex.Dr	.6600	.06000	3
				N.Dr.	.5622	.05745	18
				Total	.5762	.06629	21
		Total	Ex.Dr	Ex.Dr	.6664	.20896	11
				N.Dr.	.5742	.12598	48
				Total	.5914	.14731	59
BRT.100.30	middle	0	Beginner	Ex.Dr	.6700	.	1
				N.Dr.	.7350	.04950	2

			Total	.7133	.05132	3
		M.Exp.	Ex.Dr	.6000	.	1
			N.Dr.	.6800	.	1
			Total	.6400	.05657	2
		W.Exp.	Ex.Dr	.6700	.11790	3
			N.Dr.	.6610	.07141	10
			Total	.6631	.07846	13
		Total	Ex.Dr	.6560	.08905	5
			N.Dr.	.6738	.06923	13
			Total	.6689	.07291	18
	1	Beginner	Ex.Dr	.9400	.	1
			N.Dr.	.6088	.05515	8
			Total	.6456	.12187	9
		M.Exp.	Ex.Dr	.8100	.	1
			Total	.8100	.	1
		W.Exp.	N.Dr.	.6686	.08840	7
			Total	.6686	.08840	7
		Total	Ex.Dr	.8750	.09192	2
			N.Dr.	.6367	.07631	15
			Total	.6647	.10904	17
	Total	Beginner	Ex.Dr	.8050	.19092	2
			N.Dr.	.6340	.07397	10
			Total	.6625	.11055	12
		M.Exp.	Ex.Dr	.7050	.14849	2
			N.Dr.	.6800	.	1
			Total	.6967	.10599	3
		W.Exp.	Ex.Dr	.6700	.11790	3
			N.Dr.	.6641	.07624	17
			Total	.6650	.07977	20
		Total	Ex.Dr	.7186	.13459	7
			N.Dr.	.6539	.07420	28
			Total	.6669	.09087	35
old	0	M.Exp.	Ex.Dr	.7800	.	1
			N.Dr.	.6500	.07439	7
			Total	.6663	.08280	8
		W.Exp.	N.Dr.	.5800	.	1
			Total	.5800	.	1
		Total	Ex.Dr	.7800	.	1
			N.Dr.	.6413	.07318	8
			Total	.6567	.08261	9
	1	M.Exp.	Ex.Dr	.7700	.17000	3
			N.Dr.	.7025	.11529	4
			Total	.7314	.13259	7
		Total	Ex.Dr	.7700	.17000	3
			N.Dr.	.7025	.11529	4
			Total	.7314	.13259	7
	Total	M.Exp.	Ex.Dr	.7725	.13889	4
			N.Dr.	.6691	.08949	11
			Total	.6967	.10998	15

			W.Exp.	N.Dr.	.5800	.	1
				Total	.5800	.	1
			Total	Ex.Dr	.7725	.13889	4
				N.Dr.	.6617	.08912	12
				Total	.6894	.11018	16
young	0	Beginner		N.Dr.	.6275	.08846	4
				Total	.6275	.08846	4
		Total		N.Dr.	.6275	.08846	4
				Total	.6275	.08846	4
	1	Beginner		N.Dr.	.7425	.13376	4
				Total	.7425	.13376	4
		Total		N.Dr.	.7425	.13376	4
				Total	.7425	.13376	4
	Total	Beginner		N.Dr.	.6850	.12166	8
				Total	.6850	.12166	8
		Total		N.Dr.	.6850	.12166	8
				Total	.6850	.12166	8
Total	0	Beginner		Ex.Dr	.6700	.	1
				N.Dr.	.6633	.09092	6
				Total	.6643	.08304	7
		M.Exp.		Ex.Dr	.6900	.12728	2
				N.Dr.	.6538	.06968	8
				Total	.6610	.07622	10
		W.Exp.		Ex.Dr	.6700	.11790	3
				N.Dr.	.6536	.07201	11
				Total	.6571	.07859	14
		Total		Ex.Dr	.6767	.09438	6
				N.Dr.	.6560	.07292	25
				Total	.6600	.07620	31
	1	Beginner		Ex.Dr	.9400	.	1
				N.Dr.	.6533	.10560	12
				Total	.6754	.12862	13
		M.Exp.		Ex.Dr	.7800	.14024	4
				N.Dr.	.7025	.11529	4
				Total	.7413	.12586	8
		W.Exp.		N.Dr.	.6686	.08840	7
				Total	.6686	.08840	7
		Total		Ex.Dr	.8120	.14096	5
				N.Dr.	.6665	.09925	23
				Total	.6925	.11912	28
	Total	Beginner		Ex.Dr	.8050	.19092	2
				N.Dr.	.6567	.09834	18
				Total	.6715	.11250	20
		M.Exp.		Ex.Dr	.7500	.13115	6
				N.Dr.	.6700	.08539	12
				Total	.6967	.10622	18
		W.Exp.		Ex.Dr	.6700	.11790	3
				N.Dr.	.6594	.07658	18
				Total	.6610	.07993	21
		Total		Ex.Dr	.7382	.13190	11
				N.Dr.	.6610	.08576	48
				Total	.6754	.09938	59
BRT.100.40	middle	0	Beginner	Ex.Dr	.6000	.	1
				N.Dr.	.8350	.04950	2

			Total	.7567	.14012	3
		M.Exp.	Ex.Dr	.8000	.	1
			N.Dr.	1.3200	.	1
			Total	1.0600	.36770	2
		W.Exp.	Ex.Dr	.7967	.17039	3
			N.Dr.	.7640	.08086	10
			Total	.7715	.09974	13
		Total	Ex.Dr	.7580	.14940	5
			N.Dr.	.8177	.16907	13
			Total	.8011	.16182	18
1		Beginner	Ex.Dr	1.0100	.	1
			N.Dr.	.7313	.05592	8
			Total	.7622	.10663	9
		M.Exp.	Ex.Dr	1.0000	.	1
			Total	1.0000	.	1
		W.Exp.	N.Dr.	.7643	.10358	7
			Total	.7643	.10358	7
		Total	Ex.Dr	1.0050	.00707	2
			N.Dr.	.7467	.08033	15
			Total	.7771	.11406	17
	Total	Beginner	Ex.Dr	.8050	.28991	2
			N.Dr.	.7520	.06795	10
			Total	.7608	.10883	12
		M.Exp.	Ex.Dr	.9000	.14142	2
			N.Dr.	1.3200	.	1
			Total	1.0400	.26230	3
		W.Exp.	Ex.Dr	.7967	.17039	3
			N.Dr.	.7641	.08775	17
			Total	.7690	.09840	20
		Total	Ex.Dr	.8286	.17151	7
			N.Dr.	.7796	.13173	28
			Total	.7894	.13916	35
old	0	M.Exp.	Ex.Dr	.9000	.	1
			N.Dr.	.7829	.10673	7
			Total	.7975	.10714	8
		W.Exp.	N.Dr.	.6500	.	1
			Total	.6500	.	1
		Total	Ex.Dr	.9000	.	1
			N.Dr.	.7663	.10941	8
			Total	.7811	.11163	9
	1	M.Exp.	Ex.Dr	.9367	.11547	3
			N.Dr.	.9175	.28336	4
			Total	.9257	.21141	7
		Total	Ex.Dr	.9367	.11547	3
			N.Dr.	.9175	.28336	4
			Total	.9257	.21141	7
	Total	M.Exp.	Ex.Dr	.9275	.09605	4

			N.Dr.	.8318	.18851	11
			Total	.8573	.17111	15
		W.Exp.	N.Dr.	.6500	.	1
			Total	.6500	.	1
		Total	Ex.Dr	.9275	.09605	4
			N.Dr.	.8167	.18724	12
			Total	.8444	.17324	16
young	0	Beginner	N.Dr.	.7675	.17154	4
			Total	.7675	.17154	4
		Total	N.Dr.	.7675	.17154	4
			Total	.7675	.17154	4
	1	Beginner	N.Dr.	.8050	.15416	4
			Total	.8050	.15416	4
		Total	N.Dr.	.8050	.15416	4
			Total	.8050	.15416	4
	Total	Beginner	N.Dr.	.7863	.15231	8
			Total	.7863	.15231	8
		Total	N.Dr.	.7863	.15231	8
			Total	.7863	.15231	8
Total	0	Beginner	Ex.Dr	.6000	.	1
			N.Dr.	.7900	.13914	6
			Total	.7629	.14591	7
		M.Exp.	Ex.Dr	.8500	.07071	2
			N.Dr.	.8500	.21408	8
			Total	.8500	.19026	10
		W.Exp.	Ex.Dr	.7967	.17039	3
			N.Dr.	.7536	.08406	11
			Total	.7629	.10118	14
		Total	Ex.Dr	.7817	.14566	6
			N.Dr.	.7932	.14879	25
			Total	.7910	.14584	31
	1	Beginner	Ex.Dr	1.0100	.	1
			N.Dr.	.7558	.09895	12
			Total	.7754	.11808	13
		M.Exp.	Ex.Dr	.9525	.09946	4
			N.Dr.	.9175	.28336	4
			Total	.9350	.19748	8
		W.Exp.	N.Dr.	.7643	.10358	7
			Total	.7643	.10358	7
		Total	Ex.Dr	.9640	.08989	5
			N.Dr.	.7865	.15020	23
			Total	.8182	.15611	28
	Total	Beginner	Ex.Dr	.8050	.28991	2
			N.Dr.	.7672	.11092	18
			Total	.7710	.12477	20
		M.Exp.	Ex.Dr	.9183	.09867	6
			N.Dr.	.8725	.22840	12
			Total	.8878	.19265	18
		W.Exp.	Ex.Dr	.7967	.17039	3
			N.Dr.	.7578	.08928	18

	Total	.7633	.09936	21
Total	Ex.Dr	.8645	.15135	11
	N.Dr.	.7900	.14791	48
	Total	.8039	.15012	59

Multivariate Tests(c)

Effect		Value	F	Hypothesis df	Error df	Sig.
sphdy	Pillai's Trace	.906	42.340(a)	8.000	35.000	.000
	Wilks' Lambda	.094	42.340(a)	8.000	35.000	.000
	Hotelling's Trace	9.678	42.340(a)	8.000	35.000	.000
	Roy's Largest Root	9.678	42.340(a)	8.000	35.000	.000
sphdy * Age	Pillai's Trace	.481	1.426	16.000	72.000	.015
	Wilks' Lambda	.573	1.404(a)	16.000	70.000	.017
	Hotelling's Trace	.650	1.381	16.000	68.000	.018
	Roy's Largest Root	.429	1.929(b)	8.000	36.000	.046
sphdy * Gender	Pillai's Trace	.469	3.861(a)	8.000	35.000	.002
	Wilks' Lambda	.531	3.861(a)	8.000	35.000	.002
	Hotelling's Trace	.882	3.861(a)	8.000	35.000	.002
	Roy's Largest Root	.882	3.861(a)	8.000	35.000	.002
sphdy * Dr.Exp	Pillai's Trace	.613	1.990	16.000	72.000	.025
	Wilks' Lambda	.467	2.028(a)	16.000	70.000	.023
	Hotelling's Trace	.970	2.062	16.000	68.000	.021
	Roy's Largest Root	.738	3.322(b)	8.000	36.000	.006
sphdy * Dr.Hrs.perWeek	Pillai's Trace	.327	2.127(a)	8.000	35.000	.059
	Wilks' Lambda	.673	2.127(a)	8.000	35.000	.059
	Hotelling's Trace	.486	2.127(a)	8.000	35.000	.059
	Roy's Largest Root	.486	2.127(a)	8.000	35.000	.059
sphdy * Age * Gender	Pillai's Trace	.474	1.397	16.000	72.000	.017
	Wilks' Lambda	.580	1.370(a)	16.000	70.000	.018
	Hotelling's Trace	.632	1.343	16.000	68.000	.020
	Roy's Largest Root	.401	1.806(b)	8.000	36.000	.011
sphdy * Age * Dr.Exp	Pillai's Trace	.321	2.070(a)	8.000	35.000	.066
	Wilks' Lambda	.679	2.070(a)	8.000	35.000	.066
	Hotelling's Trace	.473	2.070(a)	8.000	35.000	.066
	Roy's Largest Root	.473	2.070(a)	8.000	35.000	.066
sphdy * Gender * Dr.Exp	Pillai's Trace	.596	1.912	16.000	72.000	.033
	Wilks' Lambda	.488	1.886(a)	16.000	70.000	.037
	Hotelling's Trace	.874	1.858	16.000	68.000	.041
	Roy's Largest Root	.570	2.565(b)	8.000	36.000	.025
sphdy * Age * Gender * Dr.Exp	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
sphdy * Age * Dr.Hrs.perWeek	Pillai's Trace	.247	1.434(a)	8.000	35.000	.217
	Wilks' Lambda	.753	1.434(a)	8.000	35.000	.217

sphdy * Gender * Dr.Hrs.perWeek	Hotelling's Trace	.328	1.434(a)	8.000	35.000	.217
	Roy's Largest Root	.328	1.434(a)	8.000	35.000	.217
	Pillai's Trace	.432	3.325(a)	8.000	35.000	.066
	Wilks' Lambda	.568	3.325(a)	8.000	35.000	.066
	Hotelling's Trace	.760	3.325(a)	8.000	35.000	.076
sphdy * Age * Gender * Dr.Hrs.perWeek	Roy's Largest Root	.760	3.325(a)	8.000	35.000	.076
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
sphdy * Dr.Exp * Dr.Hrs.perWeek	Pillai's Trace	.719	2.525	16.000	72.000	.084
	Wilks' Lambda	.389	2.643(a)	16.000	70.000	.073
	Hotelling's Trace	1.297	2.755	16.000	68.000	.082
	Roy's Largest Root	1.028	4.624(b)	8.000	36.000	.081
	Pillai's Trace	.000	.(a)	.000	.000	.
sphdy * Age * Dr.Exp * Dr.Hrs.perWeek	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
sphdy * Gender * Dr.Exp * Dr.Hrs.perWeek	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
sphdy * Age * Gender * Dr.Exp * Dr.Hrs.perWeek	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000
	Pillai's Trace	.000	.(a)	.000	.000	.
	Wilks' Lambda	1.000	.(a)	.000	38.500	.
	Hotelling's Trace	.000	.(a)	.000	2.000	.
	Roy's Largest Root	.000	.000(a)	8.000	34.000	1.000

a Exact statistic

b The statistic is an upper bound on F that yields a lower bound on the significance level.

c Design: Intercept+Age+Gender+Dr.Exp+Dr.Hrs.perWeek+Age * Gender+Age * Dr.Exp+Gender * Dr.Exp+Age * Gender * Dr.Exp+Age * Dr.Hrs.perWeek+Gender * Dr.Hrs.perWeek+Age * Gender * Dr.Hrs.perWeek+Dr.Exp * Dr.Hrs.perWeek+Age * Dr.Exp * Dr.Hrs.perWeek+Gender * Dr.Exp * Dr.Hrs.perWeek+Age * Gender * Dr.Exp * Dr.Hrs.perWeek

Within Subjects Design: sphdy

Mauchly's Test of Sphericity(b)

Measure: brt

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon(a)		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
sphdy	.031	135.984	35	.000	.560	.874	.125

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables

is proportional to an identity matrix.

a May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in

the Tests of Within-Subjects Effects table.

b Design: Intercept+Age+Gender+Dr.Exp+Dr.Hrs.perWeek+Age * Gender+Age * Dr.Exp+Gender * Dr.Exp+Age * Gender * Dr.Exp+Age * Dr.Hrs.perWeek+Gender * Dr.Hrs.perWeek+Age * Gender * Dr.Hrs.perWeek+Dr.Exp * Dr.Hrs.perWeek+Age * Dr.Exp * Dr.Hrs.perWeek+Gender * Dr.Exp * Dr.Hrs.perWeek+Age * Gender * Dr.Exp * Dr.Hrs.perWeek

Within Subjects Design: sphdy

Tests of Within-Subjects Effects

Measure: brt

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
sphdy	Sphericity Assumed	2.708	8	.338	36.829	.000
	Greenhouse-Geisser	2.708	4.482	.604	36.829	.000
	Huynh-Feldt	2.708	6.996	.387	36.829	.000
	Lower-bound	2.708	1.000	2.708	36.829	.000
sphdy * Age	Sphericity Assumed	.194	16	.012	1.319	.018
	Greenhouse-Geisser	.194	8.965	.022	1.319	.023
	Huynh-Feldt	.194	13.991	.014	1.319	.019
	Lower-bound	.194	2.000	.097	1.319	.028
sphdy * Gender	Sphericity Assumed	.156	8	.020	2.124	.033
	Greenhouse-Geisser	.156	4.482	.035	2.124	.072
	Huynh-Feldt	.156	6.996	.022	2.124	.041
	Lower-bound	.156	1.000	.156	2.124	.015
sphdy * Dr.Exp	Sphericity Assumed	.226	16	.014	1.536	.085
	Greenhouse-Geisser	.226	8.965	.025	1.536	.138
	Huynh-Feldt	.226	13.991	.016	1.536	.097
	Lower-bound	.226	2.000	.113	1.536	.227
sphdy * Dr.Hrs.perWeek	Sphericity Assumed	.174	8	.022	2.371	.072
	Greenhouse-Geisser	.174	4.482	.039	2.371	.095
	Huynh-Feldt	.174	6.996	.025	2.371	.072
	Lower-bound	.174	1.000	.174	2.371	.131
sphdy * Age * Gender	Sphericity Assumed	.194	16	.012	1.321	.018
	Greenhouse-Geisser	.194	8.965	.022	1.321	.023
	Huynh-Feldt	.194	13.991	.014	1.321	.019
	Lower-bound	.194	2.000	.097	1.321	.028
sphdy * Age * Dr.Exp	Sphericity Assumed	.083	8	.010	1.133	.340
	Greenhouse-Geisser	.083	4.482	.019	1.133	.344
	Huynh-Feldt	.083	6.996	.012	1.133	.342
	Lower-bound	.083	1.000	.083	1.133	.293
sphdy * Gender * Dr.Exp	Sphericity Assumed	.482	16	.030	3.280	.087
	Greenhouse-Geisser	.482	8.965	.054	3.280	.091
	Huynh-Feldt	.482	13.991	.034	3.280	.088
	Lower-bound	.482	2.000	.241	3.280	.067
sphdy * Age * Gender * Dr.Exp	Sphericity Assumed	.000	0	.	.	.

sphdy * Age * Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
	Huynh-Feldt	.000	.000	.	.	.
	Lower-bound	.000	.000	.	.	.
	Sphericity Assumed	.102	8	.013	1.388	.200
sphdy * Gender * Dr.Hrs.perWeek	Greenhouse-Geisser	.102	4.482	.023	1.388	.235
	Huynh-Feldt	.102	6.996	.015	1.388	.210
	Lower-bound	.102	1.000	.102	1.388	.245
	Sphericity Assumed	.237	8	.030	3.224	.072
sphdy * Age * Gender * Dr.Hrs.perWeek	Greenhouse-Geisser	.237	4.482	.053	3.224	.091
	Huynh-Feldt	.237	6.996	.034	3.224	.063
	Lower-bound	.237	1.000	.237	3.224	.079
	Sphericity Assumed	.000	0	.	.	.
sphdy * Dr.Exp * Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
	Huynh-Feldt	.000	.000	.	.	.
	Lower-bound	.000	.000	.	.	.
	Sphericity Assumed	.436	16	.027	2.968	.070
sphdy * Age * Dr.Exp * Dr.Hrs.perWeek	Greenhouse-Geisser	.436	8.965	.049	2.968	.093
	Huynh-Feldt	.436	13.991	.031	2.968	.098
	Lower-bound	.436	2.000	.218	2.968	.162
	Sphericity Assumed	.000	0	.	.	.
sphdy * Gender * Dr.Exp * Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
	Huynh-Feldt	.000	.000	.	.	.
	Lower-bound	.000	.000	.	.	.
	Sphericity Assumed	.000	0	.	.	.
sphdy * Age * Gender * Dr.Exp * Dr.Hrs.perWeek	Greenhouse-Geisser	.000	.000	.	.	.
	Huynh-Feldt	.000	.000	.	.	.
	Lower-bound	.000	.000	.	.	.
	Sphericity Assumed	.000	0	.	.	.
Error(sphdy)	Greenhouse-Geisser	.000	.000	.	.	.
	Huynh-Feldt	.000	.000	.	.	.
	Lower-bound	.000	.000	.	.	.
	Sphericity Assumed	3.088	336	.009		
	Greenhouse-Geisser	3.088	188.257	.016		
	Huynh-Feldt	3.088	293.813	.011		
	Lower-bound	3.088	42.000	.074		

Tests of Within-Subjects Contrasts

Measure: brt

Source	sphdy	Type III Sum of Squares	df	Mean Square	F	Sig.
sphdy	Linear	.339	1	.339	32.880	.000
	Quadratic	.021	1	.021	1.927	.172

sphdy * Age	Cubic	.655	1	.655	50.599	.000
	Order 4	.003	1	.003	.372	.545
	Order 5	.115	1	.115	38.880	.000
	Order 6	.147	1	.147	12.103	.001
	Order 7	1.359	1	1.359	154.203	.000
	Order 8	.069	1	.069	9.453	.004
	Linear	.016	2	.008	.763	.047
	Quadratic	.013	2	.006	.572	.569
	Cubic	.065	2	.033	2.526	.092
	Order 4	.001	2	.001	.080	.923
sphdy * Gender	Order 5	.007	2	.004	1.220	.306
	Order 6	.007	2	.003	.269	.765
	Order 7	.054	2	.027	3.049	.058
	Order 8	.032	2	.016	2.157	.128
	Linear	.001	1	.001	.129	.037
	Quadratic	2.05E-005	1	2.05E-005	.002	.966
	Cubic	.091	1	.091	7.057	.011
	Order 4	.003	1	.003	.335	.566
	Order 5	.031	1	.031	10.594	.002
	Order 6	.003	1	.003	.226	.637
sphdy * Dr.Exp	Order 7	.025	1	.025	2.851	.099
	Order 8	.002	1	.002	.221	.640
	Linear	.003	2	.001	.121	.886
	Quadratic	.025	2	.012	1.131	.332
	Cubic	.096	2	.048	3.698	.033
	Order 4	.006	2	.003	.353	.705
	Order 5	.033	2	.016	5.539	.007
	Order 6	.008	2	.004	.316	.731
	Order 7	.037	2	.018	2.079	.138
	Order 8	.020	2	.010	1.382	.262
sphdy * Dr.Hrs.perWeek	Linear	.097	1	.097	9.426	.064
	Quadratic	.000	1	.000	.010	.922
	Cubic	.046	1	.046	3.547	.067
	Order 4	.002	1	.002	.208	.651
	Order 5	.011	1	.011	3.713	.061
	Order 6	.009	1	.009	.737	.395
	Order 7	.009	1	.009	.964	.332
	Order 8	.001	1	.001	.146	.704
	Linear	.010	2	.005	.461	.024
	Quadratic	.065	2	.032	2.965	.062
sphdy * Age * Gender	Cubic	.013	2	.006	.485	.619
	Order 4	.040	2	.020	2.491	.095
	Order 5	.004	2	.002	.662	.521
	Order 6	.044	2	.022	1.796	.179
	Order 7	.011	2	.006	.627	.539
	Order 8	.008	2	.004	.568	.571
	Linear	.017	1	.017	1.603	.212

sphdy * Gender * Dr.Exp	Quadratic	.004	1	.004	.324	.572
	Cubic	.017	1	.017	1.279	.265
	Order 4	.028	1	.028	3.427	.071
	Order 5	.000	1	.000	.155	.696
	Order 6	.002	1	.002	.129	.721
	Order 7	.015	1	.015	1.732	.195
	Order 8	.002	1	.002	.215	.645
	Linear	.030	2	.015	1.478	.240
	Quadratic	.038	2	.019	1.750	.186
	Cubic	.001	2	.001	.056	.946
	Order 4	.076	2	.038	4.691	.014
	Order 5	.002	2	.001	.271	.764
	Order 6	.218	2	.109	8.963	.001
	Order 7	.048	2	.024	2.745	.076
	Order 8	.068	2	.034	4.664	.015
sphdy * Age * Gender * Dr.Exp	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
sphdy * Age * Dr.Hrs.perWeek	Linear	.053	1	.053	5.128	.063
	Quadratic	.011	1	.011	.989	.326
	Cubic	.004	1	.004	.344	.561
	Order 4	.011	1	.011	1.402	.243
	Order 5	.001	1	.001	.305	.584
	Order 6	.001	1	.001	.046	.832
	Order 7	.007	1	.007	.748	.392
	Order 8	.015	1	.015	1.986	.166
sphdy * Gender * Dr.Hrs.perWeek	Linear	.001	1	.001	.110	.741
	Quadratic	.006	1	.006	.549	.463
	Cubic	.011	1	.011	.837	.365
	Order 4	.044	1	.044	5.475	.082
	Order 5	.003	1	.003	.983	.327
	Order 6	.078	1	.078	6.408	.015
	Order 7	.030	1	.030	3.370	.073
	Order 8	.064	1	.064	8.781	.067
sphdy * Age * Gender * Dr.Hrs.perWeek	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.

sphdy * Dr.Exp * Dr.Hrs.perWeek	Linear	.018	2	.009	.890	.418
	Quadratic	.024	2	.012	1.085	.347
	Cubic	.049	2	.025	1.902	.162
	Order 4	.016	2	.008	.960	.391
	Order 5	.019	2	.010	3.221	.050
	Order 6	.048	2	.024	1.974	.152
	Order 7	.189	2	.094	10.703	.090
	Order 8	.074	2	.037	5.060	.071
sphdy * Age * Dr.Exp * Dr.Hrs.perWeek	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
sphdy * Gender * Dr.Exp * Dr.Hrs.perWeek	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
sphdy * Age * Gender * Dr.Exp * Dr.Hrs.perWeek	Linear	.000	0	.	.	.
	Quadratic	.000	0	.	.	.
	Cubic	.000	0	.	.	.
	Order 4	.000	0	.	.	.
	Order 5	.000	0	.	.	.
	Order 6	.000	0	.	.	.
	Order 7	.000	0	.	.	.
	Order 8	.000	0	.	.	.
Error(sphdy)	Linear	.433	42	.010		
	Quadratic	.459	42	.011		
	Cubic	.543	42	.013		
	Order 4	.341	42	.008		
	Order 5	.124	42	.003		
	Order 6	.510	42	.012		
	Order 7	.370	42	.009		
	Order 8	.307	42	.007		

Tests of Between-Subjects Effects

Measure: brt

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	100.374	1	100.374	2378.792	.000
Age	.036	2	.018	.425	.047
Gender	.294	1	.294	6.978	.012
Dr.Exp	.054	2	.027	.637	.534
Dr.Hrs.perWeek	.011	1	.011	.272	.605
Age * Gender	.613	2	.306	7.259	.002
Age * Dr.Exp	.037	1	.037	.865	.358
Gender * Dr.Exp	.444	2	.222	5.257	.099
Age * Gender * Dr.Exp	.000	0	.	.	.
Age * Dr.Hrs.perWeek	.115	1	.115	2.719	.107
Gender * Dr.Hrs.perWeek	.046	1	.046	1.093	.302
Age * Gender * Dr.Hrs.perWeek	.000	0	.	.	.
Dr.Exp * Dr.Hrs.perWeek	.141	2	.070	1.666	.201
Age * Dr.Exp * Dr.Hrs.perWeek	.000	0	.	.	.
Gender * Dr.Exp * Dr.Hrs.perWeek	.000	0	.	.	.
Age * Gender * Dr.Exp * Dr.Hrs.perWeek	.000	0	.	.	.
Error	1.772	42	.042		

Estimated Marginal Means

1. Age

Measure: brt

Age	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
middle	.725(a)	.017	.691	.760
old	.710(a)	.023	.664	.756
young	.707(a)	.024	.658	.756

a Based on modified population marginal mean.

2. Gender

Measure: brt

Gender	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
0	.701(a)	.017	.667	.736
1	.743(a)	.017	.708	.778

a Based on modified population marginal mean.

3. Dr.Exp

Measure: brt

Dr.Exp	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Beginner	.716(a)	.020	.675	.756
M.Exp.	.752(a)	.021	.709	.795
W.Exp.	.665(a)	.021	.622	.709

a Based on modified population marginal mean.

4. Dr.Hrs.perWeek

Measure: brt

Dr.Hrs.perWeek	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Ex.Dr	.733(a)	.023	.686	.780
N.Dr.	.708(a)	.013	.682	.735

a Based on modified population marginal mean.

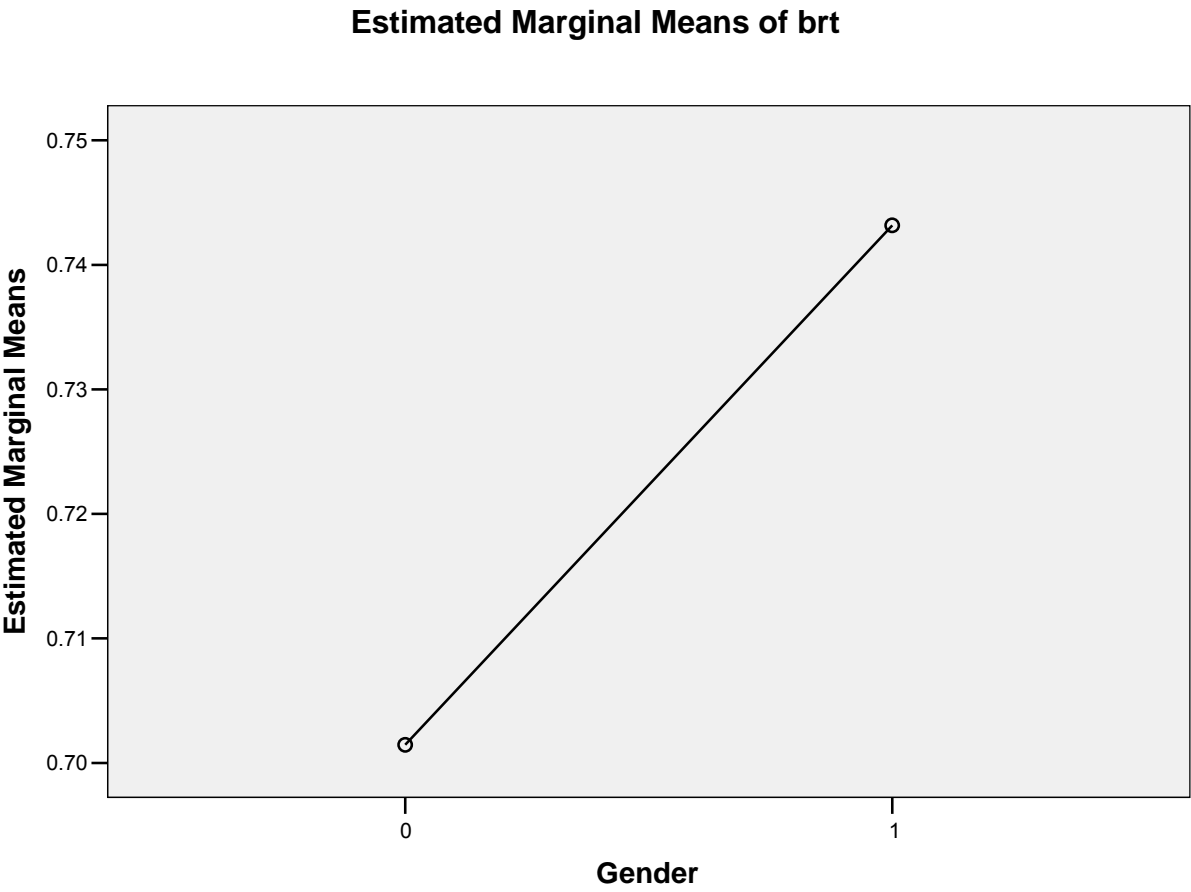
5. sphdy

Measure: brt

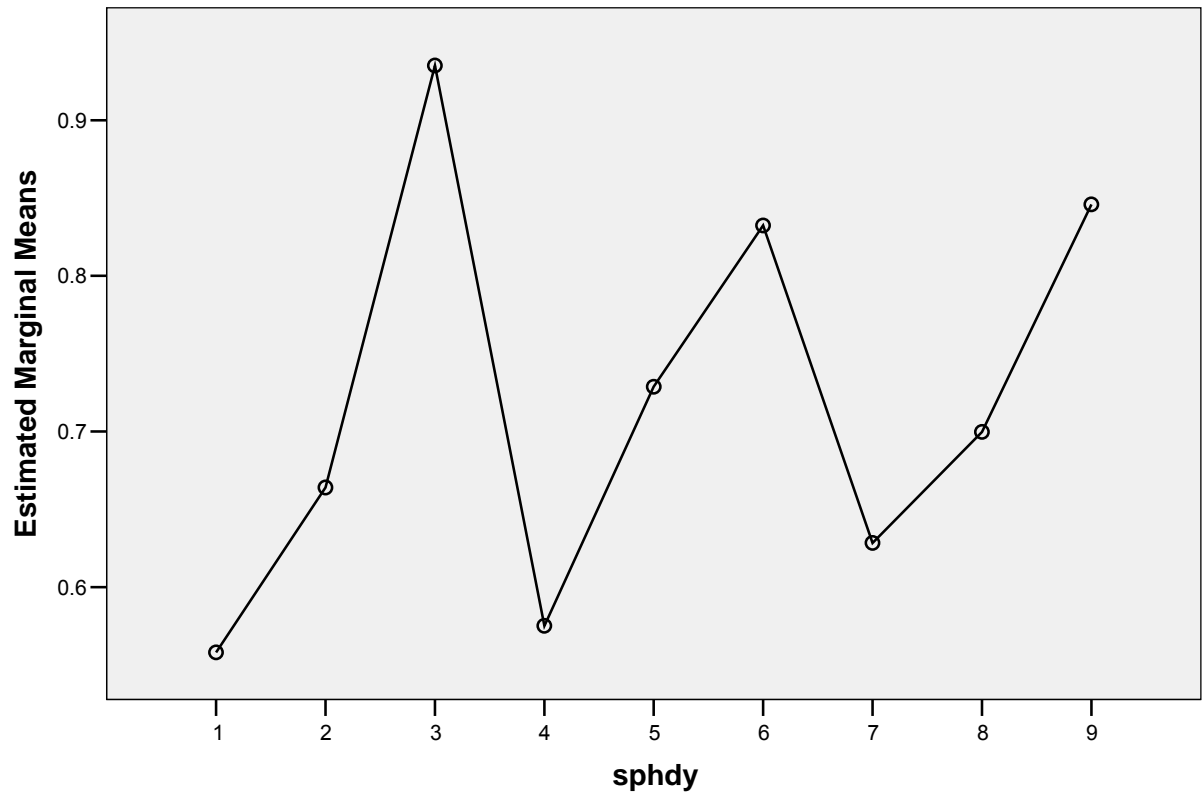
sphdy	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	.558(a)	.015	.528	.588
2	.664(a)	.019	.625	.703
3	.935(a)	.032	.870	1.000
4	.575(a)	.012	.550	.600
5	.729(a)	.018	.693	.765
6	.832(a)	.021	.790	.874
7	.628(a)	.020	.588	.669
8	.700(a)	.017	.666	.733
9	.846(a)	.023	.799	.893

a Based on modified population marginal mean.

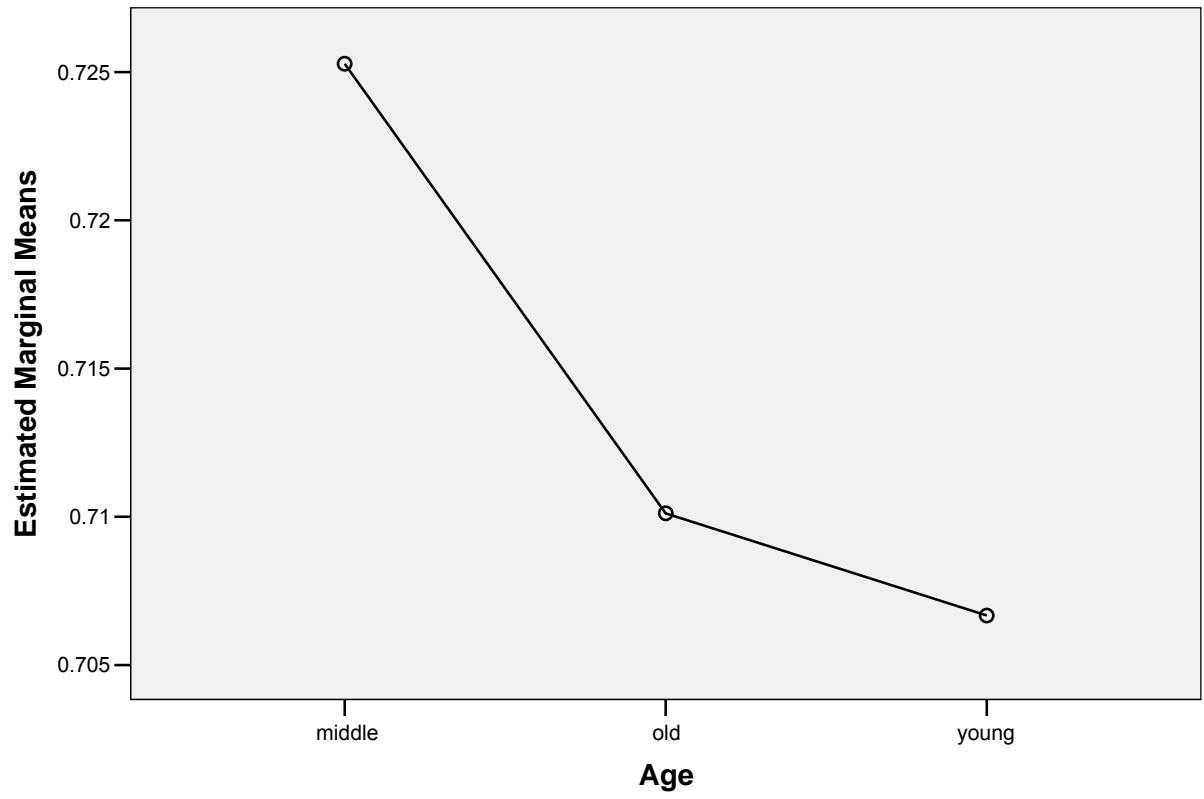
Profile Plots



Estimated Marginal Means of brt



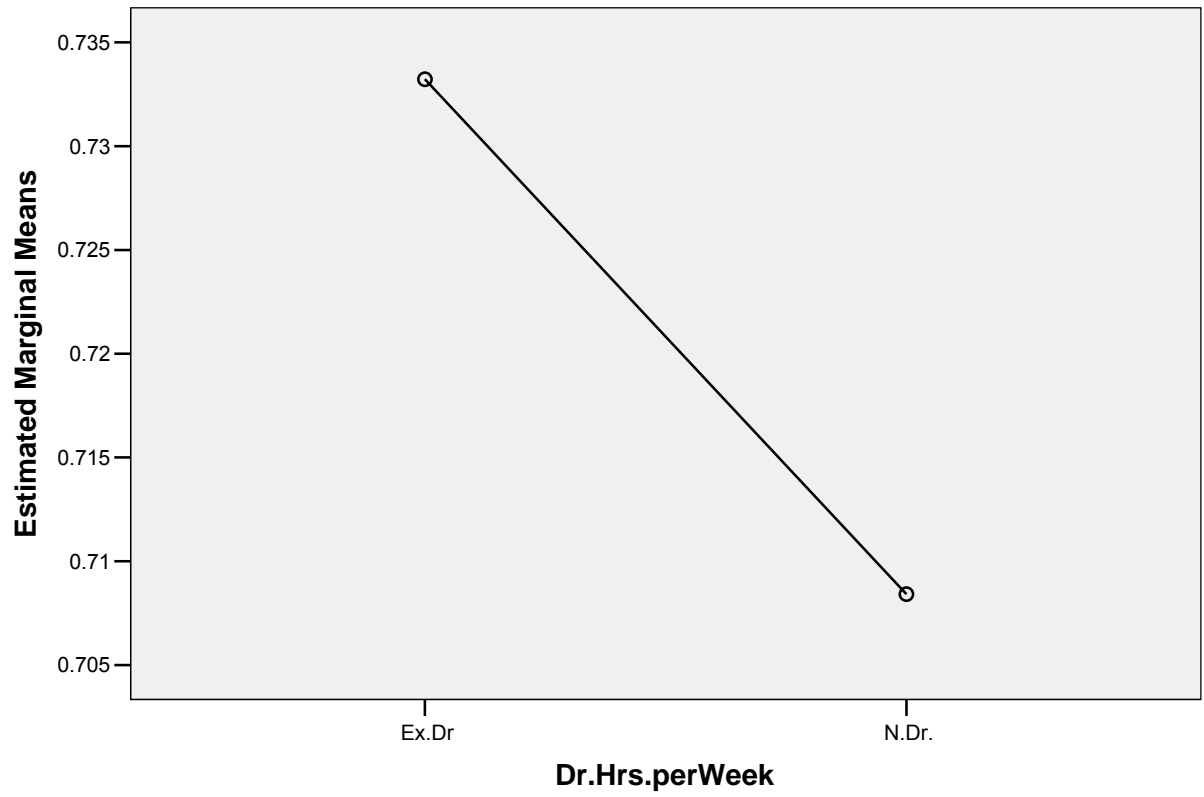
Estimated Marginal Means of brt



Estimated Marginal Means of brt



Estimated Marginal Means of brt



Appendix F

Regression Analysis for Normal Scenario

Linear Regression Analysis for BRT: Normal Scenario (Model 1)

Variables Entered/Removed^{b,c}

Model	Variables Entered	Variables Removed	Method
1	Gender, Age	.	Enter

- a. All requested variables entered.
b. Dependent Variable: BRT
c. Linear Regression through the Origin

Model Summary

Model	R	R Square ^a	Adjusted R Square	Std. Error of the Estimate
1	.885 ^b	.783	.782	.66506

- a. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept.
b. Predictors: Gender, Age

ANOVA^{c,d}

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	841.868	2	420.934	951.688	.000 ^a
	Residual	233.978	529	.442		
	Total	1075.846 ^b	531			

- a. Predictors: Gender, Age
b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.
c. Dependent Variable: BRT
d. Linear Regression through the Origin

Coefficients^{a,b}

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Age	.025	.001	.753	29.121	.000
	Gender	.401	.054	.191	7.376	.000

- a. Dependent Variable: BRT
b. Linear Regression through the Origin

Nonlinear Regression Analysis: Normal Scenario (Model 2)

Iteration History (b)

Iteration Number(a)	Residual Sum of Squares	Parameter					
		b1	b2	b3	b4	b5	b6
1.0	185.186	.000	.000	.000	.000	.000	.000
1.1	4578.307	-3.688	.594	.000	-1.909	.000	.051
1.2	68.399	-.033	-.033	.000	.033	.000	.015
2.0	68.399	-.033	-.033	.000	.033	.000	.015
2.1	382.670	-.527	-.526	-2.634	-.209	.013	.027
2.2	58.573	-.071	-.071	-.121	.071	.014	.016
3.0	58.573	-.071	-.071	-.121	.071	.014	.016
3.1	47.716	-.083	-.084	-.570	.071	.013	.017
4.0	47.716	-.083	-.084	-.570	.071	.013	.017
4.1	37.752	-.152	-.153	-.506	.079	.013	.020
5.0	37.752	-.152	-.153	-.506	.079	.013	.020
5.1	30.270	-.330	-.322	-.034	.089	.007	.025
6.0	30.270	-.330	-.322	-.034	.089	.007	.025
6.1	47.351	-.234	-.228	-.289	.310	-.007	.025
6.2	29.179	-.355	-.349	-.272	.088	.005	.025
7.0	29.179	-.355	-.349	-.272	.088	.005	.025
7.1	29.239	-.335	-.330	-.305	.137	.002	.025
7.2	29.155	-.357	-.351	-.285	.095	.003	.025
8.0	29.155	-.357	-.351	-.285	.095	.003	.025
8.1	29.155	-.345	-.340	-.296	.118	.003	.025
8.2	29.155	-.355	-.349	-.287	.099	.003	.025
9.0	29.155	-.355	-.349	-.287	.099	.003	.025
9.1	29.154	-.351	-.346	-.291	.106	.003	.025
10.0	29.154	-.351	-.346	-.291	.106	.003	.025
10.1	29.154	-.343	-.338	-.298	.122	.003	.025
11.0	29.154	-.343	-.338	-.298	.122	.003	.025
11.1	29.154	-.335	-.330	-.307	.137	.002	.025
12.0	29.154	-.335	-.330	-.307	.137	.002	.025
12.1	29.155	-.319	-.315	-.324	.168	.002	.025
12.2	29.154	-.331	-.326	-.311	.145	.002	.025
13.0	29.154	-.331	-.326	-.311	.145	.002	.025
13.1	29.154	-.323	-.319	-.320	.160	.002	.025
14.0	29.154	-.323	-.319	-.320	.160	.002	.025
14.1	29.154	-.315	-.311	-.329	.176	.002	.025
15.0	29.154	-.315	-.311	-.329	.176	.002	.025
15.1	29.154	-.298	-.295	-.349	.208	.002	.025
15.2	29.154	-.309	-.305	-.336	.187	.002	.025
16.0	29.154	-.309	-.305	-.336	.187	.002	.025

16.1	29.154	-.298	-.295	-.350	.208	.002	.025
17.0	29.154	-.298	-.295	-.350	.208	.002	.025
17.1	29.154	-.285	-.284	-.366	.231	.002	.025
18.0	29.154	-.285	-.284	-.366	.231	.002	.025
18.1	29.153	-.273	-.273	-.384	.254	.001	.025
19.0	29.153	-.273	-.273	-.384	.254	.001	.025
19.1	29.154	-.249	-.251	-.422	.300	.001	.025
19.2	29.153	-.265	-.266	-.397	.269	.001	.025
20.0	29.153	-.265	-.266	-.397	.269	.001	.025
20.1	29.153	-.250	-.253	-.421	.296	.001	.025
21.0	29.153	-.250	-.253	-.421	.296	.001	.025
21.1	29.153	-.234	-.239	-.451	.326	.001	.025
22.0	29.153	-.234	-.239	-.451	.326	.001	.025
22.1	29.153	-.217	-.226	-.485	.356	.001	.025
23.0	29.153	-.217	-.226	-.485	.356	.001	.025
23.1	29.153	-.200	-.213	-.523	.386	.001	.025
24.0	29.153	-.200	-.213	-.523	.386	.001	.025
24.1	29.153	-.182	-.201	-.564	.416	.001	.025
25.0	29.153	-.182	-.201	-.564	.416	.001	.025
25.1	29.153	-.163	-.190	-.610	.446	.001	.025
26.0	29.153	-.163	-.190	-.610	.446	.001	.025
26.1	29.153	-.143	-.180	-.659	.476	.001	.025
27.0	29.153	-.143	-.180	-.659	.476	.001	.025
27.1	29.153	-.123	-.171	-.711	.506	.001	.025
28.0	29.153	-.123	-.171	-.711	.506	.001	.025
28.1	29.153	-.101	-.163	-.763	.535	.001	.025
29.0	29.153	-.101	-.163	-.763	.535	.001	.025
29.1	29.153	-.078	-.156	-.814	.565	.001	.025
30.0	29.153	-.078	-.156	-.814	.565	.001	.025
30.1	29.153	-.056	-.151	-.860	.592	.001	.025
31.0	29.153	-.056	-.151	-.860	.592	.001	.025
31.1	29.153	-.015	-.142	-.940	.641	.001	.025
32.0	29.153	-.015	-.142	-.940	.641	.001	.025
32.1	29.153	.009	-.140	-.977	.667	.001	.025
33.0	29.153	.009	-.140	-.977	.667	.001	.025
33.1	29.153	.052	-.134	-1.046	.717	.001	.025
34.0	29.153	.052	-.134	-1.046	.717	.001	.025
34.1	29.153	.101	-.129	-1.116	.770	.001	.025
35.0	29.153	.101	-.129	-1.116	.770	.001	.025
35.1	29.153	.151	-.126	-1.181	.823	.001	.025
36.0	29.153	.151	-.126	-1.181	.823	.001	.025
36.1	29.153	.251	-.119	-1.298	.929	.000	.025
36.2	29.153	.178	-.124	-1.214	.852	.000	.025
37.0	29.153	.178	-.124	-1.214	.852	.000	.025
37.1	29.153	.230	-.121	-1.270	.907	.000	.025
38.0	29.153	.230	-.121	-1.270	.907	.000	.025
38.1	29.153	.286	-.119	-1.324	.966	.000	.025

39.0	29.153	.286	-.119	-1.324	.966	.000	.025
39.1	29.153	.343	-.117	-1.375	1.024	.000	.025
40.0	29.153	.343	-.117	-1.375	1.024	.000	.025
40.1	29.153	.456	-.113	-1.473	1.141	.000	.025
40.2	29.153	.374	-.116	-1.402	1.056	.000	.025
41.0	29.153	.374	-.116	-1.402	1.056	.000	.025
41.1	29.153	.432	-.114	-1.451	1.116	.000	.025
42.0	29.153	.432	-.114	-1.451	1.116	.000	.025
42.1	29.153	.495	-.112	-1.501	1.180	.000	.025
43.0	29.153	.495	-.112	-1.501	1.180	.000	.025
43.1	29.153	.551	-.111	-1.542	1.238	.000	.025
44.0	29.153	.551	-.111	-1.542	1.238	.000	.025
44.1	29.153	.654	-.109	-1.612	1.343	.000	.025
44.2	29.153	.596	-.110	-1.573	1.284	.000	.025
45.0	29.153	.596	-.110	-1.573	1.284	.000	.025
45.1	29.153	.681	-.109	-1.626	1.370	.000	.025
46.0	29.153	.681	-.109	-1.626	1.370	.000	.025
46.1	29.153	.772	-.107	-1.685	1.463	.000	.025
47.0	29.153	.772	-.107	-1.685	1.463	.000	.025
47.1	29.153	.864	-.106	-1.733	1.555	.000	.025
48.0	29.153	.864	-.106	-1.733	1.555	.000	.025
48.1	29.153	.955	-.105	-1.779	1.648	.000	.025
49.0	29.153	.955	-.105	-1.779	1.648	.000	.025
49.1	29.153	1.047	-.104	-1.813	1.740	.000	.025
50.0	29.153	1.047	-.104	-1.813	1.740	.000	.025
50.1	29.153	1.139	-.103	-1.854	1.833	.000	.025
51.0	29.153	1.139	-.103	-1.854	1.833	.000	.025
51.1	29.153	1.222	-.103	-1.890	1.917	.000	.025
52.0	29.153	1.222	-.103	-1.890	1.917	.000	.025
52.1	29.153	1.374	-.102	-1.952	2.070	.000	.025
52.2	29.153	1.271	-.102	-1.910	1.966	.000	.025
53.0	29.153	1.271	-.102	-1.910	1.966	.000	.025
53.1	29.153	1.365	-.102	-1.947	2.061	.000	.025
54.0	29.153	1.365	-.102	-1.947	2.061	.000	.025
54.1	29.153	1.463	-.101	-1.984	2.160	.000	.025
55.0	29.153	1.463	-.101	-1.984	2.160	.000	.025
55.1	29.153	1.553	-.101	-2.017	2.250	.000	.025
56.0	29.153	1.553	-.101	-2.017	2.250	.000	.025
56.1	29.153	1.719	-.100	-2.074	2.417	.000	.025
56.2	29.153	1.607	-.100	-2.035	2.305	.000	.025
57.0	29.153	1.607	-.100	-2.035	2.305	.000	.025
57.1	29.153	1.711	-.100	-2.070	2.409	.000	.025
58.0	29.153	1.711	-.100	-2.070	2.409	.000	.025
58.1	29.153	1.820	-.099	-2.106	2.518	.000	.025
59.0	29.153	1.820	-.099	-2.106	2.518	.000	.025
59.1	29.153	1.920	-.099	-2.136	2.618	.000	.025
60.0	29.153	1.920	-.099	-2.136	2.618	.000	.025

60.1	29.153	2.105	-.098	-2.191	2.805	.000	.025
60.2	29.153	1.979	-.099	-2.154	2.677	.000	.025
61.0	29.153	1.979	-.099	-2.154	2.677	.000	.025
61.1	29.153	2.091	-.098	-2.187	2.791	.000	.025
62.0	29.153	2.091	-.098	-2.187	2.791	.000	.025
62.1	29.153	2.209	-.098	-2.219	2.909	.000	.025
63.0	29.153	2.209	-.098	-2.219	2.909	.000	.025
63.1	29.153	2.317	-.098	-2.248	3.017	.000	.025
64.0	29.153	2.317	-.098	-2.248	3.017	.000	.025
64.1	29.153	2.519	-.097	-2.300	3.219	.000	.025
64.2	29.153	2.381	-.097	-2.265	3.081	.000	.025
65.0	29.153	2.381	-.097	-2.265	3.081	.000	.025
65.1	29.153	2.505	-.097	-2.296	3.205	.000	.025
66.0	29.153	2.505	-.097	-2.296	3.205	.000	.025
66.1	29.153	2.633	-.097	-2.327	3.334	.000	.025
67.0	29.153	2.633	-.097	-2.327	3.334	.000	.025
67.1	29.153	2.752	-.096	-2.355	3.453	.000	.025
68.0	29.153	2.752	-.096	-2.355	3.453	.000	.025
68.1	29.153	2.974	-.096	-2.405	3.676	.000	.025
68.2	29.153	2.821	-.096	-2.371	3.523	.000	.025
69.0	29.153	2.821	-.096	-2.371	3.523	.000	.025
69.1	29.153	2.954	-.096	-2.400	3.656	.000	.025
70.0	29.153	2.954	-.096	-2.400	3.656	.000	.025
70.1	29.153	3.093	-.096	-2.430	3.795	.000	.025
71.0	29.153	3.093	-.096	-2.430	3.795	.000	.025
71.1	29.153	3.222	-.095	-2.457	3.924	.000	.025
72.0	29.153	3.222	-.095	-2.457	3.924	.000	.025
72.1	29.153	3.464	-.095	-2.505	4.166	.000	.025
72.2	29.153	3.297	-.095	-2.472	3.999	.000	.025
73.0	29.153	3.297	-.095	-2.472	3.999	.000	.025
73.1	29.153	3.439	-.095	-2.500	4.142	.000	.025
74.0	29.153	3.439	-.095	-2.500	4.142	.000	.025
74.1	29.153	3.589	-.095	-2.529	4.291	.000	.025
75.0	29.153	3.589	-.095	-2.529	4.291	.000	.025
75.1	29.153	3.727	-.095	-2.554	4.430	9.80E-005	.025
76.0	29.153	3.727	-.095	-2.554	4.430	9.80E-005	.025
76.1	29.153	3.988	-.094	-2.601	4.691	9.24E-005	.025
76.2	29.153	3.808	-.094	-2.569	4.511	9.64E-005	.025
77.0	29.153	3.808	-.094	-2.569	4.511	9.64E-005	.025
77.1	29.153	3.965	-.094	-2.596	4.668	9.31E-005	.025
78.0	29.153	3.965	-.094	-2.596	4.668	9.31E-005	.025
78.1	29.153	4.127	-.094	-2.624	4.830	9.00E-005	.025
79.0	29.153	4.127	-.094	-2.624	4.830	9.00E-005	.025
79.1	29.153	4.279	-.094	-2.649	4.982	8.73E-005	.025
80.0	29.153	4.279	-.094	-2.649	4.982	8.73E-005	.025
80.1	29.153	4.567	-.094	-2.695	5.271	8.23E-005	.025
80.2	29.153	4.363	-.094	-2.662	5.067	8.59E-005	.025

81.0	29.153	4.363	-.094	-2.662	5.067	8.59E-005	.025
81.1	29.153	4.526	-.094	-2.688	5.229	8.32E-005	.025
82.0	29.153	4.526	-.094	-2.688	5.229	8.32E-005	.025
82.1	29.153	4.680	-.093	-2.712	5.384	8.08E-005	.025
83.0	29.153	4.680	-.093	-2.712	5.384	8.08E-005	.025
83.1	29.153	4.965	-.093	-2.754	5.670	7.66E-005	.025
83.2	29.153	4.777	-.093	-2.726	5.481	7.95E-005	.025
84.0	29.153	4.777	-.093	-2.726	5.481	7.95E-005	.025
84.1	29.153	4.964	-.093	-2.754	5.668	7.68E-005	.025
85.0	29.153	4.964	-.093	-2.754	5.668	7.68E-005	.025
85.1	29.153	5.141	-.093	-2.779	5.845	7.45E-005	.025
86.0	29.153	5.141	-.093	-2.779	5.845	7.45E-005	.025
86.1	29.153	5.334	-.093	-2.806	6.039	7.21E-005	.025
87.0	29.153	5.334	-.093	-2.806	6.039	7.21E-005	.025
87.1	29.153	5.516	-.093	-2.830	6.221	7.00E-005	.025
88.0	29.153	5.516	-.093	-2.830	6.221	7.00E-005	.025
88.1	29.153	5.858	-.092	-2.875	6.563	6.63E-005	.025
88.2	29.153	5.611	-.093	-2.842	6.316	6.90E-005	.025
89.0	29.153	5.611	-.093	-2.842	6.316	6.90E-005	.025
89.1	29.153	5.797	-.092	-2.866	6.501	6.70E-005	.025
90.0	29.153	5.797	-.092	-2.866	6.501	6.70E-005	.025
90.1	29.153	5.973	-.092	-2.888	6.677	6.53E-005	.025
91.0	29.153	5.973	-.092	-2.888	6.677	6.53E-005	.025
91.1	29.153	6.301	-.092	-2.929	7.007	6.21E-005	.025
91.2	29.153	6.083	-.092	-2.902	6.788	6.43E-005	.025
92.0	29.153	6.083	-.092	-2.902	6.788	6.43E-005	.025
92.1	29.153	6.298	-.092	-2.928	7.004	6.23E-005	.025
93.0	29.153	6.298	-.092	-2.928	7.004	6.23E-005	.025
93.1	29.153	6.503	-.092	-2.952	7.209	6.05E-005	.025
94.0	29.153	6.503	-.092	-2.952	7.209	6.05E-005	.025
94.1	29.153	6.724	-.092	-2.977	7.429	5.87E-005	.025
95.0	29.153	6.724	-.092	-2.977	7.429	5.87E-005	.025
95.1	29.153	6.927	-.092	-3.000	7.633	5.72E-005	.025
96.0	29.153	6.927	-.092	-3.000	7.633	5.72E-005	.025
96.1	29.153	7.303	-.092	-3.040	8.008	5.44E-005	.025
96.2	29.153	7.041	-.092	-3.012	7.747	5.64E-005	.025
97.0	29.153	7.041	-.092	-3.012	7.747	5.64E-005	.025
97.1	29.153	7.268	-.092	-3.036	7.974	5.47E-005	.025
98.0	29.153	7.268	-.092	-3.036	7.974	5.47E-005	.025
98.1	29.153	7.481	-.092	-3.058	8.187	5.33E-005	.025
99.0	29.153	7.481	-.092	-3.058	8.187	5.33E-005	.025
99.1	29.153	7.890	-.091	-3.100	8.596	5.07E-005	.025
99.2	29.153	7.592	-.091	-3.070	8.298	5.26E-005	.025
100.0	29.153	7.592	-.091	-3.070	8.298	5.26E-005	.025
100.1	29.153	7.809	-.091	-3.091	8.515	5.13E-005	.025
101.0	29.153	7.809	-.091	-3.091	8.515	5.13E-005	.025
101.1	29.153	8.021	-.091	-3.112	8.727	5.00E-005	.025

102.0	29.153	8.021	-.091	-3.112	8.727	5.00E-005	.025
102.1	29.153	8.413	-.091	-3.149	9.119	4.78E-005	.025
102.2	29.153	8.153	-.091	-3.125	8.859	4.93E-005	.025
103.0	29.153	8.153	-.091	-3.125	8.859	4.93E-005	.025
103.1	29.153	8.404	-.091	-3.148	9.110	4.79E-005	.025
104.0	29.153	8.404	-.091	-3.148	9.110	4.79E-005	.025
104.1	29.153	8.647	-.091	-3.171	9.353	4.67E-005	.025
105.0	29.153	8.647	-.091	-3.171	9.353	4.67E-005	.025
105.1	29.153	8.911	-.091	-3.194	9.618	4.54E-005	.025
106.0	29.153	8.911	-.091	-3.194	9.618	4.54E-005	.025
106.1	29.153	9.150	-.091	-3.215	9.857	4.43E-005	.025
107.0	29.153	9.150	-.091	-3.215	9.857	4.43E-005	.025
107.1	29.153	9.623	-.091	-3.256	10.330	4.22E-005	.025
107.2	29.153	9.269	-.091	-3.225	9.975	4.38E-005	.025
108.0	29.153	9.269	-.091	-3.225	9.975	4.38E-005	.025
108.1	29.153	9.507	-.091	-3.245	10.213	4.28E-005	.025
109.0	29.153	9.507	-.091	-3.245	10.213	4.28E-005	.025
109.1	29.153	9.732	-.091	-3.264	10.439	4.19E-005	.025
110.0	29.153	9.732	-.091	-3.264	10.439	4.19E-005	.025
110.1	29.153	10.159	-.091	-3.299	10.866	4.02E-005	.025
110.2	29.153	9.884	-.091	-3.276	10.591	4.13E-005	.025
111.0	29.153	9.884	-.091	-3.276	10.591	4.13E-005	.025
111.1	29.153	10.175	-.091	-3.300	10.881	4.02E-005	.025
112.0	29.153	10.175	-.091	-3.300	10.881	4.02E-005	.025
112.1	29.153	10.462	-.090	-3.322	11.169	3.91E-005	.025
113.0	29.153	10.462	-.090	-3.322	11.169	3.91E-005	.025
113.1	29.153	10.767	-.090	-3.345	11.473	3.81E-005	.025
114.0	29.153	10.767	-.090	-3.345	11.473	3.81E-005	.025
114.1	29.153	11.074	-.090	-3.368	11.781	3.71E-005	.025
115.0	29.153	11.074	-.090	-3.368	11.781	3.71E-005	.025
115.1	29.153	11.363	-.090	-3.389	12.070	3.62E-005	.025
116.0	29.153	11.363	-.090	-3.389	12.070	3.62E-005	.025
116.1	29.153	11.667	-.090	-3.411	12.374	3.53E-005	.025
117.0	29.153	11.667	-.090	-3.411	12.374	3.53E-005	.025
117.1	29.153	11.959	-.090	-3.431	12.666	3.45E-005	.025
118.0	29.153	11.959	-.090	-3.431	12.666	3.45E-005	.025
118.1	29.153	12.263	-.090	-3.451	12.970	3.37E-005	.025
119.0	29.153	12.263	-.090	-3.451	12.970	3.37E-005	.025
119.1	29.153	12.579	-.090	-3.472	13.286	3.29E-005	.025
120.0	29.153	12.579	-.090	-3.472	13.286	3.29E-005	.025
120.1	29.153	12.869	-.090	-3.491	13.576	3.22E-005	.025
121.0	29.153	12.869	-.090	-3.491	13.576	3.22E-005	.025
121.1	29.153	13.392	-.090	-3.524	14.099	3.10E-005	.025
121.2	29.153	13.048	-.090	-3.503	13.756	3.18E-005	.025
122.0	29.153	13.048	-.090	-3.503	13.756	3.18E-005	.025
122.1	29.153	13.410	-.090	-3.525	14.118	3.10E-005	.025
123.0	29.153	13.410	-.090	-3.525	14.118	3.10E-005	.025

123.1	29.153	13.755	-.090	-3.546	14.463	3.03E-005	.025
124.0	29.153	13.755	-.090	-3.546	14.463	3.03E-005	.025
124.1	29.153	14.085	-.090	-3.566	14.792	2.96E-005	.025
125.0	29.153	14.085	-.090	-3.566	14.792	2.96E-005	.025
125.1	29.153	14.444	-.090	-3.587	15.151	2.89E-005	.025
126.0	29.153	14.444	-.090	-3.587	15.151	2.89E-005	.025
126.1	29.153	14.778	-.090	-3.606	15.485	2.83E-005	.025
127.0	29.153	14.778	-.090	-3.606	15.485	2.83E-005	.025
127.1	29.153	15.479	-.090	-3.646	16.187	2.70E-005	.025
127.2	29.153	14.917	-.090	-3.614	15.625	2.80E-005	.025
128.0	29.153	14.917	-.090	-3.614	15.625	2.80E-005	.025
128.1	29.153	15.168	-.090	-3.628	15.876	2.76E-005	.025

Derivatives are calculated analytically.

a Major iteration number is displayed to the left of the decimal, and minor iteration number is to the right of the decimal.

b Run stopped after 285 model evaluations and 128 derivative evaluations because the relative reduction between successive residual sums of squares is at most SSSCON = 1.00E-008.

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
b1	15.168	26001556 89478.738	- 51079872724 18.910	51079872724 49.250
b2	-.090	26001574 18656.301	- 51079906693 91.140	51079906693 90.960
b3	-3.628	10478869 62486879. 000	- 20585664500 75016.000	20585664500 75009.000
b4	15.876	142818.13 3	-280549.325	280581.077
b5	2.76E-005	.256	-.502	.502
b6	.025	.000	.024	.025

Correlations of Parameter Estimates

	b1	b2	b3	b4	b5	b6
b1	1.000	-1.000	1.000	-.001	.001	.005
b2	-1.000	1.000	-1.000	.001	-.001	-.005
b3	1.000	-1.000	1.000	-.001	.001	.005
b4	-.001	.001	-.001	1.000	-1.000	.000
b5	.001	-.001	.001	-1.000	1.000	.000
b6	.005	-.005	.005	.000	.000	1.000

ANOVA(a)

Source	Sum of Squares	df	Mean Squares
Regression	1046.694	6	174.449
Residual	29.153	525	.056
Uncorrected Total	1075.846	531	
Corrected Total	124.285	530	

Dependent variable: BRT

a R squared = $1 - (\text{Residual Sum of Squares}) / (\text{Corrected Sum of Squares}) = .665$.

Linear Regression Analysis for BRT: Normal Scenario (Model 3)

Variables Entered/Removed^{b,c}

Model	Variables Entered	Variables Removed	Method
1	Dis. Headway, Gender ^a , Speed	.	Enter

a. All requested variables entered.

b. Dependent Variable: BRT

c. Linear Regression through the Origin

Model Summary

Model	R	R Square ^a	Adjusted R Square	Std. Error of the Estimate
1	.985 ^b	.970	.970	.24812

a. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept.

b. Predictors: Dis.Headway, Gender, Speed

ANOVA^{c,d}

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1043.340	3	347.780	5648.971	.000 ^a
	Residual	32.506	528	.062		
	Total	1075.846 ^b	531			

a. Predictors: Dis.Headway, Gender, Speed

b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.

c. Dependent Variable: BRT

d. Linear Regression through the Origin

Coefficients^{a,b}

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Gender	.078	.021	.037	3.665	.000
	Speed	-.002	.000	-.108	-4.568	.000
	Dis.Headway	.049	.001	1.062	45.473	.000

a. Dependent Variable: BRT

b. Linear Regression through the Origin

Appendix G

Regression Analysis for Surprised Scenario

Linear Regression Analysis for BRT: Surprised Scenario (Model 1)

Variables Entered/Removed^{b,c}

Model	Variables Entered	Variables Removed	Method
1	Speed, Gender, Age, Dis. ^a Headway	.	Enter

- a. All requested variables entered.
b. Dependent Variable: BRT
c. Linear Regression through the Origin

Model Summary

Model	R	R Square ^a	Adjusted R Square	Std. Error of the Estimate
1	.975 ^b	.951	.951	.1875

- a. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept.
b. Predictors: Speed, Gender, Age, Dis.Headway

ANOVA^{c,d}

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	362.841	4	90.710	2578.871	.000 ^a
	Residual	18.537	527	.035		
	Total	381.378 ^b	531			

- a. Predictors: Speed, Gender, Age, Dis.Headway
b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.
c. Dependent Variable: BRT
d. Linear Regression through the Origin

Coefficients^{a,b}

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Age	.001	.000	.055	2.380	.018
	Gender	.109	.016	.087	6.737	.000
	Dis.Headway	.023	.001	.574	24.641	.000
	Speed	.003	.000	.312	10.788	.000

- a. Dependent Variable: BRT
b. Linear Regression through the Origin

Nonlinear Regression Analysis: Surprised Scenario (Model 2)

Iteration History(b)

Iteration Number (a)	Residual Sum of Squares	Parameter							
		b1	b2	b3	b4	b5	b6	b7	b8
1.0	49.198	.000	.000	.000	.000	.000	.000	.000	.000
1.1	25.891	-1.396	3.615	.000	-1.396	.000	.019	-1.396	.000
2.0	25.891	-1.396	3.615	.000	-1.396	.000	.019	-1.396	.000
2.1	16.960	-5.151	4.869	.024	-.142	-3.84E-005	.015	-.142	.000
3.0	16.960	-5.151	4.869	.024	-.142	-3.84E-005	.015	-.142	.000
3.1	77953.942	-7.644	2.432	.030	-2.575	.000	.015	7.226	.020
3.2	31.534	-5.395	4.630	.019	-.382	.000	.015	.587	.005
3.3	16.136	-5.148	4.872	.018	-.139	.000	.015	-.150	.002
4.0	16.136	-5.148	4.872	.018	-.139	.000	.015	-.150	.002
4.1	16.200	-5.181	4.840	.018	-.174	.000	.015	-.045	.004
4.2	16.133	-5.145	4.874	.018	-.136	.000	.015	-.156	.002
5.0	16.133	-5.145	4.874	.018	-.136	.000	.015	-.156	.002
5.1	16.129	-5.140	4.879	.018	-.132	.000	.015	-.167	.002
6.0	16.129	-5.140	4.879	.018	-.132	.000	.015	-.167	.002
6.1	16.130	-5.155	4.865	.018	-.150	.000	.015	-.120	.003
6.2	16.129	-5.141	4.879	.018	-.135	.000	.015	-.162	.003
7.0	16.129	-5.141	4.879	.018	-.135	.000	.015	-.162	.003
7.1	16.129	-5.147	4.873	.018	-.143	.000	.015	-.143	.003
8.0	16.129	-5.147	4.873	.018	-.143	.000	.015	-.143	.003
8.1	16.130	-5.160	4.860	.018	-.156	.000	.015	-.105	.004
8.2	16.129	-5.149	4.870	.018	-.146	.000	.015	-.135	.003
9.0	16.129	-5.149	4.870	.018	-.146	.000	.015	-.135	.003
9.1	16.129	-5.156	4.864	.018	-.152	.000	.015	-.118	.003
10.0	16.129	-5.156	4.864	.018	-.152	.000	.015	-.118	.003
10.1	16.129	-5.167	4.853	.018	-.162	.000	.015	-.084	.004
10.2	16.129	-5.158	4.862	.018	-.154	.000	.015	-.112	.004
11.0	16.129	-5.158	4.862	.018	-.154	.000	.015	-.112	.004
11.1	16.128	-5.162	4.857	.018	-.158	.000	.015	-.098	.004
12.0	16.128	-5.162	4.857	.018	-.158	.000	.015	-.098	.004
12.1	16.129	-5.171	4.849	.018	-.166	.000	.015	-.073	.005
12.2	16.128	-5.166	4.854	.018	-.161	.000	.015	-.089	.004
13.0	16.128	-5.166	4.854	.018	-.161	.000	.015	-.089	.004
13.1	16.128	-5.172	4.848	.018	-.166	.000	.015	-.072	.005
14.0	16.128	-5.172	4.848	.018	-.166	.000	.015	-.072	.005
14.1	16.127	-5.176	4.844	.018	-.170	.000	.015	-.060	.006
15.0	16.127	-5.176	4.844	.018	-.170	.000	.015	-.060	.006

15.1	16.129	-5.183	4.837	.018	-.177	.000	.015	-.040	.008
15.2	16.127	-5.177	4.843	.018	-.171	.000	.015	-.056	.006
16.0	16.127	-5.177	4.843	.018	-.171	.000	.015	-.056	.006
16.1	16.127	-5.181	4.839	.018	-.175	.000	.015	-.046	.007
17.0	16.127	-5.181	4.839	.018	-.175	.000	.015	-.046	.007
17.1	16.126	-5.183	4.837	.018	-.177	.000	.015	-.039	.008
18.0	16.126	-5.183	4.837	.018	-.177	.000	.015	-.039	.008
18.1	16.126	-5.187	4.833	.018	-.181	.000	.015	-.027	.010
18.2	16.126	-5.185	4.835	.018	-.179	.000	.015	-.034	.009
19.0	16.126	-5.185	4.835	.018	-.179	.000	.015	-.034	.009
19.1	16.125	-5.189	4.832	.018	-.182	.000	.015	-.024	.011
20.0	16.125	-5.189	4.832	.018	-.182	.000	.015	-.024	.011
20.1	16.124	-5.190	4.830	.018	-.183	.000	.015	-.020	.013
21.0	16.124	-5.190	4.830	.018	-.183	.000	.015	-.020	.013
21.1	16.126	-5.194	4.827	.018	-.186	.000	.015	-.011	.017
21.2	16.123	-5.191	4.830	.018	-.184	.000	.015	-.018	.014
22.0	16.123	-5.191	4.830	.018	-.184	.000	.015	-.018	.014
22.1	16.122	-5.193	4.828	.018	-.185	.000	.015	-.014	.016
23.0	16.122	-5.193	4.828	.018	-.185	.000	.015	-.014	.016
23.1	16.122	-5.195	4.826	.018	-.187	.000	.015	-.008	.021
24.0	16.122	-5.195	4.826	.018	-.187	.000	.015	-.008	.021
24.1	16.118	-5.195	4.825	.018	-.187	.000	.015	-.008	.023
25.0	16.118	-5.195	4.825	.018	-.187	.000	.015	-.008	.023
25.1	16.117	-5.197	4.824	.018	-.188	.000	.015	-.005	.027
26.0	16.117	-5.197	4.824	.018	-.188	.000	.015	-.005	.027
26.1	16.113	-5.197	4.823	.018	-.189	.000	.015	-.004	.030
27.0	16.113	-5.197	4.823	.018	-.189	.000	.015	-.004	.030
27.1	16.122	-5.199	4.822	.018	-.190	.000	.015	-.001	.038
27.2	16.111	-5.197	4.823	.018	-.189	.000	.015	-.004	.032
28.0	16.111	-5.197	4.823	.018	-.189	.000	.015	-.004	.032
28.1	16.110	-5.198	4.823	.018	-.189	.000	.015	-.003	.035
29.0	16.110	-5.198	4.823	.018	-.189	.000	.015	-.003	.035
29.1	16.107	-5.199	4.822	.018	-.189	.000	.015	-.002	.040
30.0	16.107	-5.199	4.822	.018	-.189	.000	.015	-.002	.040
30.1	16.101	-5.199	4.821	.018	-.189	.000	.015	-.001	.046
31.0	16.101	-5.199	4.821	.018	-.189	.000	.015	-.001	.046
31.1	16.134	-5.200	4.820	.018	-.190	.000	.015	.000	.057
31.2	16.100	-5.199	4.821	.018	-.189	.000	.015	-.001	.047
32.0	16.100	-5.199	4.821	.018	-.189	.000	.015	-.001	.047
32.1	16.099	-5.199	4.821	.018	-.189	.000	.015	-.001	.049
33.0	16.099	-5.199	4.821	.018	-.189	.000	.015	-.001	.049
33.1	16.096	-5.200	4.821	.018	-.189	.000	.015	-.001	.054
34.0	16.096	-5.200	4.821	.018	-.189	.000	.015	-.001	.054
34.1	16.095	-5.200	4.820	.018	-.189	.000	.015	.000	.062
35.0	16.095	-5.200	4.820	.018	-.189	.000	.015	.000	.062
35.1	16.085	-5.201	4.820	.018	-.189	.000	.015	.000	.067
36.0	16.085	-5.201	4.820	.018	-.189	.000	.015	.000	.067

36.1	16.099	-5.201	4.820	.018	-.189	.000	.015	-9.67E-005	.076
36.2	16.084	-5.201	4.820	.018	-.189	.000	.015	.000	.069
37.0	16.084	-5.201	4.820	.018	-.189	.000	.015	.000	.069
37.1	16.082	-5.201	4.820	.018	-.189	.000	.015	.000	.072
38.0	16.082	-5.201	4.820	.018	-.189	.000	.015	.000	.072
38.1	16.079	-5.201	4.820	.018	-.189	.000	.015	.000	.077
39.0	16.079	-5.201	4.820	.018	-.189	.000	.015	.000	.077
39.1	16.074	-5.201	4.819	.018	-.189	.000	.015	-9.12E-005	.084
40.0	16.074	-5.201	4.819	.018	-.189	.000	.015	-9.12E-005	.084
40.1	16.115	-5.202	4.819	.018	-.188	.000	.015	-1.51E-005	.096
40.2	16.073	-5.201	4.819	.018	-.189	.000	.015	-9.07E-005	.085
41.0	16.073	-5.201	4.819	.018	-.189	.000	.015	-9.07E-005	.085
41.1	16.071	-5.202	4.819	.018	-.188	.000	.015	-7.33E-005	.088
42.0	16.071	-5.202	4.819	.018	-.188	.000	.015	-7.33E-005	.088
42.1	16.069	-5.202	4.819	.018	-.188	.000	.015	-4.99E-005	.092
43.0	16.069	-5.202	4.819	.018	-.188	.000	.015	-4.99E-005	.092
43.1	16.075	-5.202	4.818	.018	-.188	.000	.015	-1.91E-005	.102
43.2	16.067	-5.202	4.819	.018	-.188	.000	.015	-4.48E-005	.095
44.0	16.067	-5.202	4.819	.018	-.188	.000	.015	-4.48E-005	.095
44.1	16.066	-5.202	4.819	.018	-.188	.000	.015	-2.90E-005	.100
45.0	16.066	-5.202	4.819	.018	-.188	.000	.015	-2.90E-005	.100
45.1	16.063	-5.202	4.818	.018	-.187	.000	.015	-2.11E-005	.105
46.0	16.063	-5.202	4.818	.018	-.187	.000	.015	-2.11E-005	.105
46.1	16.079	-5.203	4.818	.018	-.186	.000	.015	-6.57E-006	.115
46.2	16.063	-5.202	4.818	.018	-.187	.000	.015	-2.06E-005	.106
47.0	16.063	-5.202	4.818	.018	-.187	.000	.015	-2.06E-005	.106
47.1	16.062	-5.203	4.818	.018	-.187	.000	.015	-1.74E-005	.108
48.0	16.062	-5.203	4.818	.018	-.187	.000	.015	-1.74E-005	.108
48.1	16.061	-5.203	4.818	.018	-.187	.000	.015	-1.22E-005	.112
49.0	16.061	-5.203	4.818	.018	-.187	.000	.015	-1.22E-005	.112
49.1	16.060	-5.203	4.818	.018	-.186	.000	.015	-9.17E-006	.116
50.0	16.060	-5.203	4.818	.018	-.186	.000	.015	-9.17E-006	.116
50.1	16.066	-5.204	4.817	.018	-.185	.000	.015	-3.80E-006	.125

50.2	16.059	-5.203	4.817	.018	-.186	.000	.015	-8.83E-006	.117
51.0	16.059	-5.203	4.817	.018	-.186	.000	.015	-8.83E-006	.117
51.1	16.059	-5.203	4.817	.018	-.186	.000	.015	-7.51E-006	.119
52.0	16.059	-5.203	4.817	.018	-.186	.000	.015	-7.51E-006	.119
52.1	16.059	-5.204	4.817	.018	-.185	.000	.015	-5.36E-006	.123
53.0	16.059	-5.204	4.817	.018	-.185	.000	.015	-5.36E-006	.123
53.1	16.058	-5.205	4.816	.018	-.184	.000	.015	-4.04E-006	.127
54.0	16.058	-5.205	4.816	.018	-.184	.000	.015	-4.04E-006	.127
54.1	16.064	-5.207	4.814	.018	-.179	.000	.015	-1.75E-006	.135
54.2	16.058	-5.205	4.816	.018	-.184	.000	.015	-3.94E-006	.128
55.0	16.058	-5.205	4.816	.018	-.184	.000	.015	-3.94E-006	.128
55.1	16.058	-5.205	4.816	.018	-.183	.000	.015	-3.47E-006	.130
56.0	16.058	-5.205	4.816	.018	-.183	.000	.015	-3.47E-006	.130
56.1	16.058	-5.206	4.815	.018	-.181	.000	.015	-2.66E-006	.133
57.0	16.058	-5.206	4.815	.018	-.181	.000	.015	-2.66E-006	.133
57.1	16.057	-5.207	4.814	.018	-.179	.000	.015	-2.42E-006	.135
58.0	16.057	-5.207	4.814	.018	-.179	.000	.015	-2.42E-006	.135
58.1	16.057	-5.231	4.791	.018	-.132	.000	.015	-1.85E-006	.138
58.2	16.057	-5.208	4.813	.018	-.178	.000	.015	-2.34E-006	.135
59.0	16.057	-5.208	4.813	.018	-.178	.000	.015	-2.34E-006	.135
59.1	16.057	-5.211	4.810	.018	-.172	.000	.015	-2.15E-006	.136
60.0	16.057	-5.211	4.810	.018	-.172	.000	.015	-2.15E-006	.136
60.1	16.057	-5.237	4.785	.018	-.120	.000	.015	-2.14E-006	.136
60.2	16.057	-5.213	4.808	.018	-.167	.000	.015	-2.15E-006	.136
61.0	16.057	-5.213	4.808	.018	-.167	.000	.015	-2.15E-006	.136
61.1	16.057	-5.219	4.802	.018	-.156	.000	.015	-2.15E-006	.136
61.2	16.057	-5.216	4.805	.018	-.162	.000	.015	-2.15E-006	.136

Derivatives are calculated numerically.

a Major iteration number is displayed to the left of the decimal, and minor iteration number is to the right of the decimal.

b Run stopped after 143 model evaluations and 61 derivative evaluations because the relative reduction between successive residual sums of squares is at most SS_{CON} = 1.00E-008.

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
b1	-5.216	43154271 73849.149	- 84777007552 31.200	84777007552 20.770
b2	4.805	43154271 73848.588	- 84777007552 20.080	84777007552 29.690
b3	.018	16047584 015.211	- 31525642687. 159	31525642687. 195
b4	-.162	730.585	-1435.403	1435.080
b5	.000	1.496	-2.940	2.939
b6	.015	.001	.013	.016
b7	2.15E-006	.000	-4.01E-005	3.58E-005
b8	.136	.119	-.097	.370

Correlations of Parameter Estimates

	b1	b2	b3	b4	b5	b6	b7	b8
b1	1.000	-1.000	1.000	-.001	.001	.008	.184	.177
b2	-1.000	1.000	-1.000	.001	-.001	-.008	-.184	-.177
b3	1.000	-1.000	1.000	-.001	.001	.008	.184	.177
b4	-.001	.001	-.001	1.000	-1.000	.000	.000	.000
b5	.001	-.001	.001	-1.000	1.000	.000	.000	.000
b6	.008	-.008	.008	.000	.000	1.000	.001	.001
b7	.184	-.184	.184	.000	.000	.001	1.000	.998
b8	.177	-.177	.177	.000	.000	.001	.998	1.000

ANOVA(a)

Source	Sum of Squares	df	Mean Squares
Regression	365.320	8	45.665
Residual	16.057	523	.031
Uncorrected Total	381.378	531	
Corrected Total	30.587	530	

Dependent variable: BRT

a R squared = 1 - (Residual Sum of Squares) / (Corrected Sum of Squares) = .475.

Appendix H

Regression Analysis for Stationary Scenario

Nonlinear Regression Analysis: Stationary Scenario (Model 1)

Iteration History (b)

Iteration Number(a)	Residual Sum of Squares	Parameter						
		b1	b2	b3	b4	b5	b6	b7
1.0	916.277	.000	.000	.000	.000	.000	.000	.000
1.1	17.344	-4.095	1.220	.000	-.001	.014	1.220	.000
2.0	17.344	-4.095	1.220	.000	-.001	.014	1.220	.000
2.1	22.805	-11.383	4.865	.018	-.001	.010	4.865	.001
2.2	11.545	-6.813	2.580	.018	-.001	.010	2.580	.001
3.0	11.545	-6.813	2.580	.018	-.001	.010	2.580	.001
3.1	10.865	-5.469	3.901	-.001	-.001	.010	-.079	.001
4.0	10.865	-5.469	3.901	-.001	-.001	.010	-.079	.001
4.1	274.708	-4.904	4.456	.006	-.001	.010	-1.197	-.025
4.2	9.612	-5.563	3.809	.006	-.001	.010	.133	-.001
5.0	9.612	-5.563	3.809	.006	-.001	.010	.133	-.001
5.1	11.295	-5.440	3.929	.006	-.001	.010	-.130	.004
5.2	9.450	-5.545	3.826	.006	-.001	.010	.105	.000
6.0	9.450	-5.545	3.826	.006	-.001	.010	.105	.000
6.1	9.418	-5.537	3.834	.006	-.001	.010	.087	.001
7.0	9.418	-5.537	3.834	.006	-.001	.010	.087	.001
7.1	9.442	-5.639	3.734	.006	-.001	.010	.276	.003
7.2	9.374	-5.577	3.794	.006	-.001	.010	.163	.002
8.0	9.374	-5.577	3.794	.006	-.001	.010	.163	.002
8.1	9.364	-5.629	3.744	.006	-.001	.010	.239	.004
9.0	9.364	-5.629	3.744	.006	-.001	.010	.239	.004
9.1	9.323	-5.586	3.785	.006	-.001	.010	.156	.004
10.0	9.323	-5.586	3.785	.006	-.001	.010	.156	.004
10.1	9.352	-5.548	3.823	.006	-.001	.010	.081	.006
10.2	9.321	-5.586	3.786	.006	-.001	.010	.156	.005
11.0	9.321	-5.586	3.786	.006	-.001	.010	.156	.005
11.1	9.320	-5.579	3.793	.006	-.001	.010	.141	.005
12.0	9.320	-5.579	3.793	.006	-.001	.010	.141	.005
12.1	9.320	-5.565	3.806	.006	-.001	.010	.115	.006
13.0	9.320	-5.565	3.806	.006	-.001	.010	.115	.006
13.1	9.319	-5.562	3.810	.006	-.001	.010	.109	.006
14.0	9.319	-5.562	3.810	.006	-.001	.010	.109	.006
14.1	9.319	-5.552	3.819	.006	-.001	.010	.090	.007
15.0	9.319	-5.552	3.819	.006	-.001	.010	.090	.007
15.1	9.318	-5.546	3.825	.006	-.001	.010	.078	.008
16.0	9.318	-5.546	3.825	.006	-.001	.010	.078	.008
16.1	9.319	-5.535	3.836	.006	-.001	.010	.057	.010
16.2	9.317	-5.542	3.828	.006	-.001	.010	.072	.009

17.0	9.317	-5.542	3.828	.006	-.001	.010	.072	.009
17.1	9.316	-5.535	3.835	.006	-.001	.010	.058	.010
18.0	9.316	-5.535	3.835	.006	-.001	.010	.058	.010
18.1	9.315	-5.531	3.840	.006	-.001	.010	.050	.011
19.0	9.315	-5.531	3.840	.006	-.001	.010	.050	.011
19.1	9.316	-5.523	3.848	.006	-.001	.010	.035	.013
19.2	9.314	-5.528	3.843	.006	-.001	.010	.045	.012
20.0	9.314	-5.528	3.843	.006	-.001	.010	.045	.012
20.1	9.313	-5.523	3.848	.006	-.001	.010	.035	.014
21.0	9.313	-5.523	3.848	.006	-.001	.010	.035	.014
21.1	9.311	-5.519	3.851	.006	-.001	.010	.030	.015
22.0	9.311	-5.519	3.851	.006	-.001	.010	.030	.015
22.1	9.313	-5.514	3.857	.006	-.001	.010	.020	.018
22.2	9.310	-5.518	3.853	.006	-.001	.010	.027	.016
23.0	9.310	-5.518	3.853	.006	-.001	.010	.027	.016
23.1	9.309	-5.514	3.857	.006	-.001	.010	.020	.019
24.0	9.309	-5.514	3.857	.006	-.001	.010	.020	.019
24.1	9.307	-5.512	3.859	.006	-.001	.010	.017	.021
25.0	9.307	-5.512	3.859	.006	-.001	.010	.017	.021
25.1	9.308	-5.508	3.863	.006	-.001	.010	.011	.025
25.2	9.306	-5.510	3.860	.006	-.001	.010	.015	.022
26.0	9.306	-5.510	3.860	.006	-.001	.010	.015	.022
26.1	9.305	-5.508	3.863	.006	-.001	.010	.011	.025
27.0	9.305	-5.508	3.863	.006	-.001	.010	.011	.025
27.1	9.302	-5.506	3.864	.006	-.001	.010	.008	.028
28.0	9.302	-5.506	3.864	.006	-.001	.010	.008	.028
28.1	9.311	-5.503	3.868	.006	-.001	.010	.004	.034
28.2	9.301	-5.506	3.865	.006	-.001	.010	.008	.029
29.0	9.301	-5.506	3.865	.006	-.001	.010	.008	.029
29.1	9.300	-5.504	3.866	.006	-.001	.010	.007	.031
30.0	9.300	-5.504	3.866	.006	-.001	.010	.007	.031
30.1	9.300	-5.503	3.868	.006	-.001	.010	.004	.036
31.0	9.300	-5.503	3.868	.006	-.001	.010	.004	.036
31.1	9.297	-5.502	3.868	.006	-.001	.010	.004	.038
32.0	9.297	-5.502	3.868	.006	-.001	.010	.004	.038
32.1	9.296	-5.501	3.869	.006	-.001	.010	.003	.042
33.0	9.296	-5.501	3.869	.006	-.001	.010	.003	.042
33.1	9.295	-5.501	3.870	.006	-.001	.010	.003	.044
34.0	9.295	-5.501	3.870	.006	-.001	.010	.003	.044
34.1	9.295	-5.500	3.871	.006	-.001	.010	.002	.048
34.2	9.294	-5.500	3.870	.006	-.001	.010	.002	.046
35.0	9.294	-5.500	3.870	.006	-.001	.010	.002	.046
35.1	9.294	-5.500	3.871	.006	-.001	.010	.002	.049
36.0	9.294	-5.500	3.871	.006	-.001	.010	.002	.049
36.1	9.293	-5.499	3.871	.006	-.001	.010	.001	.052
37.0	9.293	-5.499	3.871	.006	-.001	.010	.001	.052
37.1	9.293	-5.499	3.872	.006	-.001	.010	.001	.055

38.0	9.293	-5.499	3.872	.006	-.001	.010	.001	.055
38.1	9.293	-5.768	4.141	.005	-.001	.010	.001	.056
39.0	9.293	-5.768	4.141	.005	-.001	.010	.001	.056
39.1	9.293	-6.341	4.715	.004	-.001	.010	.001	.056
39.2	9.293	-5.836	4.209	.005	-.001	.010	.001	.056
40.0	9.293	-5.836	4.209	.005	-.001	.010	.001	.056
40.1	9.293	-5.917	4.290	.005	-.001	.010	.001	.056
41.0	9.293	-5.917	4.290	.005	-.001	.010	.001	.056
41.1	9.293	-5.825	4.198	.005	-.001	.010	.001	.056
42.0	9.293	-5.825	4.198	.005	-.001	.010	.001	.056
42.1	9.293	-5.733	4.106	.005	-.001	.010	.001	.056
43.0	9.293	-5.733	4.106	.005	-.001	.010	.001	.056
43.1	9.293	-5.640	4.014	.005	-.001	.010	.001	.056
44.0	9.293	-5.640	4.014	.005	-.001	.010	.001	.056
44.1	9.293	-5.733	4.106	.005	-.001	.010	.001	.056
45.0	9.293	-5.733	4.106	.005	-.001	.010	.001	.056
45.1	9.293	-5.640	4.014	.005	-.001	.010	.001	.056

Derivatives are calculated numerically.

a Major iteration number is displayed to the left of the decimal, and minor iteration number is to the right of the decimal.

b Run stopped after 102 model evaluations and 45 derivative evaluations because the relative reduction between successive residual sums of squares is at most SSCON = 1.00E-008.

Parameter Estimates

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
b1	-5.640	27947882 02848.517	- 54903656641 32.070	54903656641 20.790
b2	4.014	27947882 02848.523	- 54903656641 22.430	54903656641 30.460
b3	.005	35415178 14.015	- 6957317118.0 29	6957317118.0 40
b4	.001	.000	-.002	2.22E-005
b5	.010	.000	.009	.011
b6	.001	.004	-.007	.009
b7	.056	.051	-.044	.156

Correlations of Parameter Estimates

	b1	b2	b3	b4	b5	b6	b7
b1	1.000	-1.000	1.000	.023	.007	-.004	.020
b2	-1.000	1.000	-1.000	-.023	-.007	.004	-.020
b3	1.000	-1.000	1.000	.023	.007	-.004	.020
b4	.023	-.023	.023	1.000	.000	.000	.000
b5	.007	-.007	.007	.000	1.000	.000	.000
b6	-.004	.004	-.004	.000	.000	1.000	-.996

b7	.020	-.020	.020	.000	.000	-.996	1.000
----	------	-------	------	------	------	-------	-------

ANOVA(a)

Source	Sum of Squares	df	Mean Squares
Regression	265.664	7	37.952
Residual	9.293	524	.018
Uncorrected Total	274.957	531	
Corrected Total	16.207	530	

Dependent variable: BRT

a R squared = 1 - (Residual Sum of Squares) / (Corrected Sum of Squares) = .427.

Linear Regression Analysis for BRT: Stationary Scenario (Model 2)

Variables Entered/Removed^{b,c}

Model	Variables Entered	Variables Removed	Method
1	Dis. Headway, Gender, Age, Speed ^a	.	Enter

a. All requested variables entered.

b. Dependent Variable: BRT

c. Linear Regression through the Origin

Model Summary

Model	R	R Square ^a	Adjusted R Square	Std. Error of the Estimate
1	.981 ^b	.962	.962	.14058

a. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept.

b. Predictors: Dis.Headway, Gender, Age, Speed

ANOVA^{c,d}

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	264.542	4	66.135	3346.435	.000 ^a
	Residual	10.415	527	.020		
	Total	274.957 ^b	531			

a. Predictors: Dis.Headway, Gender, Age, Speed

b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.

c. Dependent Variable: BRT

d. Linear Regression through the Origin

Coefficients^{a,b}

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Age	.002	.000	.112	5.454	.000
	Gender	.035	.012	.033	2.857	.004
	Speed	.001	.000	.145	4.985	.000
	Dis.Headway	.017	.001	.719	26.582	.000

a. Dependent Variable: BRT

b. Linear Regression through the Origin

Appendix I

Regression Analysis for Acceleration/Deceleration Reaction Time

Regression Analysis for ADRT

Variables Entered/Removed^{b,c}

Model	Variables Entered	Variables Removed	Method
1	Gender, Age	.	Enter

- a. All requested variables entered.
 b. Dependent Variable: AC.RT
 c. Linear Regression through the Origin

Model Summary

Model	R	R Square ^a	Adjusted R Square	Std. Error of the Estimate
1	.886 ^b	.785	.774	.392159

- a. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept.
 b. Predictors: Gender, Age

ANOVA^{c,d}

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.391	2	10.695	69.547	.000 ^a
	Residual	5.844	38	.154		
	Total	27.235 ^b	40			

- a. Predictors: Gender, Age
 b. This total sum of squares is not corrected for the constant because the constant is zero for regression through the origin.
 c. Dependent Variable: AC.RT
 d. Linear Regression through the Origin

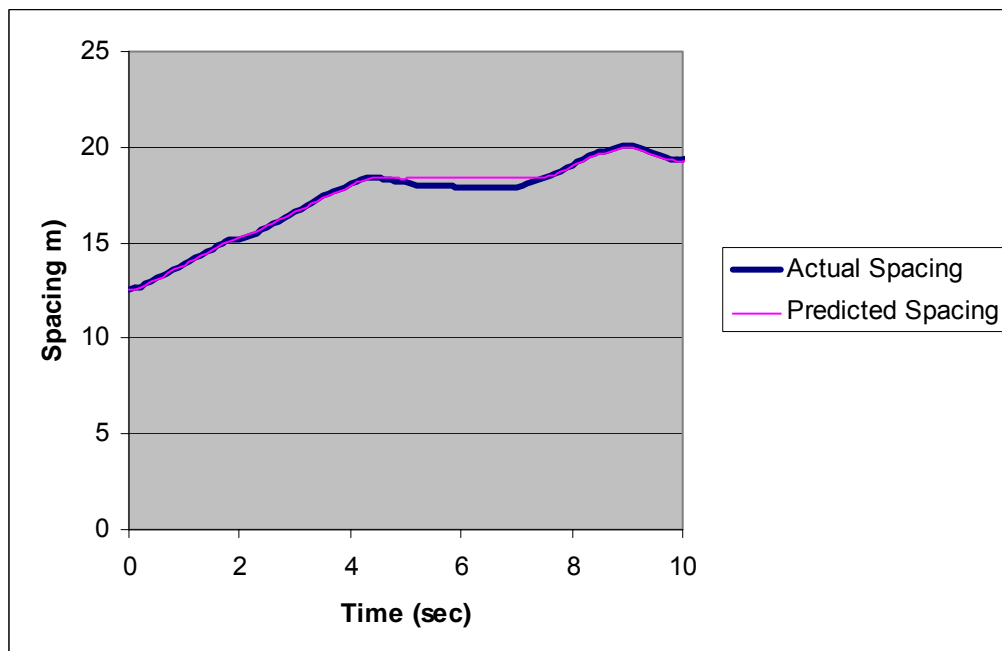
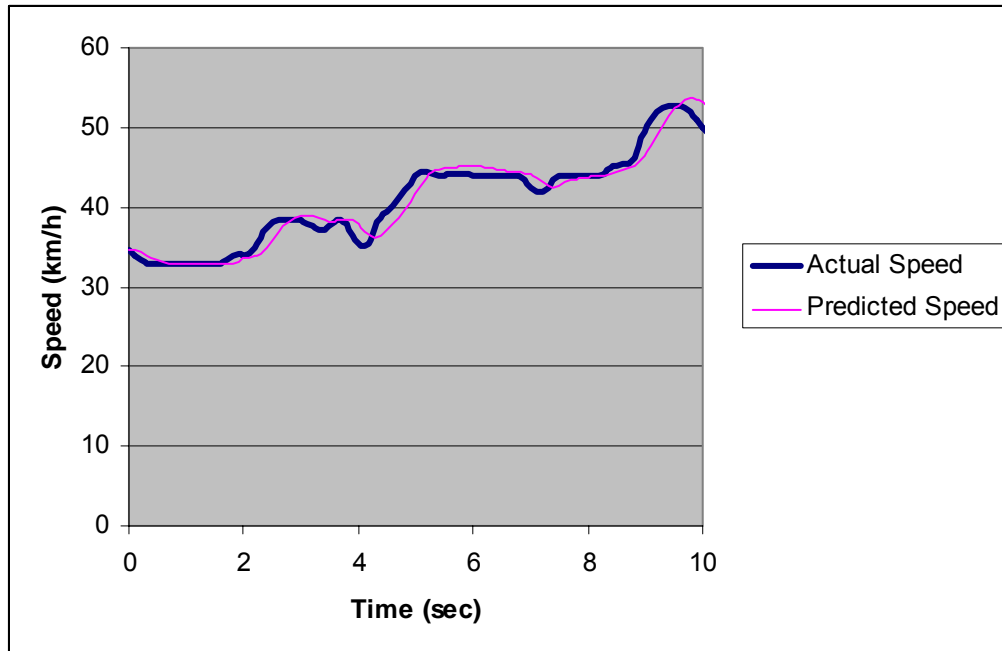
Coefficients^{a,b}

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	Age	.017	.002	.846	10.184	.000
	Gender	.159	.153	.086	1.034	.031

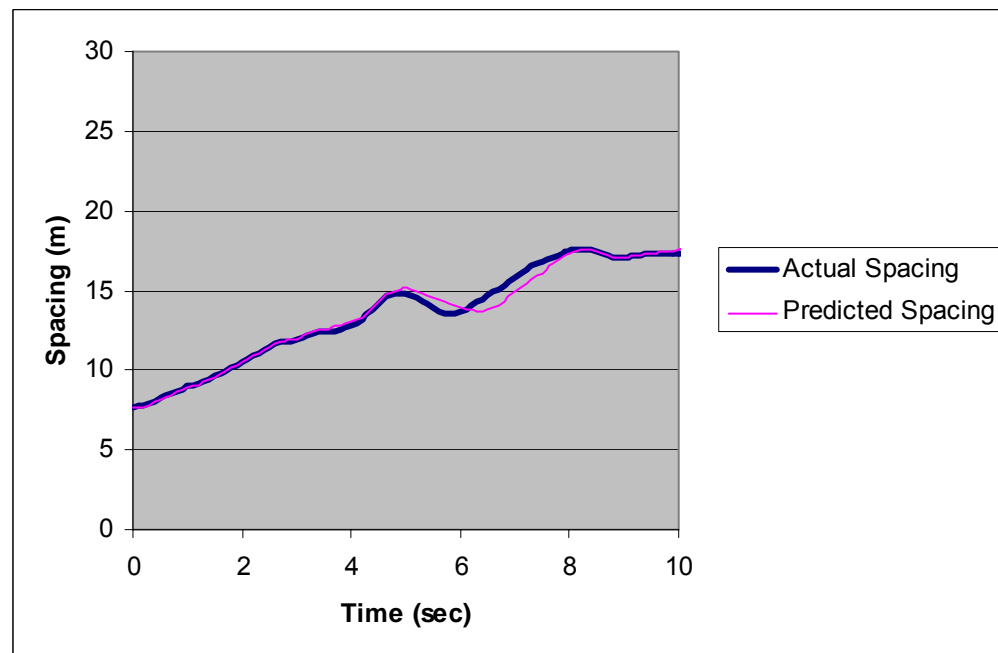
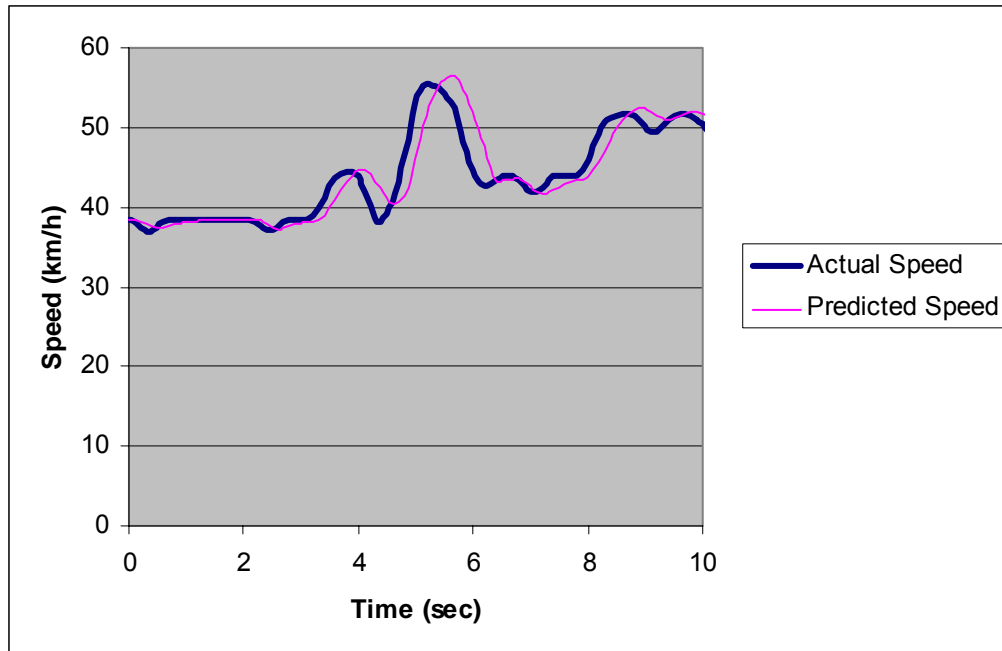
- a. Dependent Variable: AC.RT
 b. Linear Regression through the Origin

Appendix J

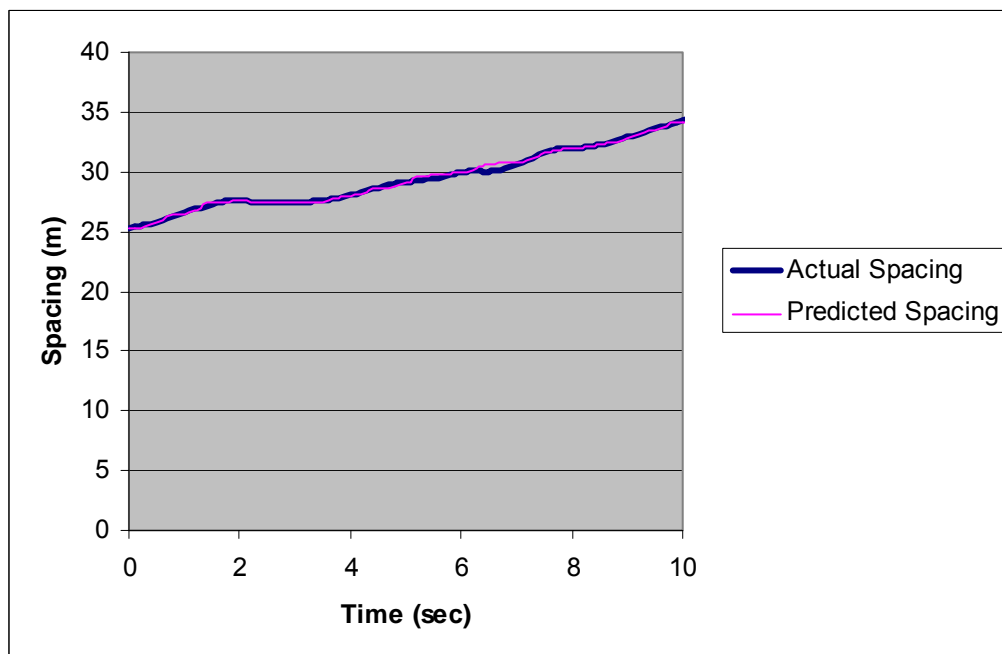
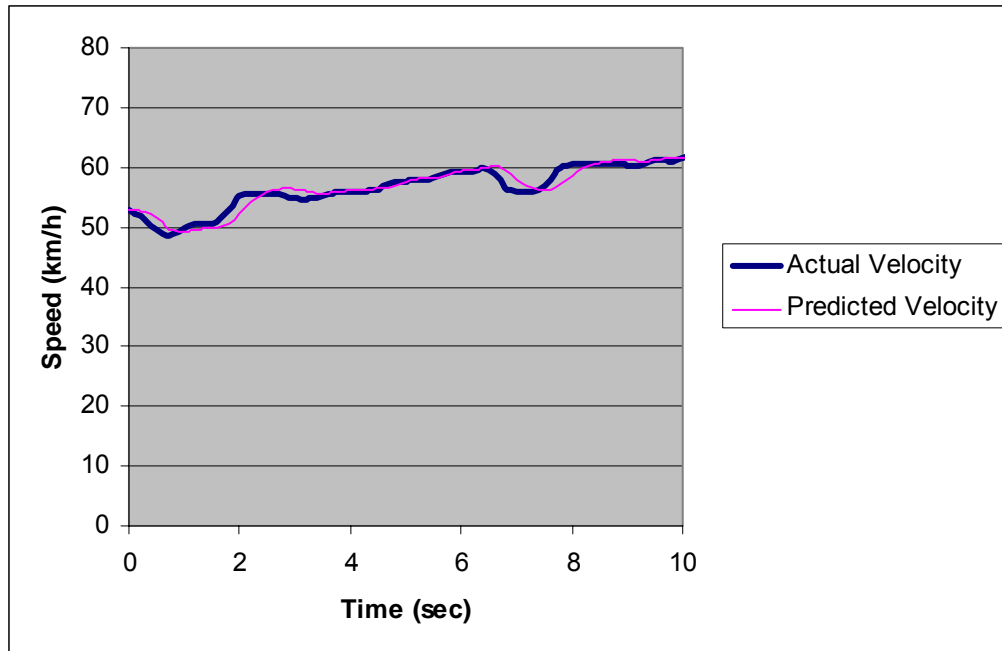
Qualitative Validation of Spacing and Speed Profiles (5 Samples)



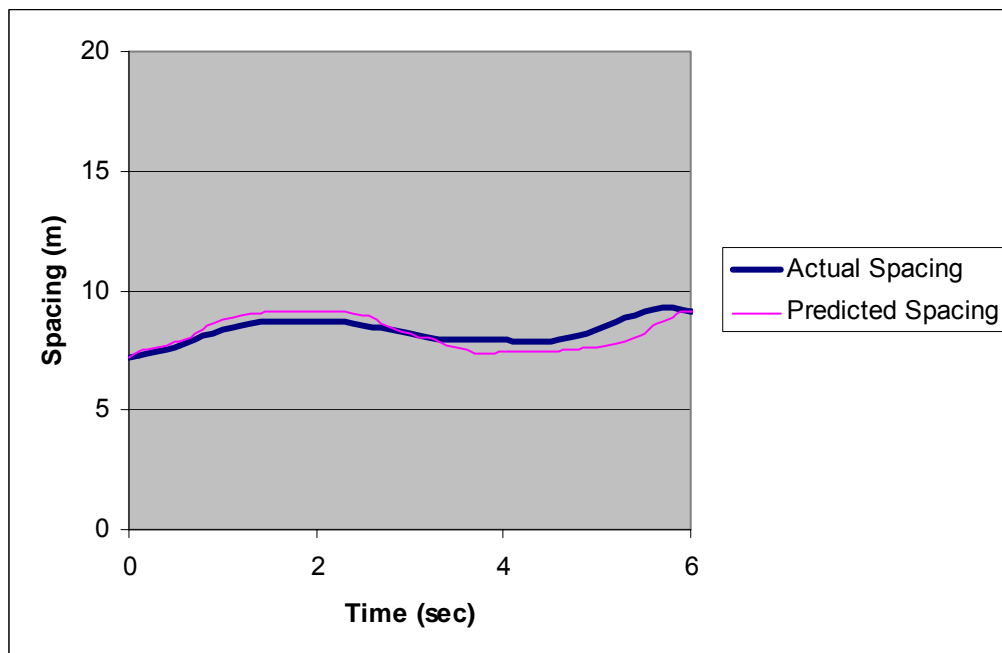
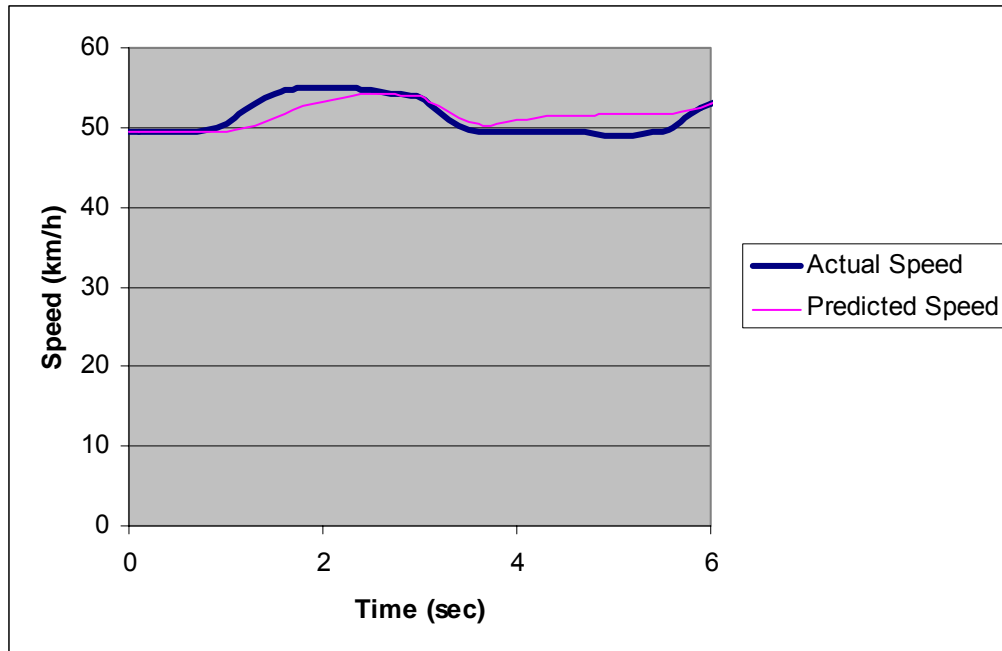
Speed and Spacing profile of Sample 1



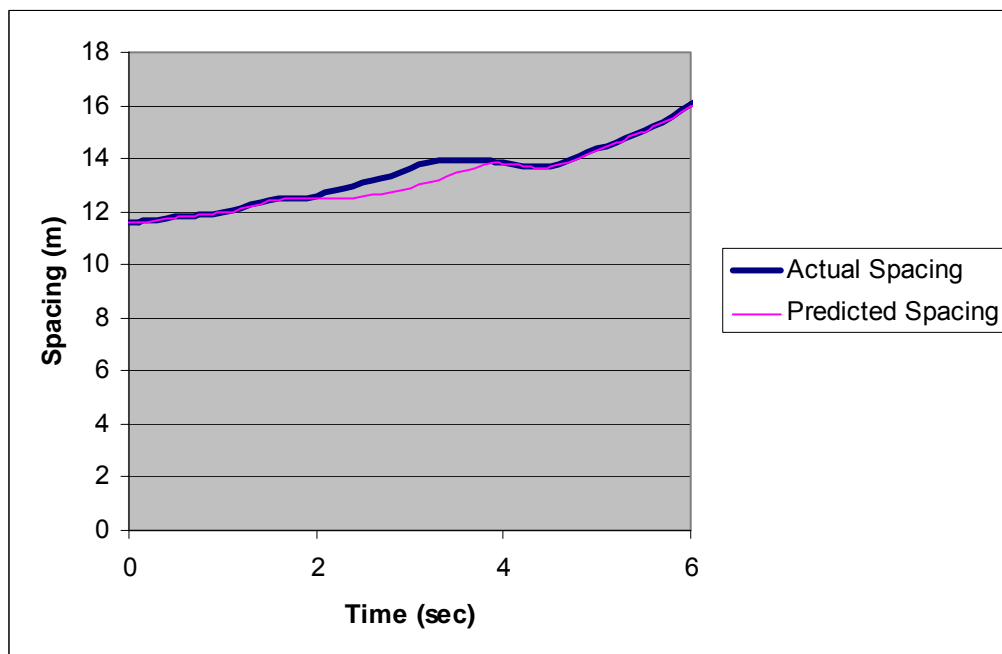
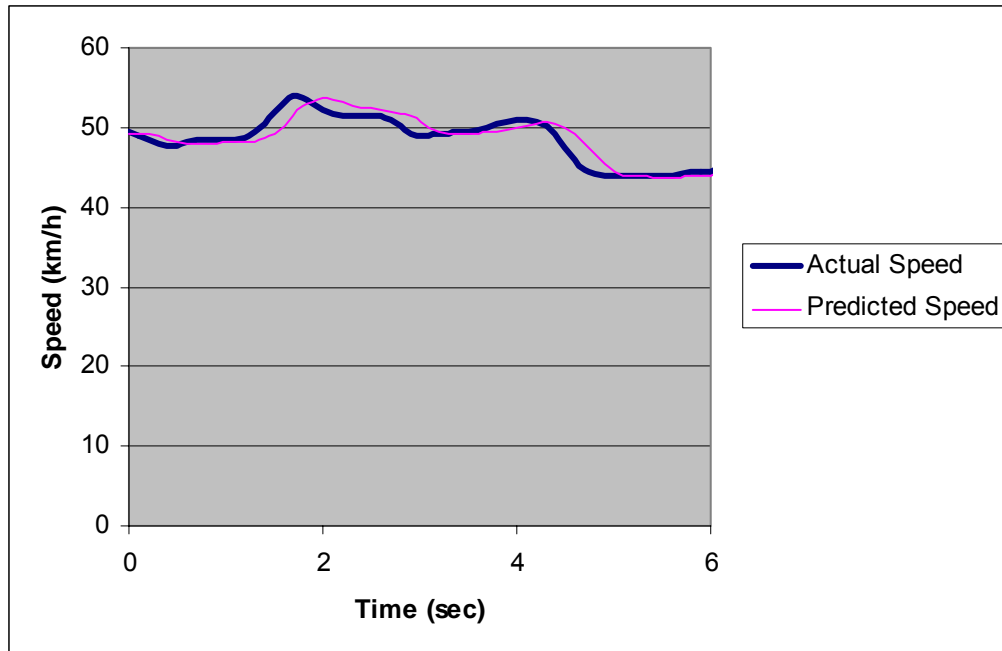
Speed and Spacing profile of Sample 2



Speed and Spacing profile of Sample 3



Speed and Spacing profile of Sample 4



Speed and Spacing profile of Sample 5