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# ANTICIPATORY HEART RATE RESPONSES OF MOTOR VEHICLE DRIVERS RIDING AS PASSENGERS

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The heart rate of drivers and non-drivers was recorded while they were being driven around a circuit on public roads for the experiment described in this research note. As the vehicle negotiated a "hazard", the heart rate of the drivers increased markedly, while the heart rate of the non-drivers did not.

A second study showed similar but smaller differences between experienced truck drivers being driven around a course by newly qualified drivers, and experienced drivers being driven by other experienced truck drivers. Those

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20. Abstract (continued)

driven by the newly qualified drivers had the higher response.

A third study showed an elevated response in a group of trainee truck drivers over a nine-day course of instruction.

These findings are discussed within the wider context of shared driving on long journeys.

## Introduction

Zeier (1979) has argued that a promising approach for elucidating the functioning of complex person-machine-environment systems, such as motor vehicle driving, is to record concurrent physiological activity while subjects are actually performing the driving task. This strategy has been used in studying the role of various parameters affecting car driving, such as traffic events (Helander 1974), traffic density (Dilling et al. 1974), road conditions (Helander 1976), speed (Zeier and Battig 1977), long-term driving (O'Hanlon and Kelley 1977; Fagerstrom and Lisper 1977), night driving (Caille and Bassano 1977; Riemersma et al. 1977), and heat stress (Mackie and O'Hanlon 1977).

This approach was adopted by Lisper, Laurell & Stening (1973) when investigating the effects of experience of the driver on heart rate, respiration rate and subsidiary reaction time over a three hour continuous driving task. From accident statistics, a difference was hypothesised between experienced and inexperienced drivers in vulnerability to continuous driving. This difference was used as a basis for a comparison of changes in autonomic measures and reaction time over driving time. The results showed statistically significant effects of experience on both types of measure. The reaction time data pointed to inexperienced drivers being more vulnerable to long term driving than experienced drivers. However, the autonomic variables of heart rate and respiration rate pointed in the opposite direction in that there was a tendency for experienced drivers to have a faster and more extensive decrease of level of activation than inexperienced drivers. This contradiction was resolved with reference to statistical data and validation of the reaction time task. Hence, reaction time was preferred to the autonomic measures, but careful note was made of the requirement for more thorough study of the relation between behavioural and physiological measures.

James & Goldman (1971) carried out a study which examined driver behaviour through an intersection controlled by a traffic signal. The purpose of the study was to discover if driving behaviour varied according to the size of the vehicle driven, the sex of the driver, the presence or absence of passengers, time of day and the presence or absence of precipitation. In general, the results showed that drivers without passengers were less cautious than those drivers with passengers.

However, little attention has been paid to the responses of passengers while travelling, particularly passengers with experience of driving. Questions arise as to whether such passengers react to road and traffic conditions, if such arousal can be detected by means of the heart rate response, and if responding is mediated by driving experience. These issues may be of importance in situations such as long distance coach driving, where a relief driver rests while the vehicle is in motion. A similar situation can occur during the family holiday that involves long distance driving. Often the driving task is shared, with one partner driving and the other 'resting' as a front seat passenger. These considerations led to the following studies.

Study 1.

In order to test the proposition that a driver travelling as a front seat passenger would respond differently from a non-driver, Magowan (1974) observed the heart rate of five drivers and five non-drivers when being driven over a short circuit of public roads. The subjects were male undergraduates, aged between 20 and 23 years. The vehicle employed was a 1971, 3.5 litre Rover automatic, driven by an experienced university chauffeur. Prior to being driven round the circuit, a basal heart rate record was obtained for each subject in the laboratory.

The circuit round which each subject was driven contained the following features:-

1. A left turn from a major to a minor road.

2. A right turn from a minor to a major road.

3. A traffic light controlled pedestrian crossing.

4. A right turn from a major road to a minor road.

5. A 90 degree bend.

6. A left turn from a minor to a major road.

For each of these 'hazards', arbitrary approach and exit points were selected from the existing kerbside features. These points, such as lamp standards, trees, telephone poles etc., were marked with chalk and were used as reference points for recording heart rate response. (The term 'hazard' should not be construed in the sense of an 'accident black spot' but as any road feature which may require a driver to undertake some manoevure, such as to change speed or direction). Heart rate was recorded during the time the vehicle took to travel between the approach and exit marks for each hazard. These observations were expressed in terms of percentage deviation from resting level.

The results are shown in Figure 1. For the group of drivers, the mean percentage heart rate change over the six hazards increased by 7.59%, whereas the heart rate response for non-drivers increased by only 2.58% ($F=12.44$, $p=0.003$). These observations would appear to support the notion that drivers travelling as front seat passengers are less relaxed than non-drivers.

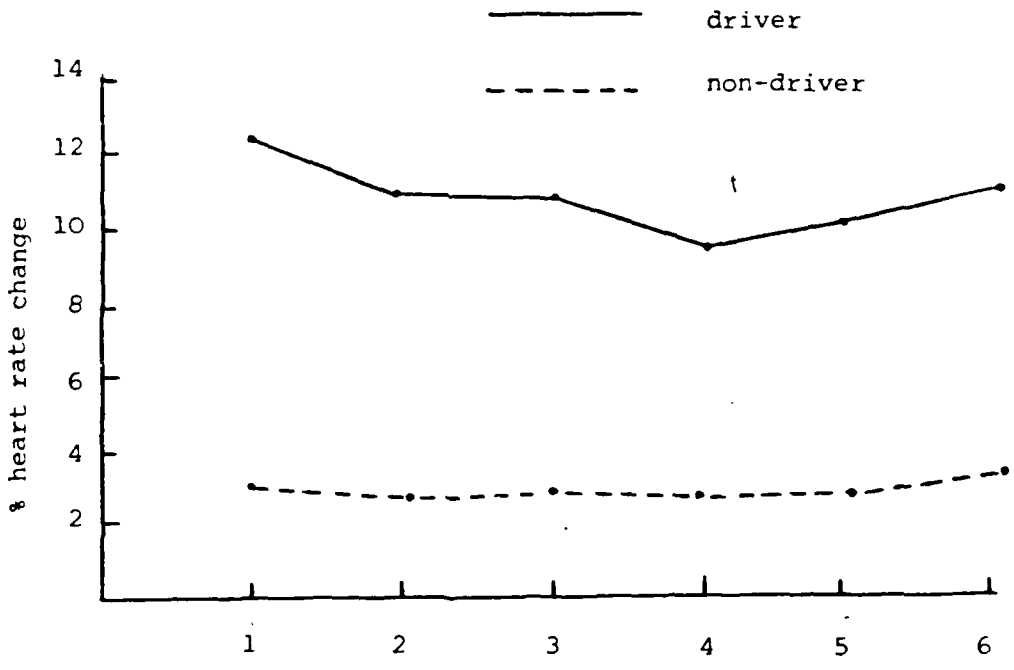


Fig 1 Mean percentage heart rate change for drivers and non drivers

Study 2.

Using the same circuit and procedure as in Study 1, Henderson (1975) observed the heart rate responses of eleven experienced heavy goods vehicle drivers, while they were riding as front seat passengers in a 3 ton minibus. The subjects and the vehicle were provided by the Northern Ireland Road Transport Industry Training Board. All the subjects were male. A group of five subjects was driven by other experienced heavy goods vehicle drivers, whereas a second group of six subjects was driven by newly qualified heavy goods vehicle drivers.

The results are shown in Figure 2. The group driven by newly qualified drivers demonstrated a mean elevated heart rate response of 9.33% across the six hazards, whereas the heart rate response of the group driven by other experienced drivers increased by only 4.25% ($F=5.87$, $p=0.025$). This study would seem to demonstrate that the heart rate response of an experienced driver riding as a front seat passenger is influenced by his perception of the experience of the driver of the vehicle.

Study 3.

In a further study, Moore (1976) examined how the heart rate response developed during the training of heavy goods vehicle drivers. The exigencies of the training programme made it impossible to design a trial, but she was able to observe eight male trainee drivers while under instruction. These were selected by the Northern Ireland Road Transport Industry Training Board and the observations took place on the Board's practice circuit.

Since testing sessions could not interfere with the training programme, testing occured after the morning training session and finished before the afternoon training session began. The time available for testing was approximately one hour per day.

There were three different lengths of instruction course i.e. 8, 9, and 10 days. The length of the subject's course was determined by an assessment of his capability by a senior instructor.

Prior to testing, a basal or resting heart rate of each subject was taken. Heart rate recordings were taken of each trainee while they were being driven round the circuit by a fellow trainee in a heavy goods vehicle. These observations of heart rate were expressed as a percentage deviation from resting level.

The circuit contained examples of the main hazards that a driver would experience during normal driving i.e. crossroads, intersections, steep

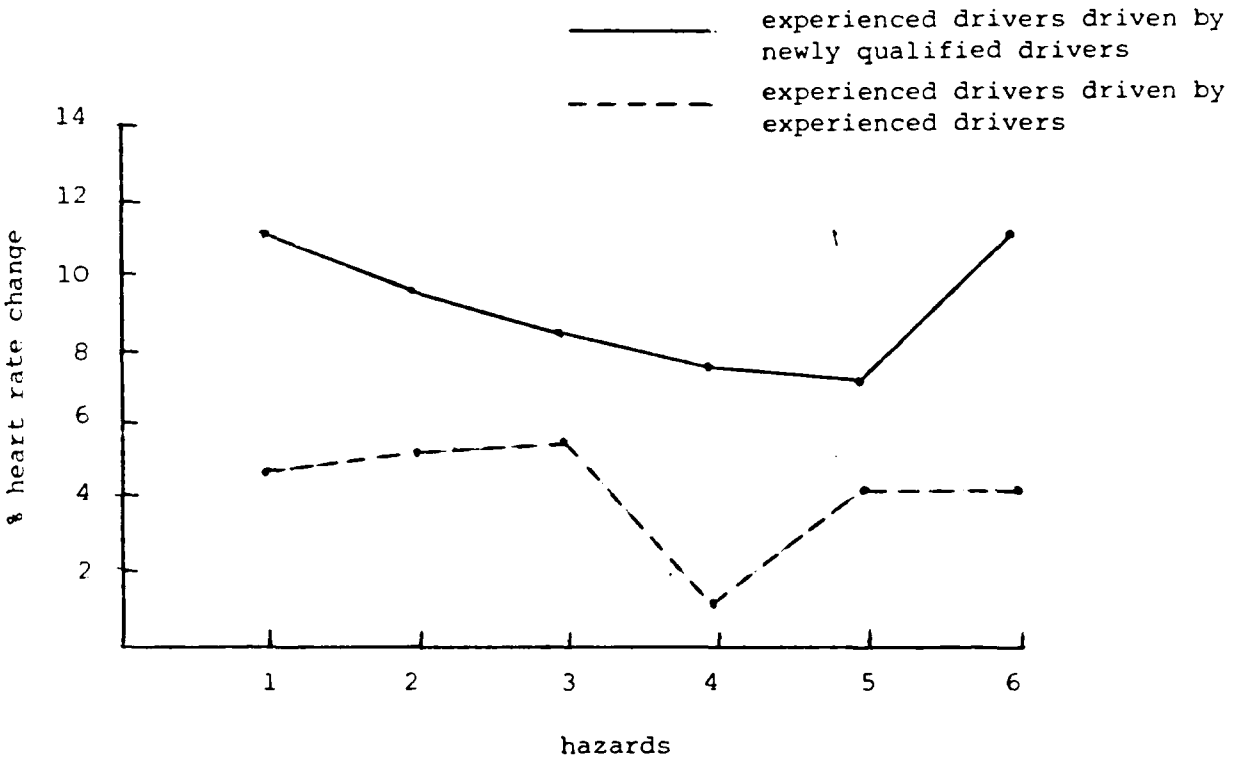


Fig 2 Mean percentage heart rate change for experienced drivers driven by newly qualified drivers and experienced drivers driven by experienced drivers

hills and a roundabout.

A route on the practice circuit was chosen with the aid of a senior instructor to ensure a good variation of hazards, and arbitary approach and exit points for each hazard were marked with cones. Heart rate was recorded during the time the vehicle took to travel between the approach and exit cones for each hazard.

Eight hazards were selected, and each subject experienced them in the following order:-

1. A left turn from a minor to a major road.

2. A 360 degree turn at a roundabout.

3. A 1/2 mile length of major road.

4. An extreme left turn from a major road to a secondary road , with the added hazards of two converging manoeuverability areas.

5. A right turn from a secondary road to the right fork of two converging minor roads.

6. A right turn from the left fork of two converging minor roads to a secondary road, and a left turn from the secondary to the minor road.

7. Negotiating a steep hill.

8. From the left fork of two converging minor roads, crossing a major road, and taking the right fork of two converging minor roads.

The results are presented graphically in Figure 3 for the nine days of recording. Plotted are the daily mean percentage change of heart rate in respect of the passengers over all hazards. Statistical treatment was not considered appropriate because of the small number of subjects, and also because the number of subjects reduced from the eighth day onwards as trainees undertook their proficiency test and left the course. The results show a consistently high elevation of heart rate in passengers of around 30% throughout the training period. Two factors probably contributed to the relatively high heart rate response of these subjects, namely, that the subjects may have had little regard for the driving skill of their fellow trainee, and that the training context could itself have been highly arousing.

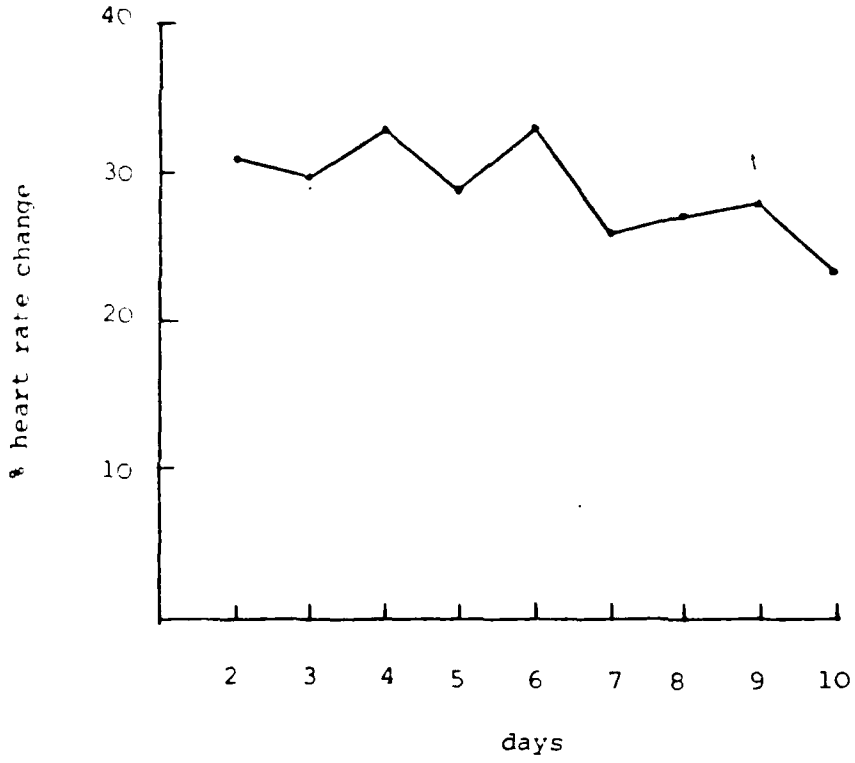


Fig 3 Mean percentage heart rate change for trainee truck drivers over a nine day period

## Discussion

In this series of studies, an elevated heart rate response was observed in front seat passengers when:-

a) the passenger was a fairly inexperienced driver (Study 1);

b) an experienced driver was being driven by a less experienced driver (Study 2);

c) both the passenger and driver were inexperienced in driving a particular type of vehicle (Study 3).

Conversely, the heart rate response of front seat passengers showed little increase when:-

a) the passenger was a non-driver (Study 1);

b) an experienced driver was being driven by another driver of similar experience and/or by a driver in whom the passenger had confidence (Study 2).

Although further controlled studies would be necessary to test these propositions, it would appear that this series of observations could have some implications for safety, particularly in situations where drivers share the driving task on long journeys and also attempt to rest while riding as front seat passengers. It would seem that the practice of drivers attempting to rest while riding as front seat passengers may not be prudent, unless both drivers have equivalent and substantial experience and/or considerable confidence in each others driving.

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