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Improving long term driving comfort by taking breaks – How break activity affects effectiveness

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ABSTRACT

During long duration journeys, drivers are encouraged to take regular breaks. The benefits of breaks have been documented for safety; breaks may also be beneficial for comfort. The activity undertaken during a break may influence its effectiveness. Volunteers completed 3 journeys on a driving simulator. Each 130 min journey included a 10 min break after the first hour. During the break volunteers either stayed seated, left the simulator and sat in an adjacent room, or took a walk on a treadmill. The results show a reduction in driver discomfort during the break for all 3 conditions, but the effectiveness of the break was dependent on activity undertaken. Remaining seated in the vehicle provided some improvement in comfort, but more was experienced after leaving the simulator and sitting in an adjacent room. The most effective break occurred when the driver walked for 10 min on a treadmill. The benefits from taking a break continued until the end of the study (after a further hour of driving), such that comfort remained the best after taking a walk and worst for those who remained seated. It is concluded that taking a break and taking a walk is an effective method for relieving driving discomfort.

1. Background

When drivers stop at highway service stations they can be observed undertaking different activities. Some choose to remain seated in their vehicles, possibly performing ‘mobile office’ tasks; many choose to walk to a café and sit for a few minutes drinking a coffee; some might take a pet dog for a short walk or play active games with children (e.g. Sammonds, 2016). It is reasonable to question whether the choice of task affects the effectiveness of taking a break from driving.

The field of driver vehicle ergonomics has, in recent years, placed large emphasis on designing seats for driver comfort. Driver comfort has developed from being considered a luxury to a requirement (Kolich and Taboun, 2004) and a comfortable seat now plays a crucial role in the perception of a vehicle's overall quality (Kyung et al., 2008, Kyung and Nussbaum, 2008). As a result, manufacturers have been pursuing more effective methods to improve seat comfort as this is seen as a direct approach to gain an advantage in the market.

Regardless of how well a seat has been designed using today's technologies, the occupant will become uncomfortable after many hours of driving (Mansfield et al., 2015; Sammonds et al., 2017) or travelling as a passenger (Hiemstra-van Mastrigt et al., 2016). When this happens the driver needs to manage their own discomfort and may employ strategies to feel refreshed. One of the methods proposed in order to combat the negative effects of long term driving is to implement breaks into a drive. The benefits of in-seat activities like eating and drinking have been reported for airline travel, but a more effective action is to take a walk around the aircraft cabin (Hiemstra-van Mastrigt et al., 2016). Drivers are encouraged to take breaks when undertaking a long term drive to combat the issues surrounding tiredness and safety (Horne and Reyner, 1995, 1999), but breaks from driving may also have a positive impact on driver discomfort. A break from driving provides the driver with the opportunity to alter their posture whilst away from the driving task and in turn, relieves pressure on compressed body parts, increasing blood flow to areas of the body that may be causing discomfort. Ravnik et al. (2008) established that discomfort could be reduced to almost zero during a 15 min break that followed 100 min of driving; suggesting that breaks from driving may have a positive impact on

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discomfort.

As the vehicle is a dynamic environment, vibration exposure is a key-contributing factor to long-term discomfort experienced by drivers (Mansfield et al., 2014). Breaks from vibration exposure may allow the negative effects of vibration exposure on discomfort to be reduced following the cessation of vibration. Yonekawa et al. (1998) investigated the effects of rest time on Temporary Threshold Shift (TTS) due to intermittent vibration exposure when using hand held tools. The authors proposed rest time of 5 min by the Labour Ministry in Japan should be increased to 10 min in order to allow for full recovery of TTS.

If the benefits of taking a break from a long-term drive and the associated vibration exposure can be well defined there may be a wide range of implications. The effect of taking a break from whole-body vibration exposure on discomfort is not well documented, although Dunstan et al. (2012) showed reductions in blood glucose and insulin for overweight/obese adults if they took breaks from sitting in a domestic setting. The US Nurses Health Study cohort showed that even small levels of activity whilst sitting can be associated with improved health outcomes, and that the most sedentary 'activity' (watching TV) is associated with increases in obesity and type 2 diabetes (Hu et al., 2003). There are many industries where taking breaks could be optimized for effectiveness. For example, drivers operating heavy machinery as part of their job have been known to work throughout the duration of a day with no breaks (Kuijt-Evers et al., 2003), out of choice (e.g. working through a lunch 'hour' so that they can finish work an hour early). Such drivers are exposed to greater magnitudes of vibration when compared to normal road users and if the benefits of taking a break from vibration exposure can be determined, there are potential implications for a range of environments outside of normal road driving.

This paper reports the results of a study that evaluated the effectiveness of taking breaks during a long term drive in order to fully understand how altering the driving posture and cessation of vibration exposure can influence driver discomfort. It aimed to determine these effects both subjectively and objectively via the use of discomfort rating scales and an objective measure of discomfort (Seat Fidgets and Movements) that was shown to be successful in Sammonds et al. (2017).

2. Methodology

10 regular drivers (7 males and 3 females) from the local and student population of Loughborough University were recruited to take part in a laboratory experiment. Participants were required to be aged between 18 and 65, and held a UK driving license at the time of participation. Participants completed a health screening questionnaire prior to participation in the study to establish if any had experienced musculoskeletal disorders in the past. Participants with a history of musculoskeletal disorders were excluded from taking part. Participants were naïve to the purpose of the study before taking part and were not informed until debriefed after all sessions were complete. The study was approved by Loughborough University Research Ethics Committee.

Each participant completed three trials each of which occurred on a separate day. Due to practical constraints it was not possible to control for day of week which has been suggested as a confounder (Bazley and Vink, 2016). Each trial had a duration of 130 min that consisted of 60 min driving, a 10 min break, followed by a further 60 min of driving using a moving-base driving simulator. Participants provided subjective ratings of discomfort verbally whilst driving via a 2 part discomfort rating scale at regular time intervals; 0, 2, 10, 20, 30, 40, 50, 60, 62, 70, 72, 80, 90, 100, 110 and 120 min. Participants were trained in the use of the discomfort rating scales prior to the study; the scales were positioned in the participants' field of view whilst driving. Part one of the discomfort scale focused on local discomfort and part two focused on overall discomfort (Fig. 1). Part one includes the 6-point discomfort scale as defined in ISO 2631-1 (1997) and part two utilizes a newly developed discomfort rating scale adapted from the Borg CR100 scale (Borg and Borg, 2002) and implemented in Mansfield et al. (2015), Sammonds (2016) and Sammonds et al. (2017). One of the main purposes of part one was to act as a primer for part two, i.e. participants were systematically guided through a process of comfort evaluation. Therefore the results reported in this paper focus on the scale in part two. Participants were not interrupted from the driving task to provide discomfort ratings; this was to ensure that the only break from driving occurred in a controlled manner. Prior to participation in the study, participants' age, height and weight were recorded in addition to temperature (°C) and relative humidity (%RH) of the laboratory (Table 1).

Vibration exposure was simulated using a Rexroth Hydraudyne B.V Micro Motion 600-6DOF-200MK5 multi-axis vibration simulator (MAVIS) located at Loughborough University. Subjects were exposed to multi-axis vibration with an r.s.s. magnitude of 0.25 m/s^2 r.m.s. The vibration was a replay of 6-dof motion at the floor of a car driving on a rough city road, and was adjusted in magnitude to represent a similar experience to a typical urban drive.

The driving rig replicated dimensions from a current production vehicle and included the seat and steering wheel (Fig. 2).

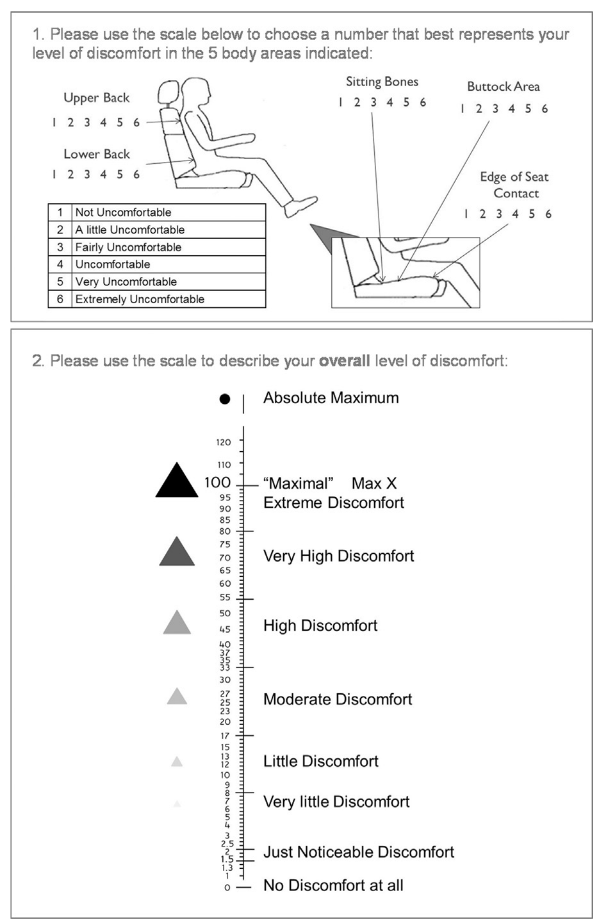

Fig. 1. Questionnaire design showing part 1; including the discomfort scale defined in ISO 2631-1 (International Organization for Standardization, 1997) and a description of the body parts analysed, and part 2; including the adapted Borg CR100 scale (Borg and Borg, 2002; Sammonds, 2016; Sammonds et al., 2017).