Young, M. S., Mahfoud, J. M., Walker, G. H., Jenkins, D. P. & Stanton, N. A. (in press). Crash dieting: The effects of eating and drinking on driving performance. Accident Analysis & Prevention.

Crash dieting: The effects of eating and drinking on driving performance

Mark S. Young*, Janina M. Mahfoud, Guy H. Walker, Daniel P. Jenkins, and Neville A. Stanton

Ergonomics Research Group, School of Engineering and Design, Brunel University, Uxbridge, Middlesex UB8 3PH, UK

Tel: +44 (0)1895 266527

Fax: +44 (0)1895 269763

email: m.young@brunel.ac.uk

* - author for correspondence

Crash dieting: The effects of eating and drinking on driving performance

ABSTRACT

Previous research suggests that compared to mobile phone use, eating and drinking while driving is more common and is seen as lower risk by drivers. Nevertheless, snacking at the wheel can affect vehicle control to a similar extent as using a hands-free phone, and is actually a causal factor in more crashes. So far, though, there has not been a controlled empirical study of this problem. In an effort to fill this gap in the literature, we used the Brunel University Driving Simulator to test participants on a typical urban scenario. At designated points on the drive, which coincided with instructions to eat or drink, a critical incident was simulated by programming a pedestrian to walk in front of the car. Whilst the driving performance variables measured were relatively unaffected by eating and drinking, perceived driver workload was significantly higher and there were more crashes in the critical incident when compared to driving normally. Despite some methodological limitations of the study, when taken together with previous research, the evidence suggests that the physical demands of eating and drinking while driving can increase the risk of a crash.

Keywords: driver distraction, crash risk, eating and drinking, workload, simulator

1. DRIVER DISTRACTIONS

With driver inattention contributing to over a quarter of all crashes (Stutts et al., 2005), there has been a surge of interest – both academic and political – in the effects of distraction on drivers and driving performance. However, investigations of the sources of these distractions have to a large extent focused on the myriad and increasing technological innovations available (in particular mobile phones), while ignoring more mundane in-car activities such as eating and drinking, map-reading, grooming, etc. (cf. White et al., 2004). In the case of mobile phones, such is the evidence on their detrimental effects for driving performance that many countries (including the UK) have now passed legislation specifically banning the use of handheld mobile phones while driving. Yet there is no specific offence for taking one's hands off the wheel for more everyday behaviours.

A recent BBC news article (BBC, 2006) put one of these routine distractions into the media spotlight. In the UK since 2000, there have been at least four high-profile and controversial cases of drivers being fined for eating snacks at the wheel. In this paper, we focus on the issue of eating and drinking when driving in order to address the question of whether such activities should give cause for concern, in much the same way as the 'outlawed' mobile phone. Given that mobile phone use is a predominant topic in the driver distraction literature, the following review draws heavily on this research in order to provide a benchmark and a framework for our study.

There is a small amount of research evidence to suggest that eating and drinking while driving should be a concern. Most of these studies have been restricted to observing the frequency of such behaviours and their perceived risks, rather than their actual effects on performance. For instance, a widespread survey of drivers in the US by the National Highway Traffic Safety Administration (NHTSA, 2003) found that nearly half of all drivers admitted to eating or drinking at least some of the time, affecting nearly one-third of all trips. Only talking to passengers and operating the radio were more frequent activities. This concords with a later observational study (Stutts et al., 2005), although the numbers are even higher, with nearly three-quarters of drivers seen to be eating or drinking, a slightly higher number talking to passengers, and over 90% operating the radio. In comparison, just over a third used a mobile phone. Thus eating/drinking while driving certainly seems to be a more prevalent activity than phoning and driving.

In light of these behavioural observations, it is perhaps unsurprising that drivers do not perceive eating/drinking as a risk factor. It did not feature in the NHTSA survey amongst the factors which drivers attributed as causing a distraction-related crash. Other research supports this conclusion (White et al., 2004), as drivers perceive eating to be a relatively low-risk activity – equivalent to putting on a seatbelt, sneezing, or taking a hands-free phone call. In comparison, a hand-held phone call is seen to be one of the worst risk factors, whilst smoking, talking to a passenger or listening to the radio are perceived as lowest risk. Furthermore, in both of these studies, there is evidence of an optimistic bias – whereby drivers believe their own risk to be lower than others'. This possibly explains why drivers do not attempt to adapt their behaviour by only eating when stopped, as they would for other, higher-risk activities such as reading or grooming (Stutts et al., 2005).

Despite these conservative risk perceptions of eating/drinking compared to phoning while driving (at least for handheld calls), analyses of crash databases suggest the actual risk is somewhat higher. The study by Stutts et al. (2005) builds on some of their previous research which implicates eating/drinking in a similar proportion of accidents as mobile phone use (1.7% vs. 1.5% respectively). A more compelling association between eating/drinking and crash risk was revealed in an epidemiological study of two years' worth of crash data by Violanti and Marshall (1996). They found that of those drivers who had had a crash, 62.3% of them also admitted to drinking at the wheel, compared to 36.4% in the non-accident group. The frequency of eating was slightly less dramatic, with 50.9% in the accident group as opposed to 42.9% for those who had not had an accident. Compare these data with mobile phone use: 13% of the accident group and 9% of the non-accident group phone and drive. It is noteworthy that a similar study by Redelmeier and Tibshirani (1997) found that mobile phone use was associated with a fourfold increase in crash risk, equivalent to drunk driving.

Thus far, the evidence for or against eating/drinking and driving has been very much indirect, through observations, self-report, and correlations. Indeed, to date the only empirical study into the effects of eating on actual driver performance was conducted by Jenness et al. (2002). They used a simulator to compare eating a cheeseburger with using a CD player, reading directions, or operating a voice-activated phone. Reading and operating the CD led to the most lane-keeping errors, speeding violations and eyes-off-road time. Whilst eating and using the phone did not affect performance to the same extent, it was still worse than the baseline comparison. Similarly, Stutts et al. (2005) in their observational study noted that eating/drinking increased the amount of time drivers had their hands off the wheel and their eyes off the road; preparing to eat and drink also resulted in more lane excursions.

Although we should be cautious in extrapolating from studies of mobile phone use, given the wealth of research in that area it is worth considering its effects on performance by way of analogy. Indeed, in establishing a baseline for the relative risk of mobile phone use, many researchers choose to compare with similar driving activities, such as conversing with a passenger or listening to the radio (Haigney and Westerman, 2001). For instance, Consiglio et al. (2003) found that a conversation with a passenger increased brake reaction times just as much as using a hand-held or hands-free phone, whilst listening to the radio did not have such an effect. They suggest that more everyday distractions need to be investigated lest the case for legislating against mobile phones be challenged: “It is sometimes argued that cellular phones are no worse than other potential distractions drivers encounter routinely, such as conversing with a passenger, eating, drinking, or listening to the radio” (Consiglio et al., 2003; p. 496).

The consensus of opinion is that using a mobile phone when driving degrades driver attention and performance, although the specific effects vary between studies. Some studies have reported that conversing on a cell phone while driving significantly increases driver workload and slows reactions (Alm and Nilsson, 1995; Haigney et al., 2000), even to the point of being worse than drunk-driving (Strayer et al., 2003). Whilst Alm and Nilsson (1995) did not find any effects on headway or lane position, others suggest drivers try to compensate by slowing down or increasing headway (Haigney et al., 2000; Strayer et al., 2003). Moreover, the evidence does little to distinguish between hand-held or hands-free phones, with similar effects on reaction times (Consiglio et al., 2003; Lamble et al. 1999), lateral position and driver mental workload (Törnros and Bolling, 2005; 2006). These findings imply that the effects are due to cognitive competition in time-sharing or divided attention (Spence and Read, 2003), rather than the simple physical interference from handling the phone (cf. Haigney and Westerman, 2001). Nevertheless, some do suggest that using a hand-held phone can affect steering ability (Haigney et al., 2000).

Thus we see that when compared to mobile phone use, eating and drinking while driving is a more prevalent behaviour, is perceived as lower risk, yet can affect performance to a similar extent and is potentially associated with a comparable increase in crash risk. Whilst the distraction effects of mobile phones are attributed to cognitive competition for attentional resources, eating/drinking are necessarily 'hand-held' activities and so may be expected to influence driving more through motor conflicts (cf. Haigney and Westerman, 2001). We do not know, on the basis of available evidence, the specific effects of eating and drinking on driving performance, crash risk, or driver mental workload. It seems that eating or drinking can have a significant adverse effect on vehicle control – in line with that of using a hands-free phone. The present study sought to clarify these effects further, by testing driver performance in critical situations using a driving simulator.

2. METHOD

2.1 Design

Given the lack of specific research directed at objectively assessing the impact of eating and drinking while driving, this study was designed to examine the effects on driving performance and subjective mental workload in a controlled empirical setting. A driving simulator was used to provide a controllable, repeatable environment which allows us to explore these potentially risky conditions in an ethical and safe context.

A fully within-subjects design was used, with the independent variable of eating/drinking compared with a control condition of baseline driving. Thus, all participants drove two separate trials in the simulator. Each trial was divided into five phases in order to structure the eating/drinking events, such that participants alternated between driving normally and driving while eating/drinking. In addition, a critical incident was invoked in both conditions, timed to coincide with the eating/drinking phases, in order to assess driver reactions and potential crash risk. Table 1 illustrates the experimental design; note that the phases were not of equal duration, and the times given are averaged across participants (owing to variations in speed). Order of conditions, as well as order of eating/drinking within the experimental condition, was counterbalanced across participants (i.e., half the participants ate in phase 2 and drank in phase 4; half drank in phase 2 and ate in phase 4).

INSERT TABLE 1 ABOUT HERE

Drawing from analogous research with mobile phone use (reviewed in the Introduction), the dependent variables centred around longitudinal and lateral control, as well as driver mental workload. Data on crashes were also recorded in an effort to quantify the association between eating/drinking and crash risk.

Driving performance measures therefore included speed, lane position, crashes (which were limited to collisions with the pedestrian during the critical incident in order to specifically evaluate the effects of eating and drinking on driver responses), and time-to-contact (TTC, a measure of how close drivers are to the car in front). Each of these variables was recorded continuously throughout the trials by the simulator software (note that TTC refers to whichever car is in front at the time, and is not related to the critical incident). Average (mean) and variance values of speed were treated to statistical analysis; for TTC, the minimum measure was used to infer the safe driving behaviours of participants. For lateral position, a derived measure of instability was used, based on the standard error of the linear regression equation of lane position against distance (see Bloomfield and Carroll, 1996). Rather than analysing mean values for lateral position, the instability measure provides a more judgemental indication of (in)consistency within each driver's run. This is particularly relevant for lane position, when it is not necessarily best driving practice to maintain position in the exact centre of the lane (see e.g., Coyne, 1994). Since the instability measure represents a participant's variability around their own track (rather than the absolute centre of the lane), it ignores distortion due to road curvature and treats the road as 'statistically straight'.

In addition to the primary task variables, subjective mental workload was also assessed using the NASA Task Load Index (TLX; Hart and Staveland, 1988), a widely used multidimensional rating scale technique comprising visual analogue scales on six dimensions (Mental Demand, Physical Demand, Temporal Demand, Performance, Effort, Frustration). The popularity of the TLX is in part due to its simplicity in administration (taking no more than a few minutes to complete) and analysis.

2.2 Apparatus

The Brunel University Driving Simulator (BUDS) is a fixed-base, fully interactive, high-fidelity environment. The simulator retains the look and feel of a normal road going car, using a Ford Mondeo as the donor car, offering a realistic and immersive experience. The visual scene is projected in VGA onto a large forward screen at 1024x768 pixel resolution, providing a field-of-view at the driver's eyepoint of approximately 60 degrees horizontal and 40 degrees vertical. Audio is reproduced in Dolby Pro Logic, with a low-frequency subwoofer under the car to suggest vibration. There is authentic haptic feedback via a games console steering wheel which has been integrated in the vehicle's steering column (thus the technology is transparent and the driver interacts with the vehicle's original steering wheel and controls). These controls are connected to the simulation computer, running STISIM Drive software version 2.06.04. The computer is equipped with a 1.2GHz processor, CreativeT 3D video acceleration, high specification NVIDIA GeForce2GTST hardware and CreativeT audio hardware

2.3 Simulator scenarios

The driving scenario was a representative urban environment, single-carriageway two-way road consisting of a mix of curved and straight sections (11 curves for a total of 1.75km), and with considerable levels of traffic, pedestrians and parked cars (eight vehicles in the driver's lane, 87 oncoming vehicles, 142 parked cars and 61 pedestrians). Along the route, there was a consistent backdrop of high-rise buildings and trees along both sides of the road. The vehicle dynamics were set up to mimic the Ford Mondeo saloon car used as the simulator vehicle (e.g., acceleration / deceleration rates of 0.35g and -0.65g respectively), data for which were provided by Robson (1997). Automatic transmission was used with upshifts occurring at a maximum 5000RPM. The route was approximately 9.75km long, which at the posted speed limit would take 438s to complete (in actual fact, variations in speed meant that the average time to completion was 553s). The driving lane was 4.5m wide.

The critical incident of the experimental design constituted a pedestrian walking in front of the car, triggered by the car passing a set point on the route (defined at 1920m and 8534m for the two events). To account for variations in approach speed, the pedestrian's walking speed was dependent on the simulated vehicle's speed at the trigger point, and remained constant as they walked across the road. In this way, it was ensured that the car and the pedestrian would coincide unless the driver intervened by braking and/or steering.

2.4 Participants

26 participants (16 male) with a mean age of 37.5 years (SD = 12.9; min = 20; max = 61) were recruited from the driver participant pool maintained at Brunel University.

All held a full UK driving licence for a minimum three years (mean = 18.0; SD = 13.8), and drove on average 12.0 thousand miles per annum (SD = 6944). Participants were paid £10, as well as receiving the food and drinks.

2.5 Procedure

Participants were briefed about the purposes of the study and signed an informed consent sheet prior to the experiment commencing. For obvious reasons, the briefing did not forewarn participants about the critical incident; rather, they were asked to drive as normal paying due regard to the environment. After the briefing, participants were asked to take a seat in the simulator vehicle, and a brief practice run was given to familiarise themselves with the controls. The duration of the practice run was variable, depending on the participants' feeling happy to continue.

Following the practice run, the two experimental trials took place. In both conditions, participants were asked to drive as they normally would, and were asked to keep their speed within the posted limit of 50mph (80km/h). The task was to follow a lead vehicle, which was programmed to match speed with the subject vehicle and keep a lead distance of 250ft (76.2m). Only in exceptional circumstances should they drive in the right-hand lane (bearing in mind this was a UK study, thus participants were driving on the left); high levels of oncoming traffic discouraged this. With the exception of one bicycle in the scenario, no overtakes were necessary given the flow of traffic. At the pre-programmed points, the pedestrian walked out in front of the car to simulate the critical incident; this occurred once in phase 2 of the trial and again in phase 4. The trial did not pause between phases, but a short break was given between trials. As stated above, the whole trial took on average approximately nine minutes to complete, and the NASA-TLX was administered following each trial.

During the eating/drinking condition, participants were instructed to take their food or drink shortly (i.e., a few seconds) prior to the critical incident. The proximity to the critical incident ensured that participants would still be carrying out the task as they encountered the pedestrian. In accordance with the experimental design, this occurred in phase 2 and phase 4 of the trial – once for food and once for drink (depending on the appropriate counterbalancing). The eating/drinking task consisted of a simple snack (i.e., packet of sweets, bottle of water – both of which were sealed), which participants had to open and consume on instruction from the experimenter. Once they had passed the pedestrian, participants finished consuming whatever they had started and carried on driving as normal. Note that they were not required to finish the entire packet/bottle.

At the end of the experiment, participants were given a debriefing (with particular explanation about the critical incident) and reimbursed for their participation. Ethical procedures of Brunel University were adhered to at all times.

2.6 Data reduction and analysis

In all analyses, the primary driving data were filtered for a short time following crashes to allow participants to revert back to their prior behaviours (i.e., criterion levels of speed and lane position). Specific filtering criteria for each participant depended somewhat on expert judgement, since it was important to determine when participants reached their own average speed and lateral position prior to the crash. Typically, this would mean filtering around 10s worth of data.

The counterbalanced nature of the design (as presented in Table 1) makes it possible to conduct overall analyses of the performance and workload variables across the two experimental conditions (i.e., control vs. eating/drinking) with a 69% chance of detecting medium effects, rising to 97% for detecting large effects (Murphy and Myors, 2004). Thus paired-samples t-tests were conducted for each of these variables. Analyses within each condition (i.e., across the five phases of the drive) were not informative due to the different durations of each phase, and were in any case unnecessary within the experimental design given the overall level of analysis (that is, any effects of eating and drinking should be revealed in the overall analyses).

The only exception is in terms of the crash data, since in order to be truly comparable, only crashes with the pedestrian during the critical incidents were analysed. These frequency data required the use of a non-parametric procedure, namely the Wilcoxon matched-pairs signed-ranks test. The corollary is that relative to the tests used elsewhere in this paper, statistical power is slightly reduced. Thus a medium effect size, for example, becomes more difficult to detect.

For the TLX, the raw scores were treated to analysis, with the simple mean constituting overall workload (as advocated by Hendy et al., 1993). This overall workload score was subject to analysis (again using t-tests), while the subscales were further treated to multiple regression in order to determine the factor loadings on the overall workload scale.

3. RESULTS

Paired samples t-tests for mean speed, speed variance, lateral instability and minimum TTC did not reveal a significant result for the effect of eating/drinking. The effect size, R_{bis}, ranged from 0.11 to 0.26, which is indicative of a small effect on mean speed, speed variance, lateral instability and minimum TTC as a result of eating/drinking whilst driving. Summary data for these variables across all the trials are given in Table 2.

INSERT TABLE 2 ABOUT HERE

Analysis of the crash data, which just compared crashes with the pedestrian during the critical incident, revealed a trend towards more crashes in the eating/drinking condition (17 in total; M = 0.7; SD = 0.69) than there were in the control condition (9 crashes; M = 0.35; SD = 0.49). This apparent difference was supported statistically at the 10% level using the Wilcoxon matched-pairs, signed ranks procedure ($W = 37.5$; exact two-tailed $p = 0.09$). Despite the reduced statistical power of the non-parametric test, an approximate measure of the effect size was obtained: $R_{bis} = 0.34$. This figure is indicative of a medium effect size for crashing in relation to eating/drinking whilst driving, and is a larger effect than that obtained from the driving performance variables. Breaking down the data further to examine whether eating or drinking themselves have differential effects on driving performance did not reveal any further significant results. Notwithstanding such findings, the descriptive data imply that with an increased sample size, there may be a greater effect of eating than drinking on crash frequency (see Table 3).

INSERT TABLE 3 ABOUT HERE

Finally, a paired-samples t-test was carried out on the overall workload scores of the TLX. The result was significant at the 1% level ($t(25) = 3.41$; $p < 0.005$), with a large effect size being detected ($R_{bis} = 0.56$), indicating higher workload in the eating/drinking condition (mean = 51.9; SD = 17.3) than in the control condition (mean = 42.7; SD = 16.7). To explore the contributions of each subscale of the TLX to the overall workload score, a linear regression analysis was conducted for each condition, entering the six subscales as independent variables in a single step, and using the overall workload score as the dependent variable. The results, in terms of standardized beta coefficients for each subscale, are presented in Table 4. For clarity, we have rank ordered the subscales with regard to their respective factor loadings. The implications of these results are discussed further in the next section.

INSERT TABLE 4 ABOUT HERE

4. DISCUSSION AND CONCLUSIONS

The main findings from this study suggest whilst eating or drinking does not seem to influence driving performance per se, driver mental workload was increased and there is evidence for more crashes when faced with a critical incident. It may therefore be suggested that whilst drivers can adapt to the circumstances and task to a certain extent, such adaptation breaks down during abnormal situations, and comes at a cost of increased workload.

The assumption of driver adaptation to the increased demand is somewhat speculative on the basis of the present study, since the design did not permit a detailed analysis of eating/drinking phases against control phases of driving. Whilst a visual inspection of the data suggested that speeds and variability decreased during the critical phases, and TTC increased (i.e., driving became more ‘cautious’), it has to be recognised that these data are likely to have been influenced by the pedestrian incident. Furthermore, the uneven duration of the phases will contribute to lower variability for the shorter (critical) phases. Nevertheless, the assumption is supported by previous research suggesting that mobile phone use can lead to similar compensatory behaviours (Haigney et al., 2000; Strayer et al., 2003; Tornros and Bolling, 2005; 2006), which is interpreted as being due to increased mental workload.

Mental workload certainly seemed to be a factor in the present study, with a clear effect of eating/drinking on driver self-reports. A more detailed analysis of the TLX subscales allows us to make some inferences about the source of this increased workload, and in particular whether the problem is through cognitive competition for attentional resources, or a fundamental motor conflict (cf. the mobile phone debate; Haigney and Westerman, 2001). Most notably, we observed that the Physical Demand subscale was the lowest factor loading on overall workload for the control condition, but the highest in the eating/drinking condition. Whilst we appreciate that these are subjective data, the suggestion is that eating/drinking increases workload more through motor conflict than cognitive competition – distinguishing this activity from mobile phone use.

Whether or not these results can be extrapolated to interpret the effects on actual performance is a subject for further research, but it is clear that the increased workload of eating/drinking is associated with more crashes in a critical incident. Of course, these two findings are probably related – drivers may have perceived higher workload because they were involved in more crashes. Nonetheless, it seems intuitive that the increased physical workload associated with eating/drinking could be a cause of degraded responses in such emergency situations. Thus, whilst drivers may appear able to cope during normal driving, it is the response to a sudden peak in demands which is affected by the additional activity. Again, these conclusions are in line with previous research on using a mobile phone while driving, which is associated with increased workload, worse reactions and increased crash risk (e.g., Alm and Nilsson, 1995; Haigney et al., 2000; Redelmeier and Tibshirani, 1997).

This study sought to clarify the effects of eating and drinking on driving performance in a representative urban scenario, including dealing with a critical incident. As far as we are aware, there have been few such empirical studies published in the literature (notable exceptions being Jenness et al., 2002, and Stutts et al., 2005). In many ways, then, ours was an exploratory study, and there are some limitations to the present experiment which restrict extrapolation of the findings. The duration of the trial was relatively short, the instructions to eat/drink were rather forced upon the participants (in real driving it is undoubtedly a more self-paced task), and the critical vs. non-critical phases were not comparable. In spite of these, we feel it is a valuable springboard for future research, and there are several theoretical and applied facets of these results which warrant further investigation. One obvious next step is to elaborate on the relative influence of cognitive interference along attentional resource dimensions (e.g., Wickens, 2002) as opposed to the physical and structural interference associated with handling the food and drink. Drivers' compensatory behaviours also require deeper analysis, with regard to the effects on performance during normal and abnormal situations, as well as where and when drivers choose to take a snack.

At the task level, it would be worthwhile delineating which stages of eating/drinking (i.e., locating the item, opening the packaging, consuming, disposing of the packaging) present the highest levels of interference (and thereby risk). If, as is implied by Stutts et al. (2005), preparing to eat has more detrimental effects on driving, practical recommendations could be made regarding the design of packaging and advice for drivers. Such recommendations would perhaps be more realistic than simply prohibiting the activity, as we should also acknowledge potential beneficial effects of eating and drinking on task performance. For instance, the NHTSA survey found that 17% of drivers fight fatigue by taking a coffee or a soft drink, and research suggests that sugary snacks or drinks can indeed help stave off sleepiness and improve lane-keeping performance (Horne and Baulk, 2004; Parkes et al., 2001; Smith and Rich, 1998).

Future research could also particularly investigate the relative demands of eating and drinking at these levels of task performance. Whilst we did not find a statistically significant effect here, the data indicate that eating may possibly have a heavier influence. Conversely, Violanti and Marshall (1996) found that drinking at the wheel was associated with higher levels of crash involvement. More empirical data are required to elucidate whether eating or drinking have differential effects on accident risk.

Taken with previous research, the results of the present study lend weight to the argument that eating or drinking at the wheel can have detrimental effects on driving safety. Since drivers do not necessarily perceive the risk (White et al., 2004), they choose not to modify their eating behaviours (Stutts et al., 2005), and rather rely on adapting their driving (cf. Haigney et al., 2000). Thus snacking at the wheel appears to have little effect on 'normal' driving (Jenness et al., 2002), which may reinforce the driver's risk perceptions. This strategy of adapting driving may be inconsequential during normal driving, but the increased crash risk (Violanti and Marshall, 1996) is realised in the abnormal situation requiring an emergency response, when the increased demands mean drivers are less able to cope. With eating and drinking, it is likely that these demands are largely of the physical rather than cognitive variety, consistent with observations that these activities result in more time with the hands off the wheel and the eyes off the road (Stutts et al., 2005).

Stutts et al. (2005) recommended that "…a better understanding of the role of driver distraction in traffic crashes is most likely to emerge from naturalistic data studies … and a variety of more controlled research studies in laboratory, simulation, or test track environments" (p. 1100). We believe that the present study is the first in the literature to specifically record the effects of eating and drinking on driving performance in such an empirically controlled manner, and to particularly examine reactions to a critical incident. Whilst we may not have answered all of the questions, we feel we have provided a foundation for future research in this area and a platform for further debate. In the meantime, though, the results of the present study in combination with previous research suggest that eating and drinking at the wheel is best confined to the service area.

5. ACKNOWLEDGEMENTS

The authors are grateful to Privilege Insurance who funded this study, and to three anonymous reviewers who provided comments on an earlier version of the paper.

6. REFERENCES

Alm, H., Nilsson, L., 1995. The effects of a mobile telephone task on driver behaviour in a car following situation. Accident Analysis and Prevention, 27(5), 707-715.

BBC (2006). What can you do while driving? Available at: http://news.bbc.co.uk/1/hi/magazine/4788910.stm (accessed 19/7/06).

Bloomfield, J. R., Carroll, S. A., 1996. New measures of driving performance. In: S. A. Robertson (Ed.), Contemporary ergonomics 1996, pp. 335-340. Taylor and Francis, London.

Consiglio, W., Driscoll, P., Witte, M., Berg, W. P., 2003. Effect of cellular telephone conversations and other potential interference on reaction time in a braking response. Accident Analysis and Prevention, 35(4), 495-500.

Coyne, P., 1994. Roadcraft: The police driver's handbook. HMSO, London.

Glass, J., Mitchell, J. E., de Zwaan, M., Wonderlich, S., Crosby, R. D., Roerig, J., Burgard, M., Lancaster, K., Voxland, J., 2004. Eating behaviour and other distracting behaviors while driving among patients with eating disorders. Comprehensive Psychiatry, 45(3), 235-237.

Haigney, D. E., Taylor, R. G., Westerman, S. J., 2000. Concurrent mobile (cellular) phone use and driving performance: task demand characteristics and compensatory processes. Transportation Research Part F, 3, 113-121.

Haigney, D., Westerman, S. J., 2001. Mobile (cellular) phone use and driving: a critical review of research methodology. Ergonomics, 44(2), 132-143.

Hart, S. G., Staveland, L. E., 1988. Development of NASA-TLX (Task Load Index): results of empirical and theoretical research. In: P. A. Hancock, N. Meshkati (Eds.), Human mental workload (pp. 138-183). North-Holland, Amsterdam.

Hendy, K. C., Hamilton, K. M., Landry, L. N., 1993. Measuring subjective mental workload: when is one scale better than many? Human Factors, 35, 579-601.

Horne, J. A., Baulk, S. D., 2004. Awareness of sleepiness when driving. Psychophysiology, 41, 161-165.

Hughes, P. K., Cole, B. L., 1986. What attracts attention when driving? Ergonomics, 29(3), 377-391.

Jenness, J. W., Lattanzio, R. J., O'Toole, M., et al., 2002. Voice-activated dialing or eating a cheeseburger: which is more distracting during simulated driving? In: Bridging Fundamentals and New Opportunities: Proceedings of the 46th Annual Meeting of the Human Factors and Ergonomics Society (pp. 592-596). HFES, Santa Monica, CA.

Lamble, D., Kauranen, T., Laakso, M., Summala, H., 1999. Cognitive load and detection thresholds in car following situations: safety implications for using mobile (cellular) telephones while driving. Accident Analysis and Prevention, 31, 617-623.

Murphy, K. R., Myors, B., 2004. Statistical power analysis: A simple and general model for traditional and modern hypothesis tests. LEA, London.

NHTSA, 2003. National survey of distracted and drowsy driving attitudes and behavior 2002: Volume 1 - Findings. Report no.: DOT HS 809 566.

Parkes, A. M., Sexton, B. F., Burton, S., et al., 2001. An evaluation of the effects of a functional energy drink on post-lunch and early evening driving performance. In: D. V. McGehee, J. D. Lee, M. Rizzo, K. Holeton, T. Lopes (Eds.), Proceedings of the International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design (pp. 70-75). University of Iowa, Iowa.

Redelmeier, D. A., Tibshirani, R. J., 1997. Association between cellular-telephone calls and motor vehicle collisions. New England Journal of Medicine, 336, 453-458.

Robson, G., 1997. Cars in the UK: A survey of all British-built and officially imported cars available in the United Kingdom since 1945. Motor Racing Publications Ltd., Croydon.

Smith, A. P., Rich, N., 1998. Effects of consumption of snacks on simulated driving. Perceptual and Motor Skills, 87(3 Part 1), 817-818.

Spence, C., Read, L., 2003. Speech shadowing while driving: On the difficulty of splitting attention between eye and ear. Psychological Science, 14(3), 251-256.

Strayer, D. L., Drews, F. A., Crouch, D. J., 2003. Fatal distraction? A comparison of the cell-phone driver and the drunk driver. In: D. V. McGehee, J. D. Lee, M. Rizzo, M. Raby and L. Boyle (Eds.), Proceedings of the 2nd International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design (pp. 25-30). University of Iowa, Iowa.

Stutts, J., Feaganes, J., Reinfurt, D., Rodgman, E., Hamlett, C., Gish, K., Staplin, L., 2005. Driver's exposure to distractions in their natural driving environment. Accident Analysis and Prevention, 37, 1093-1101.

Törnros, J. E. B., Bolling, A. K., 2005. Mobile phone use – Effects of handheld and handsfree phones on driving performance. Accident Analysis and Prevention, 37, 902-909.

Törnros, J. E. B., Bolling, A. K., 2006. Mobile phone use – effects of conversation on mental workload and driving speed in rural and urban environments. Transportation Research Part F, 9, 298-306.

Violanti, J. M., Marshall, J. R., 1996. Cellular phones and traffic accidents: an epidemiological approach. Accident Analysis and Prevention, 28(2), 265-270.

White, M. P., Eiser, J. R., Harris, P. R., 2004. Risk perceptions of mobile phone use while driving. Risk Analysis, 24(2), 323-334.

Wickens, C. D., 2002. Multiple resources and performance prediction. Theoretical Issues in Ergonomics Science, 3(2), 159-177.

LIST OF TABLES

	Control condition	Experimental condition
Phase 1 (111.1s)	Drive	Drive
Phase 2 (40.8s)	Critical incident	Eat/drink + critical incident
Phase 3 (317.1s)	Drive normally	Drive normally
Phase 4 (49.7s)	Critical incident	Eat/drink + critical incident
Phase 5 (32.1s)	Drive normally	Drive normally

Table 1: Experimental design, with mean duration of each phase in parentheses

	Mean	SD	t (df)	p
Speed (mph / km/h)	41.7 / 67.1	6.43	-1.34 (25)	0.193
Speed variance	9.17	2.95	0.534 (25)	0.598
Lateral instability	2.70	1.11	-0.777 (25)	0.445
Minimum TTC	0.281s	0.0754	-1.08 (25)	0.291

Table 2: Summary data for driving performance variables across all trials, including t statistics, degrees of freedom (df) and associated p-values for paired t-tests across control and experimental conditions

	Control condition	Experimental condition
Eating phase	7	11
Drinking phase	2	6

Table 3: Crash frequency data decomposed into eating vs. drinking against their respective control trials

Control condition		Experimental condition	
Effort	0.247	Physical demand	0.250
Frustration	0.240	Performance	0.236
Mental demand	0.229	Frustration	0.226
Performance	0.228	Mental demand	0.224
Temporal demand	0.185	Effort	0.218
Physical demand	0.178	Temporal demand	0.195

Table 4: Rank ordering of standardized beta coefficients for TLX regression in each condition