Talking whilst driving: A discussion of the difficulties of dual task performance

Alexander Brown

The need to process two tasks at once in everyday life is both common and sometimes a necessity. In other instances, it is merely convenient, such as talking on a mobile phone whilst driving a car. In some dual-tasking activities there is a deficit in one task or the other as a result of completing the two tasks simultaneously. This article will cover the nature of the dual task of talking while driving and its associated risks, and then attempt to link the constraints found in dual-tasking problems from laboratory studies to explain the deficit found when talking and driving.

Image: Public domain

It is a well-known fact that it is difficult to perform two tasks at once. One such difficulty encountered in everyday life is talking on a mobile phone whilst driving. Whilst this at first may not seem a hard dual-task, there is a marked increase in vehicle accidents as a result of combining these activities. There has been mass media coverage of this problem, with several ad campaigns being produced designed to raise peoples' awareness of the danger of using a mobile phone whilst driving, and current legislation bans the use of hand-held mobiles whilst driving a vehicle. Findings that led to this ban include that of Redelmeier and Tibshirani (1997), who note in their epidemiological study of mobile phone records that there is a fourfold increase in the risk of an accident when using a mobile phone (indeed showing a similar increase in accident likelihood to that of driving under the influence of alcohol). The Mobile Phone Report (2002) showed that braking distances when using a hand-held mobile phone were on average over 14m longer than normal when travelling at 70mph.

The difficulty of driving and talking at the same time may not be present for all aspects of driving however, with little decrease in performance seen on "automatic" aspects of driving. No detrimental effect was found for performance on speed, distance from the middle of the road, the mean decision time at when emerging from side-roads (Spence & Read, 2003), or steering (Brown, Tickner & Simmonds, 1969). Redelmeir et al. (1997) suggest that the driving/talking deficit is not a result of loss of manual dexterity but instead a loss of cognitive and attentional resources. Horswill and McKenna (1999) state that driving studies demonstrate that there is an impairment in risk-taking judgements including judging gaps, close following, and gap acceptance when performing a secondary concurrent verbal task. This suggests that these dynamic risk-taking decisions are not automatic, and indeed the interference caused by completing a verbal task at the same time increases individuals' propensity to take risks.

Treat, Turnbas and McDonald (1977) identify inattention as one of the leading causes in car accidents, and in a study of Israeli bus drivers the link is made between attentional capacity and number of accidents per year (Kahneman, Ben-Ishai, & Lotan, 1973). Kahneman et al.'s study found that the performance of accident-prone drivers' (those who had been involved in more accidents per year compared to their colleagues - unrelated to using a mobile phone) performance was significantly worse on "shadowing tasks" (which requires participants to repeat sentences spoken to them via headphones out loud). Moreover Strayer and Drews (2004) found that even when participants looked directly at objects in the driving environment, they were less likely to create a durable memory of those objects if they were conversing on a mobile phone, suggesting that very little semantic analysis of the objects occurs outside the restricted focus of attention, and supporting the idea that the driving/talking deficit stems from inattention.

Laboratory research into dual-tasking activities provides some explanations into why people experience this inattention to driving whilst talking. McLeod (1978) found that different types of task require different neural resources within the brain and hence two similar tasks completed at the same time are likely to cause interference. This would suggest that the tasks of driving and talking are similar; yet they do not involve the same senses (visual information is thought to contribute around 90% of driving input, (Sivak, 1996)), so it seems McLeod's findings alone are not sufficient to explain the distraction effect. Pashler (1994) took a different approach by breaking mental processing down into three stages; perceptual processing, response selection, and execution. Pashler states that we can deal with two tasks effectively if their outputs are of different modalities (such as movement and speech) or if the input from the task contains different information (as per McLeod's findings). Thus, the interference factor of talking whilst driving must stem from the response selection stage, where the brain is still processing the appropriate response to make to the first stimulus. This effect is dubbed the psychological refractory period (PRP), and is said to be an unavoidable effect that cannot be overcome - a bottleneck in processing. However in Pashler's study his participants are completing single dual-tasks at discrete intervals, rather than continuous dual-tasks such as driving and talking, suggesting there are other factors contributing to the deficit in attention.

Research has shown that some dual-tasks can be modulated by practice. Beilock, Bertenthal, McCoy and Carr (2004) showed that experienced golfers could in fact putt with increased accuracy if their attention was distracted. Also Allport, Antonisa and Reynolds (1972) observed that expert pianists were able to shadow speech whilst sight-reading, with no deficit in their playing. Allport et al.'s study suggests that the pianists have become so skilled and practiced at sight-reading that their brains are able to process other information at the same time as playing. These findings may explain the result that "automatic" driving was unaffected by talking.

Functional Magnetic Resonance Imaging (fMRI) studies show a differentiation in brain activation for tasks that are dissimilar. Adcock, Constable, Gore and Goldman-Rakic (2000) scanned participants completing aural "noun" tasks and visual "space" or "face" tasks and found differential cerebral activation between the tasks, namely activation of Brodmann areas 10/46, and posterior visual areas respectively. These different activations suggest that executive processes are mediated by interactions between anatomically distinct systems. Counter to these results, Just, Kellar, and Cynkar (2008) showed in their analysis of 29 participants at Carnegie Mellon University that there was a 37% reduction in brain cell firing in the parietal lobe (which is associated with spatial processing tasks), when the participants in simulated driving tasks concurrently listened to sentences. In addition to activation of speech areas, there was also a reduction of activity in spatial, visual and motor areas; enough to cause participants to make errors in the simulator. As driving and listening draw on resources from two different brain networks it would be expected from Adcock et al. that these networks could work independently on each task. Just et al. state that their study shows that there is only so much that the brain can do at one time; no matter how different the two tasks are.

The idea of the brain having a limited processing capacity is noted in Wickens's (1984) model of multiple brain resources theory, in which Wickens divides the brain into separate processing areas for auditory, visual, spatial, verbal, manual and vocal input. This model would suggest that a perfect separation of attention should be possible while executing the tasks of driving and talking; driving is visual, spatial and manual, whereas talking is auditory, vocal and verbal. In a revision of the model Wickens (1991) notes some caveats; namely that the model only applies to concurrent tasks (such as holding lane position) and not discrete task performance (such as responding to hazards), and under sufficiently demanding conditions resources can be transferred. The concept of transferral of resources under demanding conditions may explain the results from Just et al. (2008), as the majority of all information used in driving being approximately 90% visual).

In sum, there is clear evidence that constraints on dual task performance exist in the situation of talking whilst driving. This in itself appears to be an attentional problem that adversely affects risk-taking and judgements. Whilst the findings from McLeod (1978) do not help to explain this effect, Pashler's (1994) PRP theory suggests that the root cause of the problem stems from response selection. Beilock et al. (2004) and Allport et al. (1972) provide an explanation for why automatic driving skills are not impaired, and fMRI studies demonstrate that when talking and driving there is reduced activation of the areas used when driving alone, even despite the differences in the modality of the tasks. Whilst the original Wickens model does not explain the interference of talking and driving, the new revised model with additional caveats largely accounts for the effect. The extent to which the constraints on dual task performance identified in the laboratory account for the difficulties people encounter in talking whilst driving appear to be fairly extensive. Indeed, by making use of the laboratory information studies, Spence and Read (2003) have designed systems which help to reduce the effect of the dual-tasking deficit whilst talking and driving; drawing also on recent findings showing that there are extensive cross-modal links in spatial attention.

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