Are Crash Characteristics and Causation Mechanisms Similar in Crashes Involving Fatigue to those Involving Alcohol?

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Abstract
The effect of fatigue on driving has been compared to the effect of alcohol impairment in both driver performance and crash studies. However are crash characteristics and causation mechanisms similar in crashes involving fatigue to those involving alcohol when studied in the real world? This has been explored by examining data held in the EC project SafetyNet Accident Causation Database. Causation data was recorded using the SafetyNet Accident Causation System (SNACS). The focus was on Cars/MPV crashes and drivers assigned the SNACS code Alcohol or Fatigue. The Alcohol group included 44 drivers and the Fatigue group included 47. 'Incorrect direction' was a frequently occurring critical event in both the Alcohol and Fatigue groups. The Alcohol group had more contributory factors related to decision making and the Fatigue group had more contributory factors relating to incorrect observations. This analysis does not allow for generalised statements about the significance of the similarities and differences between crashes involving alcohol and fatigue, however the observed differences do suggest that attempts to quantify the effect of fatigue by using levels of alcohol impairment as a benchmark should be done with care.

INTRODUCTION

The effect of fatigue on driving has been compared to the effect of alcohol impairment in both driver performance and crash studies [1-4]. In law, drivers are considered to be impaired by alcohol if they have a blood alcohol concentration (BAC) greater than the BAC limit defined for that country. This can be measured by a breathalyser and accurately confirmed with a blood test. However, the effect of alcohol on the crash rate differs depending on the age and experience of drivers. For older, more experienced drivers, the crash rate rises from a BAC of 0.5g/l, but for young drivers a smaller amount of alcohol can have an effect and the crash rate rises from a BAC of 0.1g/l [7]. The Oxford English Dictionary [5] defines fatigue as 'extreme tiredness resulting from mental or physical exertion or illness'. However, fatigue is induced in simulator studies by depriving their participants of sleep thus inducing the state of 'sleepiness'. The European Road Safety Observatory (ERSO) review of fatigue in the context of driving [6] states that the terms 'sleepiness', 'fatigue' and 'drowsiness' have been used interchangeably in the literature and that sleepiness can be defined as the neurobiological need to sleep. The ERSO review also suggests that although fatigue can be said to be caused by exertion or the lack of sleep, the effects in terms of a decrease in mental and physical performance capacity are the same. Unlike alcohol, it is very difficult to quantify 'fatigue'. Fatigue is difficult to measure and comparisons with alcohol impairment are made to try and determine the level of impairment fatigue causes in the driving task.

The most accurate way of quantifying what level of fatigue causes impairments of a similar magnitude to alcohol is through simulator studies. It has been estimated that driving after being awake for 17 hours leads to impaired driving skills similar to those observed for a driver with a blood alcohol concentration of 0.05g/l [6]. However simulator tests have shown that although alcohol impairs all aspects of driving, sleep deprivation does not. One study found that sleep deprivation had a negative effect on monotonous tasks, reaction times and multitasking however it had little influence on the performance of more complex cognitive tasks such as logical reasoning and visual searches [1]. Impaired driving increases crash risk and it is well known that alcohol impairment is a cause of crashes. It has been suggested that 25% of crashes in the European Union are as a result of alcohol impairment [7] and it is estimated that fatigue contributes to 10- 20% of crashes [6]. If, by comparing alcohol and fatigue impairment, it can be judged what level of fatigue increases crash risk, guidance or legislation can be developed to limit driving whilst fatigued. However are crash characteristics and causation mechanisms similar in crashes involving fatigue to those involving alcohol when studied in the real world?

This question has been explored by examining data held in the SafetyNet Accident Causation Database. This database was developed as part of the SafetyNet project, a European Commission supported 6th framework project which ran from 2004 to 2008. The database was populated by data collected during accident investigations using on-scene or nearly on-scene methodologies in 6 European countries (Germany, Finland, Italy, the Netherlands, Sweden and the UK) [8]. Causation data was recorded using the SafetyNet Accident Causation System (SNACS) which was also developed as part of the SafetyNet project.

METHODOLOGY

SafetyNet Accident Causation System

The accident model on which SNACS is based states that accidents occur due to a break down in the system comprising of Man, Technology and Organisation [9]. Within the driving context the following definitions apply:

- Man: the driver's cognitive functions; observation, interpretation, planning and actions. Temporary and permanent driver states.
- Technology: the vehicle's equipment and interface; physical driver environment.
- Organisation: road environment, ambient conditions, communication, driver training.

The philosophy behind SNACS is that road traffic crashes are a result of a failure in the dynamic process of integration between humans, technology and organisation. The accident model also distinguishes between sharp and blunt end failures. Blunt end failures are elements that influence the performance of the system e.g. distraction and but do not necessarily lead to a crash. Blunt end failures produce a driving state or conditions that could affect the ability of the driver to carry out an action and lead to a sharp end failure e.g. the driver fails to brake for a red light. See [10] for a more detailed description of the development of the SNACS method. In SNACS, blunt end failures are represented by 'causes' – factors that contribute to a crash – and sharp end failures are referred to as 'critical events'. A critical event is the observable consequence of the failure in the system that leads to the crash and is expressed in terms of time, space or energy. Examples of the SNACS causes and critical events are shown in

Table **1**.

Table 1: Examples of SNACS Cause and Critical Events codes

Causes (contributory factors)			Critical Events
Organisation /Infrastructure	**Vehicle**	**Road User**	**Observable Effects**
J2 Communication failure (driver-environment) M1 Deficient instructions/ procedures M4 Inadequate training N5 Inadequate roadside design	G1 Access limitations H2 Illumination I1 Equipment failure K1 Maintenance failure – condition of vehicle	B1 Observation missed C1 Faulty diagnosis D1 Inadequate planning E4 Fatigue E7 Substance Misuse (subcategory: E7.1 Alcohol)	A1 Timing A2 Duration A3 Force A4 Distance A5 Speed A6 Direction A7 Object A8 Sequence

The SNACS method allows the relationship between causes to be examined as it records the sequence in which the various causation factors that lead to the crash occur. SNACS analysis is performed on the vehicle level, i.e. for each road user that has direct control of the vehicle. Therefore SNACS codes are applied to each driver, rider and pedestrian involved in the crash. The SNACS analyst evaluates all the available data relating to a crash. The analyst then works backwards in time from the time at which a crash is inevitable. First, the driver/rider/or pedestrian is assigned one critical event. Then one (Cause Z) or several causes, to which the critical event is a consequence of, are added. Then any causes that contributed to the cause Z are added and so on. This process produces a causation chart (Figure 1) where Y is a consequence of X and a cause to Z. Coding conventions guide when the chart is complete, which causes can directly lead to a critical event, and which causes can directly lead to a particular consequence. Subcategories of critical events and causes (indicated with dashed lines in Figure 1) are assigned to give more detail. When a subcategory is added, that part of the chart is stopped. For more information on SNACS please see the SNACS manual within the SafetyNet Deliverable 5.5 [11].

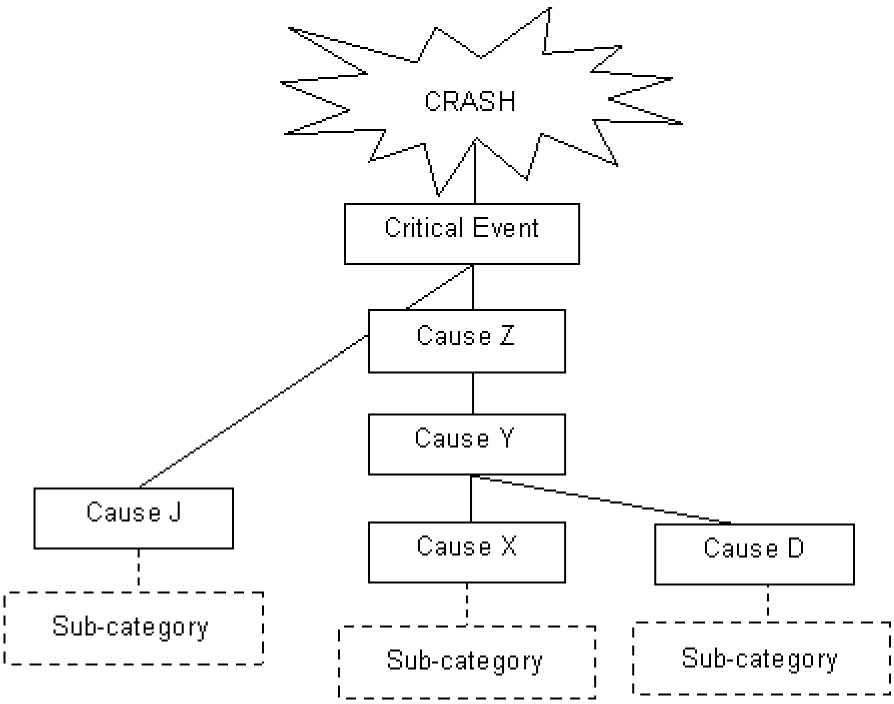

Figure 1: Example SNACS chart for one driver/rider/pedestrian (Talbot et. al. 2012)

It is possible to focus on the chart as a whole or on causation paths or cause to consequence links. If Figure 1 is taken as an example, by viewing the chart as a whole, it can be seen that Cause Y is the consequence of both Cause X and Cause D i.e. that both Cause X and D have contributed to Cause Y. Figure 1 shows 3 causation paths: Cause J to the Critical Event; Cause X to Cause Y to Cause Z to the Critical Event; and Cause D to Cause Y to Cause Z to the Critical Event. Examples of individual cause to consequence links would be Cause X to Cause Y and Cause Z to the Critical Event.
To analyse SNACS for groups of drivers, riders and/or pedestrians, the individual SNACS charts are overlaid and darker, thicker lines are used to indicate the number of times cause to consequence links occur for that group. This allows common causation paths or cause to consequence 'links' to be examined.

Alcohol and fatigue in the SNACS database

Both Alcohol and Fatigue are recorded as 'causes' in SNACS. Alcohol is a sub-category of 'Under the influence of substances' and is defined as the road user being under the influence of alcohol. Therefore Alcohol can contribute to other causes but is never a consequence. The SNACS definition does not refer to BAC limits therefore does not conform to the legal definition as discussed in the introduction. However this allows the crash investigator to code 'Alcohol' when they have evidence to suggest that this was a factor but either no breath test was administered or the driver's BAC was under the legal limit.

Fatigue is defined as 'Being mentally or physically tired/exhausted'. Three sub-category options are available:

- Circadian rhythm – driving at a time which is normally not within the normal 'waking hours' and that results in reduced output capacity.
- Extensive driving spell – not taking breaks or pausing when driving long distances and that leads to diminished driving ability.
- Other – when the type of fatigue does not fit into the other 2 categories or it is not known what type of fatigue.

Fatigue can be preceded by the causes 'Overload/Too high demand' or 'Management failure' (professional drivers) so it is occasionally a consequence of other causes as well as a contributor. The Fatigue definitions broadly agree with those discussed in the introduction and therefore those generally used in the literature.

As with all real world accident investigations and causation codes, the decision to record Alcohol or Fatigue depends on the analysts' subjective judgment. In the case of alcohol, there may have been a breath test administered at the scene or a police report recording BAC. Alternatively, the accident investigator may have judged or been told that the driver had consumed alcohol. As previously discussed the identification of fatigue is problematic. Questions such as 'how long have you been driving today?' and road users' subjective reports of tiredness are used to substantiate suspicions of fatigue.

In order to substantiate the level of inference used to assign SNACS codes, each causation path is assigned a level of confidence by the responsible accident investigator. 91% (40/44) of causation paths including 'Alcohol' were rated as having a high or reasonable level of confidence and 84% (41/49) of causation paths including 'Fatigue' were rated as having a high or reasonable level of confidence.

RESULTS

In total, 1005 crashes are included in the SafetyNet Accident Causation Database. It was decided to focus on one category of vehicles to reduce extraneous variables therefore only Cars/MPV crashes were included where the driver had been assigned the SNACS code Alcohol or Fatigue. Drivers without these codes were excluded. Drivers who were assigned a substance misuse code other than alcohol or both alcohol and fatigue were also excluded. This left 44 crashes involving 44 drivers with the SNACS code Alcohol (Alcohol group) and 45 crashes and 47 drivers with the SNACS code Fatigue (Fatigue group).

Driver and crash characteristics

Table **2** shows the gender and age ranges of drivers in the Alcohol and Fatigue groups. There is only a small difference in the gender distribution with slightly more females in the Fatigue group than the Alcohol group. Age differences are more pronounced. The Alcohol group has a bias towards younger drivers with 45% under 25 years old, whereas around half (53%) of the Fatigue group are aged between 25 and 64.

Table 2: Age and Gender distribution of the Alcohol and Fatigue groups

	Alcohol Group (n=44)	**Fatigue Group (n=47)**
Gender		
Female	16%	30%
Male	82%	70%
Unknown	2%	-
Age (years)		
15 to 17	2%	-
18 to 24	43%	28%
25 to 44	15%	38%
45 to 64	6%	15%
65 to 99	-	11%
age unknown	7%	8%

Two variables were examined to compare crash characteristics **-** accident classification and the driver manoeuvre before the crash. An accident classification system (GDV) was adopted by SafetyNet to describe the type of accident. The accident type describes the conflict situation that lead to the accident. 7 types of accidents were defined:

- Driving Accident: accident resulted from loss of control of the vehicle which is not caused by another road user
- Turning off accident: conflict between a vehicle turning off the road (e.g. turning into side road) and a vehicle travelling in the same or opposite direction.
- Turning in/crossing accident: conflict between a vehicle turning into or crossing a road without priority with another vehicle which has priority.
- Pedestrian accident: a conflict between a vehicle and a pedestrian when neither are turning.
- Accident with parked vehicles: a conflict between a vehicle and a parked vehicle or one which is manoeuvring in order to park.

- Accident in lateral traffic: a conflict between a vehicle and another travelling in the same or opposite direction.
- Other accident type: an accident that cannot be assigned to another type.

An accident type was assigned for each crash. Table 3 shows the distribution of accident types for both the Alcohol and Fatigue groups.

Table 3: Accident type

	Alcohol group (n=44)	**Fatigue group (n=45)**
Driving accident	73%	60%
Turning off accident	2%	0%
Turning in/crossing accident	7%	11%
Accident with parked vehicles	5%	2%
Accident in lateral traffic	9%	22%
Other accident type	5%	4%

Table 3 shows that the majority of crashes in each group were classed as 'Driving accidents'. However a greater proportion of the alcohol group had this classification when compared to the Fatigue group. Another difference between the two groups was that a greater proportion of the Fatigue group crashes were classified as occurring in lateral traffic.

The second crash characteristic examined was 'driver manoeuvre before crash'. This was recorded per vehicle at the point directly before the vehicle entered the conflict situation as described by the accident classification. Table 4 shows the 5 most frequent driver manoeuvres performed before the crash for both the Alcohol and Fatigue groups.

Table 4: Five most frequent pre-crash driver manoeuvres for the Alcohol and Fatigue groups

	Alcohol group (n=44)	**Fatigue group (n=47)**
Driving along a straight road	21%	40%
Driving round a left hand bend	23%	13%
Driving round a right hand bend	27%	17%
Driving round a series of bends	7%	4%
Going straight over at crossroads	7%	11%
Remainder	*15%*	*15%*

Driving along a straight road or round a left or right hand bend were the most common manoeuvres for both group but whereas for the Alcohol group the percentage of drivers fitting into each category was relatively even (21-27%), a much greater proportion of the Fatigue group were driving along a straight road (40%).

Causation mechanisms

The SNACS method dictates that each driver is assigned 1 critical event. Sub-categories giver further detail about the type of critical event and again only 1 is assigned per driver. Table 5 shows the percentage of drivers with each critical event for both the Alcohol and Fatigue groups. The assigned critical event subcategories are shown in italics. 'Timing' was the only critical event that had more than 1 subcategory and in this case the percentage of drivers represented by each subcategory has been given.

Table 5: Critical Events assigned to drivers in the Alcohol and Fatigue groups

	Alcohol group (n=44)	**Fatigue group (n=47)**
Timing	16%	28%
Premature action	*7%*	*14%*
Late action	*5%*	*5%*
No action	*5%*	*11%*
Duration *Prolonged action*	0%	2%
Force *Surplus*	11%	4%
Distance *Shortened*	0%	2%
Speed *Surplus*	32%	13%
Direction *Incorrect*	41%	49%
Sequence *Skipped action*	0%	2%

'Direction' was the most common critical event for both the alcohol and fatigue groups with just over two fifths of the Alcohol group drivers and nearly half of the Fatigue group drivers being involved in a collision because they made a manoeuvre in the wrong direction, for example leaving their lane. A higher share of drivers in the alcohol group had surplus speed as the action that lead directly to a crash and a higher share of drivers in the fatigue group had a crash as a result of timing errors, usually premature or no action.

Crashes are complex events and many causes were recorded for both the Alcohol and the Fatigue groups. However, as the focus here is on the causation mechanisms specific to alcohol and fatigue, only causation paths that include 'Alcohol' or 'Fatigue' as a contributor and/or consequence have been included in the following analyses. 86 SNACS causation paths were recorded for the drivers in the Alcohol group, with 44 including the cause 'Alcohol'. 99 causation paths were recorded for the drivers in the Fatigue group with 49 including the cause 'Fatigue'.

The following figures show the SNACS charts for the Alcohol group (Figure 2) and the Fatigue group (Figure 3). Cause to consequence links that have only been recorded once or twice are indicated by grey lines. When cause to consequence links have been recorded a number of times (>6) the lines are thick and the number of times these links occurred has been provided.

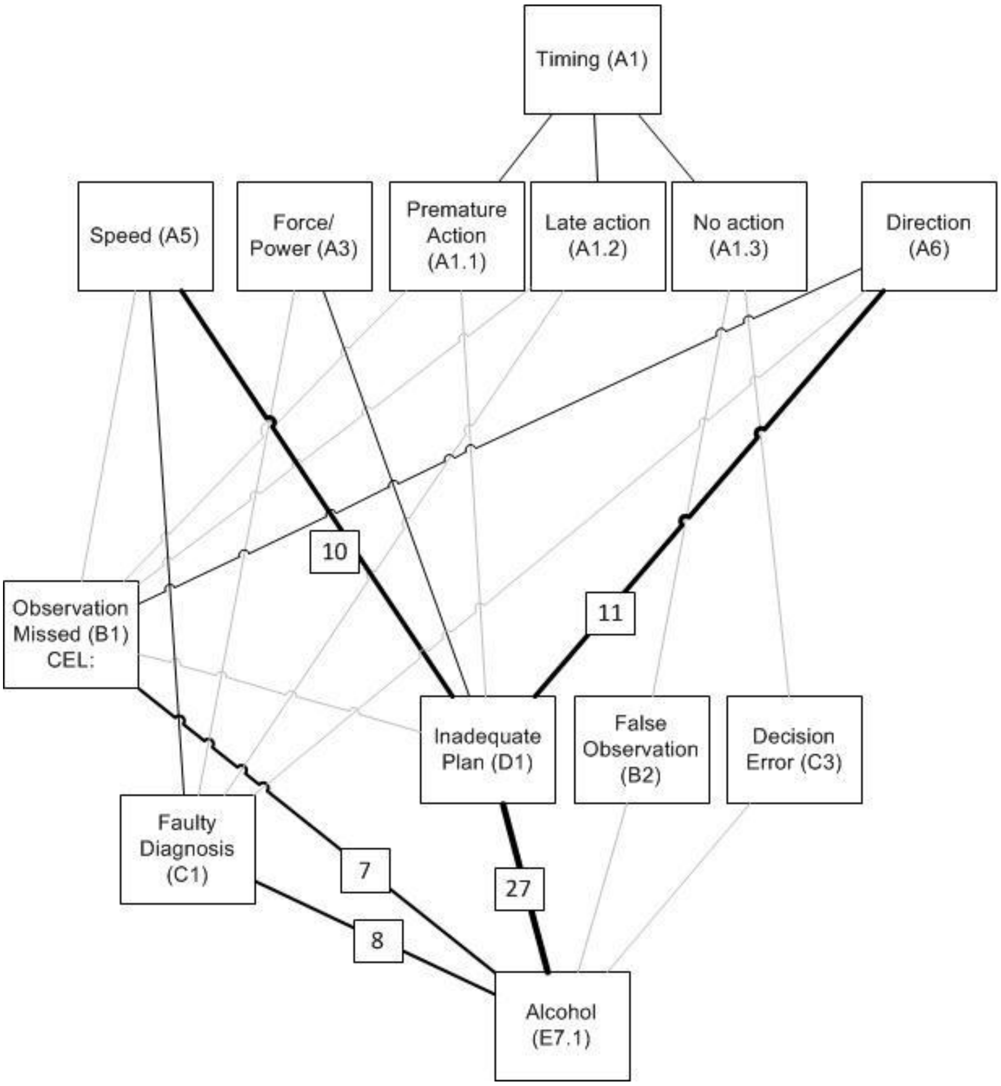

Figure 2: SNACS chart for the Alcohol group – only causation paths including 'Alcohol' (44 drivers, 44 causation paths)

Many of the causes shown as a consequence of 'Alcohol' in Figure 2 relate to erroneous decision making with drivers frequently making incomplete or wrong plans of action (Inadequate plan), sometimes making an incomplete or incorrect assessment of the situation (Faulty diagnosis) and occasionally choosing the wrong course of action (Decision error). Observations appear to be also incomplete as important factors are sometimes missed altogether (Observation Missed) or occasionally not recognised / mistaken for something else (False observation).

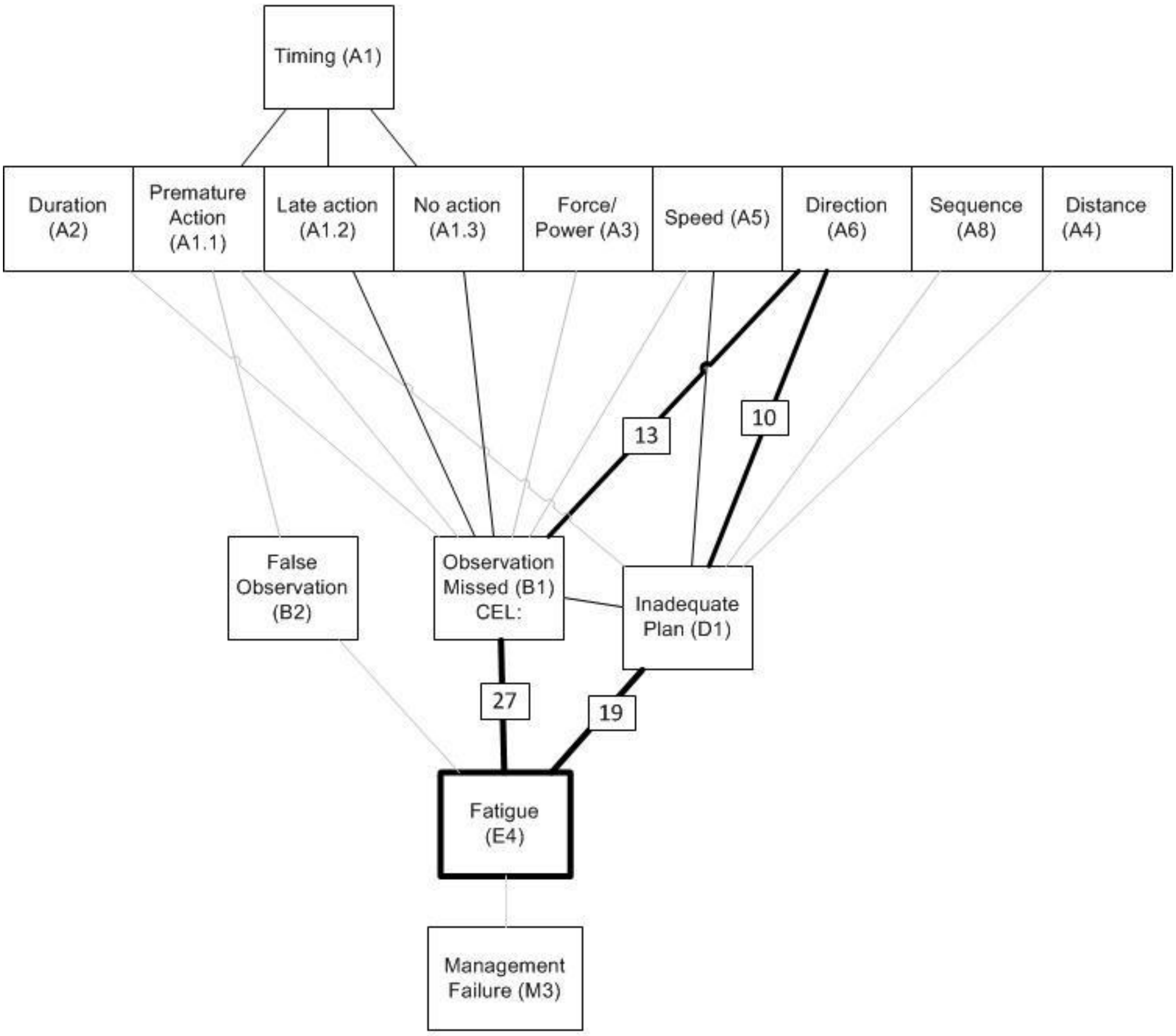

Figure 3: SNACS for Fatigue group – only causation paths including 'Fatigue' (47 drivers, 49 causation paths)

Fewer causes are shown in Figure 3 for the fatigue group than appear in Figure 2 for the Alcohol group. Although still frequent, making incomplete or wrong plans of action (Inadequate plan) occur less often for the Fatigue group. Incomplete observations appear to be a bigger factor for the Fatigue group than the Alcohol group. Both Figure 2 and Figure 3 show that these causes lead to a variety of different critical events but that 'Direction' is the most common, as indicated by Table 5. Examination of the most frequently occurring cause to consequence links as shown in Table 6, supports the idea that incorrect observations are more associated with fatigue than alcohol.

Table 6: Six most frequent cause to consequence links for the Alcohol and Fatigue groups

Alcohol Group (89 links)				**Fatigue Group (95 links)**			
Alcohol	-	Inadequate plan	30%	Fatigue	-	Observation missed	28%
Inadequate plan	-	Incorrect direction	12%	Fatigue	-	Inadequate plan	20%
Inadequate plan	-	Surplus speed	11%	Observation missed	-	Incorrect direction	14%
Alcohol	-	Faulty diagnosis	9%	Inadequate plan	-	Incorrect direction	11%
Alcohol	-	Observation missed	8%	Inadequate plan	-	Surplus speed	5%
Observation missed	-	Incorrect direction	6%	Observation missed	-	Timing (no action)	5%
		Remainder	*24%*			*Remainder*	*17%*

Table 6 shows the six most frequently occurring cause to consequence links for both the Alcohol and Fatigue groups. 28% of the links for the Fatigue group are 'Fatigue' to 'Observation missed' compared to 8% for 'Alcohol' to 'Observation missed'. The difference is small when considering links to 'Inadequate plan' – 30% for 'Alcohol to Inadequate plan' and 20% for 'Fatigue to Inadequate plan'. 'Observation missed to Incorrect direction' appears proportionately more frequently for the Fatigue group than the Alcohol group and 'Inadequate plan to Incorrect direction' appears approximately the same proportion of times for both groups.

The SNACS chart (Figure 2) indicates that the most common causation path for the Alcohol group is 'Alcohol to Inadequate plan to Incorrect Direction' followed by 'Alcohol to Inadequate plan to Surplus speed' and Figure 3 shows that 'Fatigue to Observation missed to Incorrect Direction' is the most common causation path for the Fatigue group followed by 'Fatigue to Inadequate plan to Incorrect direction. This is confirmed by Table 7 which shows the five most commonly observed causation paths for the Alcohol and Fatigue groups.

Table 7: Most common SNACS causation paths including Alcohol or Fatigue

Alcohol group (44 paths)			Percentage (count)
Alcohol -	Inadequate plan	- Incorrect direction	25% (11)
Alcohol -	Inadequate plan-	- Surplus speed	23% (10)
Alcohol -	Observation missed	- Incorrect direction	9% (4)
Alcohol -	Inadequate plan	- Surplus force	7% (3)
Alcohol -	Faulty diagnosis	- Surplus speed	7% (3)
		Remainder	*29% (13)*
Fatigue group (49 paths)			
Fatigue -	Observation missed	- Incorrect direction	25% (12)
Fatigue -	Inadequate plan	- Incorrect direction	20% (10)
Fatigue -	Observation missed	- No action	10% (5)
Fatigue -	Inadequate plan	- Surplus speed	10% (5)
Fatigue -	Observation missed	- Premature action	8% (4)
		Remainder	*27% (13)*

Both alcohol and fatigue lead to 'Inadequate plan to Incorrect direction', 'Inadequate plan to Surplus speed' and 'Observation missed to Incorrect direction' however 'Inadequate plan to Surplus speed' is proportionally more common in the Alcohol group (23% vs 10%) and 'Observation missed to Incorrect direction' is more common in the Fatigue group (25% vs 9%).

DISCUSSION

Fourty-four crashes with 44 drivers with the SNACS code 'Alcohol' and 45 crashes with 47 drivers with the SNACS code 'Fatigue' were included in the SafetyNet Accident Causation Database. There are many aspects of Alcohol and Fatigue crashes that are similar however there are also differences. There is a bias towards young drivers in the Alcohol group with 45% being under 25 years old compared with 28% of the Fatigue group. In terms of crash characteristics, the Alcohol and the Fatigue groups were relatively similar. 'Driving accident' was the most common accident type for both the Alcohol and the Fatigue group with the Alcohol group having the largest share. Impairment due to alcohol or fatigue affects the performance of the driver therefore he/she is more likely to make mistakes irrespective of the presence of other road users. It is perhaps therefore unsurprising that the majority of accidents are 'driving accidents'. Both groups have the same 5 most frequent driver manoeuvres before the crash although the order of these differs between the groups. The differences are not great however, in general, the alcohol group has slightly more crashes preceded by driving around a bend and the fatigue group has slightly more crashes preceded by driving on straight road. A possible explanation for this is that the monotony of a straight road can increase the effect of fatigue and that performing a specific manoeuvre is more difficult when impaired by alcohol.

With regard to causation mechanisms 'Incorrect direction' was a frequently occurring critical event in both the Alcohol and Fatigue groups followed by 'Surplus speed' for the Alcohol group and Timing (mainly premature or no action) for the Fatigue group. The Alcohol group had more contributory factors related to decision making and the Fatigue group had more contributory factors relating to incorrect observations.

The SNACS analysis suggests that incomplete or wrong plans of action (Inadequate plan) is an important factor associated with alcohol impairment, however this can lead to either making a wrong manoeuvre (Incorrect direction) or travelling too fast (Surplus speed). In contrast both incorrect observations (Observation missed) and making incomplete or wrong plans (Inadequate plan) are associated with crashes involving fatigue but both most commonly lead to making a wrong manoeuvre (Incorrect direction).

Missed observations are likely to be associated with fatigue because a fatigued person is less able to pay attention to their environment. This probably also applies to alcohol impairment however as previously discussed, whilst alcohol impairment affects all aspects of the driving task, drivers who are fatigued are still able to perform certain complex cognitive tasks well [1]. It is possible that a fatigued driver is able to bring his/her attention back to a task more effectively and generate a plan of action more quickly and effectively than a driver impaired by alcohol. A factor that may have influenced these findings is the age of the drivers. The drivers in the Alcohol group are generally younger than the Fatigue group. They may have less driving experience and so are less equipped to generate plans of action whilst driving. Driving whilst impaired by alcohol would exacerbate this problem.

The analysis reported here gives an indication of the similarities and differences between crashes involving alcohol and those involving fatigue that have been investigated using in-depth accident investigation methodologies. It also demonstrates the type of information available through SNACS analyses. As with any dataset however, it does have limitations. Generalising from the data has to be done with care. The data are not necessarily truly representative of the countries where they were collected. This is due in part to complexity and expense of the collection methodologies. The database is also not representative of Europe as only 6 of the member states are included and these are biased towards the best performing countries in terms of road safety. There was, however, good intercoder reliability meaning that the reliability of the SNACS data is high [12].

There are two aspects of validity to be considered – the validity of the SNACS codes themselves and the validity of the way the codes were applied by the SNACS analyst. The validity of the codes was addressed through an evaluation exercise during the SafetyNet project. This was achieved by comparing the SNACS codes and definitions to evidence of accident causation and contributory factors found in relevant literature [13]. This formed part of a wider assessment of the SNACS method, which lead to a refinement of the method to become DREAM 3.0 (Driver Reliability and Error Analysis Method) [14]. Changes included the removal of codes which had very little supportive evidence in the literature, altering of definitions to be more meaningful and the merging of codes which were found to overlap both by the SNACS coders and the literature. The 'Alcohol' code was not altered for DREAM 3.0. The term 'sleepy' was added to the definition of 'Fatigue' and the subcategories removed and replaced with a sub code indicating a sleep disorder. In addition the number of causes which could precede 'Fatigue' was increased. However this has little impact on the analysis described here so the 'Alcohol' and 'Fatigue' codes can be considered valid.

The validity of the assigning of the codes can be assessed by examining the 'level of confidence' for causation paths. This was relatively high for paths including alcohol and fatigue. Paths with low confidence were included as they were relatively few and did not seem to differ substantially from those with higher confidence levels.

In conclusion, comparing crashes involving alcohol and fatigue suggests that there are similarities in terms of crash type, driver manoeuvre and causation patterns however the differences, although in some cases subtle, do suggest that drivers' cognitive processing and actions when under the influence of alcohol are not entirely the same as when they are fatigued. Taking into account the caveats mentioned above and the small sample sizes, the analysis does not allow for generalised statements about the significance of the similarities and differences between crashes involving alcohol and fatigue. However the observed differences do suggest that attempts to quantify the effect of fatigue by using levels of alcohol impairment as a benchmark should be done with care – especially if the aim is to develop legislation. Similar analyses conducted on a larger dataset however would allow more concrete conclusions to be made – especially one that is more representative of Europe. The relationship between alcohol and fatigue was not explored here but it is likely that they interact and this would be an interesting area for further research.

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