Identifying the causes of road traffic collisions: Using police officers’ expertise to improve the reporting of contributory factors data

Jonathan J. Rolison*

Department of Psychology, University of Essex, UK

Abstract

Worldwide, road crashes are a major cause of death and serious injury. Police reports provide a rich source of data on the proximal causes (e.g., impairment by alcohol, failure to look properly) of road traffic collisions. Yet, road safety research has raised concerns about the quality and reliability of police reported data. In the UK crash report form, contributory factors are categorised (e.g., vehicle defects, driver error or reaction) to aid police officers in identifying appropriate factors. However, discord between the classification of contributory factors in crash reports and police officers’ own categorical perceptions may lead to misunderstanding, and in turn, misreporting of contributory factors. The current investigation recruited 162 police officers to report their perceptions of the relations among contributory factors in the UK crash report form. Hierarchical clustering analysis was used to identify an optimal category structure based on police officers’ perceptions. The clustering analysis identified a classification system with seven or eleven categories of contributory factors, maximising the internal coherence of categories and minimising discord with police officers’ perceptions. The findings also yielded new insights into police officers’ perceptions of crash causation and demonstrate how statistical techniques can be used to inform the design of road traffic collision report forms.

Article Info

A R T I C L E    I N F O

Keywords:
Road safety
Crash causation
Contributory factors
Policymaking
Crash reporting

A B S T R A C T

Worldwide, road crashes are a major cause of death and serious injury. Police reports provide a rich source of data on the proximal causes (e.g., impairment by alcohol, failure to look properly) of road traffic collisions. Yet, road safety research has raised concerns about the quality and reliability of police reported data. In the UK crash report form, contributory factors are categorised (e.g., vehicle defects, driver error or reaction) to aid police officers in identifying appropriate factors. However, discord between the classification of contributory factors in crash reports and police officers’ own categorical perceptions may lead to misunderstanding, and in turn, misreporting of contributory factors. The current investigation recruited 162 police officers to report their perceptions of the relations among contributory factors in the UK crash report form. Hierarchical clustering analysis was used to identify an optimal category structure based on police officers’ perceptions. The clustering analysis identified a classification system with seven or eleven categories of contributory factors, maximising the internal coherence of categories and minimising discord with police officers’ perceptions. The findings also yielded new insights into police officers’ perceptions of crash causation and demonstrate how statistical techniques can be used to inform the design of road traffic collision report forms.

1. Introduction

Road crashes are a major cause of death worldwide, accounting for more than 1.2 million deaths each year and many more non-fatal injuries (World Health Organization, 2015). Driver-related factors, namely driver actions or behaviour, contribute to most road traffic collisions and are the dominant cause of the majority of crashes (Evans, 1996). While there are multiple routes to improving road safety, such as by improving the road environment (Weijermars and Wegman, 2011), many driver-related factors are preventable (e.g., temporary distraction, exceeding the speed limit; Petridou and Moustaki, 2006; Rolison et al., 2018), implying that on the basis of reliable data about the factors that contribute to crashes road safety policies and initiatives could further be informed to improve public safety (Elder et al., 2004; Shope, 2007). Police reports provide an important source of data on the factors that contribute to road traffic collisions (e.g., UK Department for Transport (DfT, 2014). However, road safety research has raised concerns about the quality and reliability of police reported data (Couto et al., 2016; Watson et al., 2015), especially regarding the reporting of contributory factors to crashes (Imprialou and Quddus, 2019; Montella, 2011; Rolison et al., 2018), indicating that road traffic collision reports may provide a misleading picture about crash causation. The current research investigated police officers’ perceptions of existing methods for reporting contributory factors with a view to improving the quality and reliability of police reported data.

A wealth of research investigating the factors that contribute to road traffic collisions is based on police reported data (e.g., Gonzales et al., 2005; Lam, 2003; Langford and Kopp, 2006; McGwin and Brown, 1999). Police reports provide a rich source of nationally representative crash causation data, in comparison with small scale in-depth collision investigations (Beanland et al., 2013b, 2013a; Larsen, 2004). Police officers who attend a road traffic collision provide a subjective report of the factors that they believe contributed to the crash. For example, in the United Kingdom (UK), police officers who attend an incident provide a subjective report of the factors that they believe contributed to the crash. To do so, officers select among various possible contributors, categorised as road environment (e.g., animal or object in the carriageway), vehicle defects (e.g., defective steering or suspension), in-judicious action (e.g., following too close), error or reaction (e.g., poor turn or manoeuvre), impairment or distraction (e.g., fatigue), behaviour or inexperience (e.g., uncertain, nervous or panic), and vision affected (e.g., dazzling sun; UK DfT, 2018a; see Table 1 for a full list of factors). The categories used to classify contributory factors in the UK crash report are intended as a classification system to aid officers in
research has been undermined by inconsistencies in police-reported contributory factors, which may be due to a failure to articulate factors in a clear and consistent manner.

In the UK crash report form, the ‘behaviour or inexperience’ category contains various driver-related characteristics and behaviours, including some that refer explicitly to driver inexperience (e.g., ‘learner or inexperienced driver’) and others that do not refer to level of driver experience (e.g., ‘careless, reckless, or in a hurry’; UK DfT, 2018a; Table 1). It may be unclear to the reporting police officer which factors in this category should be considered in relation to inexperience. For instance, some police officers ‘aggressive driving’ may only be identified as a factor contributing to road crashes involving inexperienced drivers, which would lead to inconsistent reporting across police officers. Moreover, it may be unclear whether this category represents a unified set of related factors that might be prioritised by road safety organisations and which factors it contains could be combined to represent a coherent driver characteristic or behaviour (e.g., driver distraction).

Research in psychology has revealed that how items are categorised influences people’s perception of the items that categories contain. When categories are imposed, perceived differences between items in Table 1 Continued)

<table>
<thead>
<tr>
<th>Seven-cluster solution</th>
<th>Eleven-cluster solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>dazzle headlights</td>
<td>6</td>
</tr>
<tr>
<td>dazzle sun</td>
<td>6</td>
</tr>
<tr>
<td>rain, sleet, snow, or fog</td>
<td>6</td>
</tr>
<tr>
<td>spray from other vehicles</td>
<td>6</td>
</tr>
<tr>
<td>visor or windscreen dirty, scratched or frosted etc.</td>
<td>3</td>
</tr>
<tr>
<td>vehicle blind spot</td>
<td>6</td>
</tr>
</tbody>
</table>

identifying appropriate factors. For example, factors in the ‘injudicious action’ category are intended to relate specifically to injudicious actions or behaviours that are distinguishable from other types of actions or behaviours, such as those related to impairment or distraction (Table 1). The classification system is also intended to distinguish types of road user behaviours (e.g., injudicious action) from other behaviours (e.g., impairment or distraction) and non-driver related factors (e.g., vehicle defects). In this latter sense, the classification of contributory factors into superordinate categories helps focus road safety priorities on broad categories of crash causation (UK Department for Transport, 2014; 2017). Similarly, in the United States, drivers involved in a road traffic collision have been interviewed about the events leading up to a crash (e.g., driver distraction, exceeding the speed limit) in combination with investigation of the incident scene (NHTSA, 2008).
the same category are minimised, whereas perceived differences between items in separate categories are accentuated (Goldstone, 1994; Goldstone and Hendrickson, 2010; Schusterman et al., 2000). This tendency, known as categorical perception, illustrates how the perception of items (e.g., contributors) is influenced by imposed categories (e.g., categories used to classify contributory factors). Perceptually dissimilar items can be perceived as more similar, or even equivalent, if classified in the same category (Schusterman et al., 2000). Thus, it is crucial that when categories are used to classify fixed lists of contributory factors in a crash report that the categories contain coherent sets of similar items, maximising dissimilarity between categories. Otherwise, items contained in diverse or eclectic categories are likely to be perceived by police officers as more similar or related due to their classification in the same category. Moreover, it is important that contributory factor categories map onto police officers’ categorical perceptions of the factors. Discord between the imposed classification of contributory factors and police officers’ own categorical perceptions could lead to erroneous or inconsistent reporting due to misunderstanding of the meaning of individual factors.

In sum, it is important that when road traffic collision reports contain a fixed set of contributory factors that the factors are classified into coherent categories to minimise risk of misinterpretation by police officers. The current research investigated police officers’ perceptions of the relations among contributory factors in the UK crash report form. While the current investigation focussed on the UK crash reporting practices as a case in point, the findings are intended to inform crash reporting practices in other countries by providing new insights into effective practices for developing road traffic collision reports.

2. Methods

2.1. Participants

One hundred sixty-two police officers (76% male; M_{age} = 42.85 years; age range = 24 – 64 years) were recruited from police stations and units across the United Kingdom. The author and representatives of the UK Department for Transport (DfT) contacted police stations and units across the UK. For police stations and units that agreed to take part, participation was solicited via email invitation sent to police officers via participating stations and units. Participants completed an online study of their views about road crash causation, lasting on average 24 min. Regarding their experience, officers indicated an average of 16.13 (SD = 8.12) years of experience attending or reporting on road traffic crashes and had attended or reported on an estimated 49 (SD = 110) road crashes in the past 12 months. The largest proportion (56%) indicated road policing as their specialist unit, followed by collision investigation (17%), and forensic collision investigation (5%). Regarding education, 21% indicated high school as their highest level of educational attainment, 45% indicated college or third level education (e.g., A-levels, diploma), 30% indicated an undergraduate degree, and 4% indicated a postgraduate degree. Ethical approval for the study protocol was provided by the internal ethics review board (institution: University of Essex; title: Assessment of the reliability of police reported road crash data; protocol number: JR1601). All participants provided written informed consent prior to participating in the study.

2.2. Materials and procedure

When a police officer reports on a road crash, they complete an crash report form that includes various crash details. In the crash report, police officers provide a subjective report of the factors that they believe contributed to the road crash. Officers can select among seven categories up to six contributory factors, including road environment (e.g., defective traffic signals), vehicle defects (e.g., defective breaks), injudicious actions (e.g., exceeding the speed limit), error or reaction (e.g., failed to look properly), impairment or distraction (e.g., driver using mobile phone), behaviour or inexperience (e.g., aggressive driving), and vision affected (e.g., dazzling headlights; UK DfT, 2018a). The crash reports are processed by local authorities (police, local authority, contractor) and are provided to the UK Department for Transport (DfT) for public use (UK DfT, 2018b).

Participants were told that the purpose of the research was to assess whether the existing categories in the current crash report form adequately reflect the factors they contain. They were provided a list of 63 factors without their associated category and were asked to categorise the factors according to how they believed the factors should be grouped. Participants assigned factors to categories by clicking and dragging the factors from the list with a mouse cursor into category boxes that appeared alongside the factor list. They could create up to 15 categories of related factors, but were asked to create only as many categories as they needed to assign all factors. Participants were explained that a category could include from one to as many factors as they wished. If they believed that a factor was unrelated to crash causation, they were instructed to leave it in its position without placing it in a category. Participants could also create their own factors if they believed that factors associated with crash causation were not covered by the 63 existing factors provided. To add a new factor, participants were required to create new factors from a list of blank editable factors.

3. Results

Police officers created a mean of 9.38 (SD = 2.62; min = 4, max = 15) categories, assigning a mean of 59.89 (SD = 8.62; min = 14, max = 63) of the 63 factors. Thus, officers typically believed that most (to all) of the 63 factors are relevant to road traffic crash causation and that the factors belong to multiple distinct categories.

To investigate police officers’ judgements about the optimal category structure of the factors, their category assignments were submitted to an agglomerative hierarchical clustering analysis using the ‘Cluster’ package in R (Maechler et al., 2018). In agglomerative hierarchical clustering, each of the 63 contributory factors is first assigned to its own individual cluster. A dissimilarity matrix of the pairwise dissimilarities (i.e., distances) between each of the clusters is calculated and used to merge the clusters into increasingly inclusive clusters until all clusters are merged into a single cluster containing all 63 factors. Clusters that are least dissimilar (i.e., have the shortest distance) in the dissimilarity matrix are combined at each stage of clustering. Complete-linkage clustering using Gower distances in the dissimilarity matrix was adopted as this method is suited to categorical data (Maechler et al., 2018).

The optimal number of clusters was determined that maximised the internal coherence of the clusters (i.e., similarity of factors within clusters) and the external differences between clusters (i.e., dissimilarity of factors between clusters). Fig. 1 provides an Elbow plot of the sum of the squared distances within clusters as a measure of the dissimilarity between factors within clusters. As shown in Fig. 1, as the number of clusters increased, the sum of the squared differences within clusters decreased (i.e., similarity increased). The Elbow plot indicates an inflection point at seven clusters as increasing the number of clusters from seven (SS = 1.22) to eight (SS = 1.12) clusters showed a relatively small decrease in the sum of squared within-cluster distances, in comparison with six clusters (SS = 1.51). Thus, a seven-cluster solution provided an optimal number of clusters. However, the Elbow plot indicated a second inflection point at eleven clusters as increasing the number of clusters from eleven (SS = 0.77) to twelve (SS = 0.71) clusters showed a relatively small decrease in the sum of squared within-cluster distances, in comparison with ten clusters (SS = 0.90). Therefore, an eleven-cluster solution is also considered. Fig. 1 also provides a plot of the Silhouette coefficient, which is a measure of within-cluster consistency, with higher values indicating higher consistency. The Silhouette coefficient confirmed that within-cluster
consistency was higher for a seven-cluster solution (coefficient = 0.42) compared to smaller numbers of clusters (Fig. 1), but showed a high coefficient also for an eleven-cluster solution (coefficient = 0.43).

3.1. Seven-cluster structure of contributory factors

Provided in Fig. 2 is a dendrogram showing the hierarchical structure of the seven clusters identified by our clustering analysis. The height of the links between factors within the dendrogram indicates the distance (i.e., dissimilarity) between factors in the dissimilarity matrix. For example, ‘defective breaks’ and ‘defective steering or suspension’ exhibited a small pairwise distance in the dissimilarity matrix, as indicated by the height of their link in the dendrogram (see Fig. 2), implying that they were often assigned by police officers to the same category. The hierarchical nature of the dendrogram shows how clusters begin as single-factor clusters and are successively combined into increasingly inclusive clusters until all factors are contained in a single cluster.

Observing Fig. 2, Cluster 1 contained five of the seven factors of the ‘behaviour or inexperience’ category in the crash report form (see Table 1). These five factors related to nervousness, uncertainty, and unfamiliarity, indicating that Cluster 1 represents an ‘inexperience’ category. This implies that police officers believe that a separate inexperience category captures road crash contributory factors that are distinct from other factors. The two remaining factors in the ‘behaviour or inexperience’ category in the crash report (‘aggressive driving’, ‘careless, reckless, or in a hurry’), which relate to injudicious behaviour were instead clustered with the ten factors of the ‘driver error or reaction’ category and nine of the ten factors in the ‘injudicious action’ category in the crash report. Hence, Cluster 2 appears to represent an ‘injudicious action or driver error’ category, that includes related factors akin to poor or unwise judgement or behaviour that are distinct from other factors, such as those related to inexperience.

Cluster 3 contained all six factors of the ‘vehicle defects’ category in the crash report. The cluster also included one factor (‘not displaying lights at night or in poor visibility’) from the ‘impairment or distraction’ category, and one factor (‘visor or windscreen dirty, scratched or frosted etc.’) from the ‘vision affected’ category in the crash report. Thus, police officers believed that the latter two factors were more related to vehicle defects than to their original categories in the crash report, owing to their reference to defective features of the vehicle, namely vehicle lighting and visibility through the windscreen. Thus, Cluster 3 appears to represent a ‘vehicle defects’ category. Cluster 4 was comprised of eight of the ten factors of the ‘impairment or distraction’ category in the crash report, indicating that this cluster represents an ‘impairment or distraction’ category (Fig. 2). The remaining factor in the ‘impairment or distraction’ category of the crash report (‘rider wearing dark clothing’) was instead clustered with ‘cyclist entering road from pavement’ from the injudicious action category in Cluster 5, representing a ‘cyclist error or visibility’ category.

Cluster 6 contained nine of the ten factors from the ‘vision affected’ category in the crash report, implying that Cluster 6 is best described as a ‘vision affected’ category (Fig. 2). Cluster 7 contained all ten factors from the ‘road Environment contributed’ category in the crash report, and thus, is best described as a ‘road environment contributed’ category.

3.2. Eleven-cluster structure of contributory factors

Shown in Fig. 3 is a dendrogram identifying the eleven-cluster solution within the hierarchical structure identified in the clustering analysis. The hierarchical structure of the clusters is identical to the structure of the seven-factor solution, except that eleven, rather than seven, distinct clusters are identified. In the eleven-cluster structure, the ‘injudicious action or driver error’ category identified for the seven-factor structure, is further separated into a ‘manoeuvring error’ category, containing factors related to driver error during a manoeuvre (‘sudden braking’, ‘sverved’, ‘loss or control’, ‘junction overshoot’, ‘junction restart [moving off at junction], ‘poor turn or manoeuvre’, and ‘failed to signal or misleading signal’), a ‘judgement error’ category, containing factors related to poor judgement (‘too close to cyclist, horse or pedestrian’, ‘failed to look properly’, ‘failed to judge other person’s
3.3. Summary

Hierarchical clustering analysis on police officers’ judgements about the categorical structure of contributory factors in the current UK road crash report form confirmed that most (to all) factors were considered relevant to crash causation. The optimal categorical structure of the factors broadly confirmed the structure employed in the existing crash report, but also revealed that some factors may be better placed in alternative categories. The hierarchical nature of the analytic approach revealed how larger categories (e.g., ‘injudicious action or driver error’) can be sub-divided into smaller categories.

4. Discussion

The current research investigated police officers’ perceptions of the relations among contributory factors in a national road traffic collision report and employed hierarchical clustering analysis to identify the optimal categorical structure of the contributory factors. The clustering analysis identified a classification system with seven or eleven categories of contributory factors, maximising the internal coherence of
categories (i.e., similarity among factors within categories). The findings yield new insights into police officers’ perceptions of crash causation, as discussed below, and demonstrate how statistical clustering techniques can be used to inform the design of road crash report forms.

The current investigation focussed on the UK road traffic collision reporting procedures as a case in point with a view to informing the reporting of contributory factors internationally. In the UK crash report form, the ‘behaviour or inexperience’ category contains a variety of actions and behaviours, some of which refer explicitly to inexperience (e.g., ‘learner or inexperienced driver’) and others that do not refer to inexperience (e.g., ‘careless, reckless, or in a hurry’; Table 1). The hierarchical clustering analysis, based on police officers’ perceptions of the relations among the contributory factors, revealed a separate ‘inexperience’ category containing factors specifically related to driver inexperience (Cluster 1; Fig. 1). Hence, police officers perceived that contributory factors related to driver inexperience are qualitatively distinct from other driver actions or behaviours. Distinguishing inexperience-related factors in future developments of collision report forms should aid police officers in identifying appropriate contributory factors and reduce misinterpretations of the meaning of contributory factors. These findings have practical implications beyond the UK. In many countries, incident reports do not include a report of the contributory factors, unless a fatality occurs and an in-depth investigation is conducted. Police reports provide a rich data source for identifying patterns in crash causation. A practical implication of the current findings is that police officers’ perceptions of the relations among contributory factors should be considered during the development of incident reports to provide the most accurate picture of crash causation.

The distinction between experience-related factors and other driver actions and behaviours also resonates with a focus in the road safety literature on young inexperienced drivers (Braitman et al., 2008; Rolison et al., 2013, 2014; Scott-Parker et al., 2012). The ‘inexperience’ category addresses a coherent set of behaviours related to a public health concern. The factors in the ‘inexperience’ category may even be suited to providing a naturalistic method of assessing the effectiveness of future education and training initiatives delivered regionally or nationally to target young driver behaviour, as methodological shortcomings have been identified in other methods of evaluation (Beanland et al., 2013b, 2013c; Rodwell et al., 2018). The ‘learner or inexperienced driver’ factor was strongly associated with the ‘nervous,
uncertain, or panic ‘factor’ in police officers’ perceptions, as indicated by
the height of the link between these factors in the dendrogram (Fig. 2).
Graduated licensing systems have been introduced in multiple coun-
tries, such as the United States, where young novice drivers are re-
stricted to low-risk driving conditions (e.g., by restricting nighttime
driving) to foster skill development (Bates et al., 2014; Shope, 2007).
These systems could be assessed in terms of subsequent reduction in the
occurrence of the ‘learner or inexperienced driver’ and ‘nervous, un-
certain, or panic’ factors in road traffic collision reports. Further, the
consistent use of experience-related factors in collision report forms
internationally may also help foster national comparisons in road
safety.

The UK crash report form does not distinguish a cyclist category
from other contributory factor categories (Table 1). Rather, factors re-
lated to cyclists (e.g., ‘cyclist entering road from pavement’) are cur-
rently dispersed across categories (i.e., ‘judgement action’). Perceptions
of police officers indicated a need for a separate cyclist category to
distinguish cyclist-related factors from factors associated with other
road users, increasing the coherence of the factor categories. Compared
to car occupants, cyclists have a much higher risk of death or serious
injury when involved in a road traffic collision (Lahrmann et al., 2018;
Wegman et al., 2012). Cyclist visibility is an important determinant of
cyclist risk as increasing visibility via bicycle lights or reflective
clothing reduces risk of crash involvement (Lahrmann et al., 2018).
Larger overall numbers of cyclists on the road also improves cyclist
safety at least in part because cyclists are less likely to be overlooked by
drivers (Fyhri et al., 2017). Hence, cyclist safety could be improved
with practical interventions, such as increasing cyclist visibility and
enhancing driver awareness. The current findings suggest that a sepa-
rate contributory factor category dedicated to cyclists may help focus
road safety priorities on cyclist safety and would provide a key outcome
measure for assessing the impact of road safety policies and initiatives
targeted at safeguarding cyclists. Cycling is a frequent mode of trans-
port in many countries, such as in Denmark, Hungary, and the Neth-
erlands, where it is the most frequent mode of transport for more than a
fifth of people (European Commission, 2014). Cycling is also promoted
in plans for sustainable city transport systems (e.g., European
Commission, 2011). The current findings suggest that in the UK in-
cident reporting practices, and in the development of such practices for
the reporting of contributory factors in other countries, a separate
contributory factor category dedicated to cyclists may help focus road
safety priorities on cyclist safety. Doing so would also provide a key
outcome measure for assessing the impact of road safety policies and
initiatives targeted at safeguarding cyclists.

The hierarchical clustering identified cases where contributory
factors were better placed in different categories to those used in the
current UK crash reporting form. For example, the ‘vehicle defects’
category contained ‘not displaying lights at night or in poor visibility’,
which currently appears in the ‘imPAIRment or distraction’ category.
This factor was not strongly associated with other factors more closely
related to driver impairment (e.g., ‘fatigue’) or distraction (e.g., ‘dis-
traction in vehicle’) according to police officers’ perceptions, as in-
dicated by the height of the links between these factors in the den-
drogram (Fig. 2). The clustering analysis also indicated that the ‘visor or
windscreen dirty, scratched, or frosted etc.’ factor, currently in the
‘vision affected’ category of the crash report form, is more appropriately
placed in the ‘vehicle defects’ category. Indeed, this factor explicitly
refers to vehicle defects. Psychological research has revealed that cat-
egory membership alters perception of the items that categories con-
tain (Goldstone and Hendrickson, 2010; Schusterman et al., 2000).
When a category structure is imposed, such as categorising contributory
factors, perceived differences between items in the same category are
diminished and perceived differences between items in separate cate-
gories are exaggerated. Eclectic, or incoherent, contributory factor ca-
tegories may minimise perceived differences between factors within a
category, leading to misreporting due to misunderstanding of the
meaning of individual contributory factors. Aligning the category
structure with police officers’ perceptions maximises category co-
herence, improving ease of crash reporting and reducing risk of re-
porting errors.

A positive feature of the hierarchical clustering approach employed in
the current research is that clusters are successively combined into
increasingly inclusive clusters. As such, clusters can be divided into
smaller clusters without altering the overall structure (Maechler et al.,
2018). The clustering analysis revealed an eleven-cluster solution, in
which two categories in the seven-cluster solution were divided into
less inclusive factor categories (Figures 2 & 3). In the eleven-cluster
solution, the ‘injudicious action or driver error’ category was further
divided into a ‘manoeuvring error’ category, a ‘judgement error’ cate-
gory, and an ‘injudicious action’ category. Therefore, the ‘injudicious
action or driver error’ category could be divided into smaller, more
coherent, categories that focus on more specific aspects of driver ac-
tions and behaviour. The hierarchical structure also indicated that the
‘imPAIRment or distraction’ category could be divided into an ‘driver
imPAIRment’ category and a ‘driver fitness’ category. Hence, the eleven-
item category structure identifies more specific aspects of driver-related
factors.

Intriguingly, in the eleven-cluster solution the ‘driver using mobile
phone’ factor was clustered within the ‘driver impairment’ category
with other factors related to impairment of the driver (e.g., ‘impaired by
alcohol’), rather than in the ‘distraction’ category with factors specifi-
cally related to distraction (e.g., ‘distraction in vehicle’; Fig. 3). This
suggests that police officers consider mobile phone use as more related
to impairment of the driver than to distraction. Mobile phone use
during driving is associated with impaired driving performance (Drews
et al., 2008; Strayer et al., 2006). Even when using hands-free tech-
nology, mobile phone use impairs driver reactions by reducing atten-
tional processing of the visual scene (Strayer et al., 2003). Hence, as
police officers suggest, mobile phone use may be more accurately
described as impairing driving ability, rather than distracting the driver
from the act of driving, such as by averting their gaze. Mobile phone use
is an under-reported factor in road crash records (NHTSA, 2009;
Rolison et al., 2018). Categorising mobile phone use as a driver im-
PAIRment, rather than a distraction, could help reduce under-reporting
by better aligning its categorisation in the crash report form with police
officers’ perception of how it contributes to road crashes. On this basis,
combined with a focus on more specific categories of factors, the
eleven-item category structure may yield better insights into crash
causation than the seven-item structure.

The current study has limitations. First, to identify the ideal cate-
gory structure of the contributory factors, hierarchical clustering ana-
lysis was conducted on police officers’ perceptions of the relations
among the factors, rather than devise an objective method of estimating
relations among the factors. In other words, police officers may be
biased in their perceptions of contributory factors, leading to a biased
category structure. However, the purpose of the current research was to
devise a category structure that minimises discord with police officers’
perceptions, in turn, reducing misinterpretation of the meaning of in-
dividual contributory factors. Hence, the proposed category structure
provides an ergonomic design that is tailored to the user.

Second, police officers may have used their prior knowledge of the
current UK road traffic collision reporting form, rather than their own
perceptions of the contributory factors, to inform their grouping of the
factors. Indeed, many features of the category structure devised from
police officers’ perceptions were compatible with the current collision
reporting form. However, as discussed above, the perceptions of police
officers also exhibited systematic differences from the current con-
tributory factor category structure. These differences imply a discord
between the current UK collision report form and the perceptions of
police officers who use the form to report on road traffic collisions.
While the category structure revealed by the current study shows ad-
vantages over the current report form in terms of its concordance with
police officers’ perceptions, future research should seek to examine to what extent the new category structure improves incident reporting. A first step would be to assess whether collisions are reported differently with the new category structure compared to the current incident report form in terms of the factors selected by the police officer for a road traffic collision. By virtue of the closer alignment with police officers’ perceptions of causation, the new category structure may also be easier and faster to complete by police officers than the current form, potentially leading to more efficient reporting and fewer reporting errors.

In conclusion, the current research investigated police officers’ perceptions of the relations among contributory factors in the UK road traffic collision reporting form. Hierarchical clustering analysis revealed an optimal category structure of the factors that minimised discord with police officers’ perceptions. The analysis also yielded new insights into police officers’ perceptions of crash causation as well as demonstrating how statistical clustering analysis can be used to inform the design of road crash reports.

Author contributions
Jonathan Rolison designed the research, conducted the research and statistical analyses, and wrote the article.

Declaration of Competing Interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements
The research was supported by a grant awarded by the UK Engineering and Physical Sciences Research Council (EPSRC Reference: EP/M017877/1; “A new metric for the assessment of driver crash risks”).

References