



Driver distraction and driver inattention: Definition, relationship and taxonomy

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ABSTRACT

There is accumulating evidence that driver distraction and driver inattention are leading causes of vehicle crashes and incidents. However, as applied psychological constructs, they have been inconsistently defined and the relationship between them remains unclear. In this paper, driver distraction and driver inattention are defined and a taxonomy is presented in which driver distraction is distinguished from other forms of driver inattention. The taxonomy and the definitions provided are intended (a) to provide a common framework for coding different forms of driver inattention as contributing factors in crashes and incidents, so that comparable estimates of their role as contributing factors can be made across different studies, and (b) to make it possible to more accurately interpret and compare, across studies, the research findings for a given form of driver inattention.

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1. Introduction

“Driver distraction” is not a new problem in road safety. It has been around for as long as people have been driving cars (Caird & Dewar, 2007), and there is no reason to believe that the situation is any different for “driver inattention”. There is increasing evidence that driver distraction and driver inattention are major contributing factors in car and truck crashes and incidents (e.g., Klauer et al., 2006; Olson et al., 2009), and it is likely that the problem will increase as more technologies find their way into vehicles. In response, there has been an explosion in research on these topics, culminating recently in the publication of entire books on driver distraction (Regan et al., 2008; Rupp, 2010), the initiation of a biannual International Conference on Driver Distraction and Inattention series (Regan & Victor, 2009) and the staging by the US Transportation Secretary Ray LaHood of annual National Summits on Distracted Driving, in 2009 and 2010 (e.g., see Department of Transportation, 2010 (DOT) at <http://www.distraction.gov/>). These activities build on earlier, similar, initiatives (e.g., Hedlund et al., 2005; Faulks et al., 2005).

The terms driver distraction and driver inattention are frequently discussed in the literature. However, as applied psychological constructs, they are inconsistently defined and the relationship between them is unclear. This has a number of implications. First, it can make the interpretation and comparison of

research findings across studies for a given form of inattention difficult, or even impossible. Secondly, similar studies may be measuring slightly different constructs and measuring different outcomes (Lee et al., 2008; Regan et al., 2009). Thirdly, different definitions can lead to different classification schemes for coding crash data, resulting in different estimates of the role of driver distraction and driver inattention in crashes, near-crashes and incidents (Gordon, 2008; Gordon & Evans, 2008; Pettitt et al., 2005). Finally, a lack of understanding of the different forms of driver inattention and the mechanisms that give rise to them has implications for the types of countermeasures considered, and for their potential effectiveness.

In the current paper, driver distraction and driver inattention are defined and, through the development of a taxonomy, an attempt is made to distinguish driver distraction from other forms of driver inattention. The definitions and taxonomy presented represent an attempt to address the issues noted above. This paper is not about facts and figures pertaining to driver distraction and driver inattention. Other published sources exist which summarise more broadly the extant state of knowledge on these topics (e.g., Caird & Dewar, 2007; Ho & Spence, 2008; Kircher, 2007; Ranney, 2008; Regan et al., 2008; Young et al., 2003). We start here by considering what is meant by the term “driver distraction”.

2. What is driver distraction?

The term distraction has been defined as the “diversion of the mind, attention, etc., from a particular object or course; the fact of having one’s attention or concentration disturbed by something” (Shorter Oxford English Dictionary on Historical Principles, 2002,

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pp. 716). While this definition is devoid of context, it does imply that distraction involves a diversion of attention away from something and that this “something” disturbs one’s concentration on something else.

Pettitt et al. (2005) highlight the diversity that exists across research studies in the definition of driver distraction, noting that it is not uncommon for studies to investigate driver distraction without first defining the construct itself. Driver distraction is, they suggest, an everyday term, the meaning of which has become “somewhat abstract” and lacking in precision for scientific purposes (pp. 2). This diversity in definition can, as noted, be problematic. However, it is perhaps understandable given the different purposes for which such definitions have been derived. For scientific purposes, as noted by Pettitt et al., a precise definition that is used consistently across research studies is desirable, so that the interpretation and comparison of research findings across studies is made possible. However, a more operational definition may be required in other situations; as, for example, when a researcher is required to code and analyse driver behaviours observed from video footage collected from instrumented vehicles in naturalistic driving studies (e.g., Klauer et al., 2006). In the Klauer et al. study, for example, driver distraction is defined as occurring when “. . . a driver has chosen to engage in a secondary task that is not necessary to perform the primary driving task” (pp. xiv). Operational definitions, such as this, aid in the ease, accuracy and consistency of coding driver behaviours observable in video footage. The question is whether it might be possible to develop a generally accepted definition that is suitable enough for both scientific and operational purposes.

One approach to developing a generally accepted definition of driver distraction that might serve both purposes is to assemble a group of experts and try to come to some common agreement about what it means. This was done at an International Conference on Distracted Driving in Canada in 2005 (Hedlund et al., 2005) which yielded the following definition:

- (1) “a diversion of attention from driving, because the driver is temporarily focusing on an object, person, task or event not related to driving, which reduces the driver’s awareness, decision making ability and/or performance, leading to an increased risk of corrective actions, near-crashes, or crashes” (pp. 2).

Another approach is to systematically review, compare, and analyse definitions cited in the literature to reveal elements considered and invoked previously in defining the construct. This has been done in at least two known papers (Lee et al., 2008; Pettitt et al., 2005). These exercises revealed the following two definitions, respectively:

- (2) “Driver distraction is the diversion of attention away from activities critical for safe driving toward a competing activity” (Lee et al., 2008, pp. 34).
- (3) “Driver distraction:
 - Delay by the driver in the recognition of information necessary to safely maintain the lateral and longitudinal control of the vehicle (the driving task) (Impact)
 - Due to some event, activity, object or person, within or outside the vehicle (Agent)
 - That compels or tends to induce the driver’s shifting attention away from fundamental driving tasks (Mechanism)
 - By compromising the driver’s auditory, biomechanical, cognitive or visual faculties, or combinations thereof (Type)” (Pettitt et al., 2005, pp. 11).

The more traditional approach has been to define driver distraction based on the categorisation of human functional failures observed as contributing factors in road crashes.

- (4) Driver distraction occurs “whenever a driver is delayed in the recognition of information needed to safely accomplish the driving task, because some event, activity, object, or person within [or outside] his vehicle, compelled or tended to induce the driver’s shifting of attention away from the driving task” (Treat, 1980, pp. 21).
- (5) Driver distraction results “from interference between a driving task and an external stimulation without link with driving (e.g., guide a vehicle and tune the radio). This secondary task can be gestural or visuo-cognitive” (Hoel et al., 2010, pp. 576).

These various approaches, in combination, reveal some key elements which have been thought about in defining driver distraction:

- there is a diversion of attention away from driving, or safe driving;
- attention is diverted toward a competing activity, inside or outside the vehicle, which may or may not be driving-related;
- the competing activity may compel or induce the driver to divert attention toward it; and
- there is an implicit, or explicit, assumption that safe driving is adversely effected.

We shall return to these key elements later in the paper. In the next section, we review definitions of “driver inattention”.

3. What is driver inattention?

A suitable starting point in defining “inattention” is to define “attention”. Attention has been defined as the “concentration of the mind upon an object; maximal integration of the higher mental processes” (Macquarie Dictionary, 1988, pp. 147). In the scientific literature there are as many definitions of attention as there are attempts to define it, reflecting the diversity of opinion that exists about what it means, even after more than 100 years of scientific research on the topic. Nevertheless, there do exist parsimonious definitions that seem to capture the essence of the construct, such as that proffered by Streff and Spradlin (2000) “. . . the process of concentrating or focusing limited cognitive resources to facilitate perception or mental activity” (pp. 3).

“Inattention”, on the other hand, has been defined as the “failure to pay attention or take notice” (Shorter Oxford English Dictionary on Historical Principles, 2002, pp. 1340). Of course, this is not a definition of *driver* inattention, as it is devoid of context. However, it is interesting as it implies (a) that a person has control of their attention and (b) that to be inattentive is to be somehow negligent.

Very few definitions of driver inattention exist in the literature, and those that do, like driver distraction, vary in meaning. Lee et al., 2008, for example, define driver inattention as “diminished attention to activities critical for safe driving in the absence of a competing activity” (pp. 32). Victor et al., 2008 define driver inattention as “improper selection of information, either a lack of selection or the selection of irrelevant information” (pp. 137). For Treat (1980), driver inattention occurs “whenever a driver is delayed in the recognition of information needed to safely accomplish the driving task, because of having chosen to direct his attention elsewhere for some non-compelling reason” (pp. 21). Senders defines driver ‘inattention’ as “an *ex post facto* identification of something that was not being looked at and was immediately followed by a reportable accident that might have been avoided if the ‘something’ had been looked at” (Senders, J.W., personal communication, 28th September 2010). As one can see, these meanings are diverse.

Driver inattention has been variously coded in crash and observational studies. In a recent crash study, driver inattention was defined as occurring “when the driver’s mind has wandered from the driving task for some non-compelling reason” such as when

the driver is “focusing on internal thoughts (i.e., daydreaming, problem solving, worrying about family problems, etc.) and not focusing attention on the driving task” (Craft & Preslopsky, 2009, pp. 3). Talbot and Fagerlind (2009), in a pan-European study of 1005 crashes, defined driver inattention as “low vigilance due to loss of focus” (pp. 4). In the 100-car naturalistic driving study, inattention was defined as “any point in time that a driver engages in a secondary task, exhibits symptoms of moderate to severe drowsiness, or looks away from the forward roadway” (Klauer et al., 2006, pp. 21). In this definition, it seems that inattention is defined both by driver activity and driver state (i.e., drowsiness). The latter authors suggest, as have some others (see below), that there exist different forms of driver inattention.

3.1. Previous taxonomies of driver inattention

The detailed analysis of data from in-depth crash studies can provide important insights into the role of driver inattention in vehicle crashes, some of which have not been picked up in the mainstream literature on driver inattention. Van Elslande and Fouquet (2007a, 2007b), for example, have identified five categories of “human functional failures” which may lead to crashes: failures in information acquisition, failures in diagnosing the situation, failures in predicting the situation, failures in deciding to make a particular manoeuvre, failures in performing an action, and a general category of failure relating to driver state (e.g., failures arising from loss of ability, impairment, etc.). Within each of these categories of failure, the authors describe how various disturbances of attention may play a factor in failures which contribute to crashes.

Of particular relevance here is Van Elslande and Fouquet's (2007a, 2007b) first category of functional failure (i.e., failure in information acquisition). Here, they delineate five types of what might be regarded as perceptual (not attentional per se) failures (labelled P1–P5) that have contributed to crashes (2007a, pp. 19–20; 2007b, pp. 12–14):

P1 failure—Non-detection in visibility constraints: Here, the driver cannot detect or has difficulty detecting information critical for safe driving because certain things physically prevent the driver from detecting it. These include, for example, environmental constraints linked to the layout of the road, the presence of other vehicles that obstruct vision, and luminosity problems;

P2 failure—Information acquisition focused on a partial component of the situation: Here, the drivers focuses their eyes and their attention on one aspect of driving to the exclusion of another, which results in them failing to detect another hazard (e.g., an oncoming vehicle) that is more time-critical for safe driving;

P3 failure—Cursory or hurried information acquisition: This failure occurs when the driver gives cursory or hurried attention to driving-related information, thus not perceiving all of the information required. A driver faced with a familiar driving manoeuvre, for example, may allocate insufficient attention in searching for information and fail to notice a vehicle crossing their trajectory;

P4 failure—Momentary interruption in information acquisition activity: Here, the driver momentarily diverts his or her eyes and attention away from the road scene toward a competing activity. The competing activity could be an outside “attractor” (Van Elslande & Fouquet, 2007a, pp. 20) such as an advertising billboard, the need to re-position the rear-view mirror, or searching for a car park, which disrupts their attention. Additionally, the driver's eyes and attention could be diverted due to the “weak solicitation of resources” by the ongoing driving task (i.e., monotony), which can “drift” their focus of vision and attention to activities secondary, and non-related, to driving, such as conversing with a passenger, tuning the radio, or looking at something in the environment (Van Elslande & Fouquet, 2007a, pp. 20);

P5 failure—Neglecting the need to search for information: In this case a driver who is under some constraint, and is familiar with the route, neglects to focus attention on activities critical for safe driving, e.g., a driver approaching an intersection with the right of way, neglects to check for conflicting vehicles, resulting in a collision or near-collision with a driver who runs a red light.

In a more recent publication, Hoel et al., 2010 report on an in-depth analysis of vehicle crashes involving 251 drivers in France. They distilled three broad categories of attentional “default” that emerged as contributing factors in the crashes analysed: “inattention”, “attentional competition” and “distraction” (Hoel et al., 2010, pp. 595). All three categories, they argue, derive from interference between driving and another task. For driver inattention, this interference occurs between a driving activity and “personal concerns” (i.e., internalised thoughts). For distraction, this occurs from the interference between a driving activity and a secondary activity, which is non-driving-related, such as tuning the radio. Attentional competition arises from interference between tasks that are relevant for driving, such as controlling the vehicle and navigating. This taxonomy of “attentional defaults” (pp. 577) incorporates the P2 and P4 failures described above. For Hoel et al. (2010), it appears that inattention is synonymous with driver preoccupation in internalised thought, whereas distraction is the diversion of attention away from driving activity toward *non-driving* tasks.

Another, complementary, taxonomy useful in characterising driver inattention is the Driver Reliability and Error Analysis Method (DREAM; Wallén Warner et al., 2008). DREAM is an adaptation of the Cognitive Reliability and Error Analysis Method (CREAM; Hollnagel, 1998) which was developed to analyse accidents within process control domains such as in nuclear power plants. The purpose of DREAM is to systematically classify accident causation information, which has been collected from in-depth road crash investigations (Wallén Warner et al., 2008). The classification scheme in DREAM Version 3.0 includes 51 “General Genotypes”, or factors, which have been found to be contributing factors in road crashes, including inattention. Within this classification system, driver inattention is defined as “Any condition, state or event that causes the driver to pay less attention than required for the driving task” (Wallén Warner et al., 2008, pp. 12). This was further decomposed into the following “Specific Genotypes”: “driving-related distractors inside vehicle”; “driving-related distractors outside vehicle”; “non-driving-related distractors inside vehicle”; “non-driving-related distractors outside vehicle”; and “thoughts/daydreaming”. In the latter category the driver was defined as being “distracted by his/her own thoughts—including thoughts about how to, for example, find the best route” (Wallén Warner et al., 2008, pp. 12). Interestingly, Wallén Warner et al. (2008), unlike Hoel et al. (2010), regard driver preoccupation in internalised thoughts and daydreaming as manifestations of driver distraction.

Treat (1980), in his seminal paper on pre-crash factors involved in traffic accidents, proposed a different taxonomy from those above which differentiated between driver inattention and driver distraction. In seeking to explain why drivers were delayed in their recognition of situations requiring “adjustment of speed or path of travel for safe completion of the driving task” (pp. 21), he distinguished between the following contributing factors: inattention, external distraction, internal distraction, and inadequate or improper outlook. He defined these as follows:

- 1) Inattention—“whenever a driver is delayed in the recognition of information needed to safely accomplish the driving task, because of having chosen to direct his attention elsewhere for some non-compelling reason” (pp. 21).

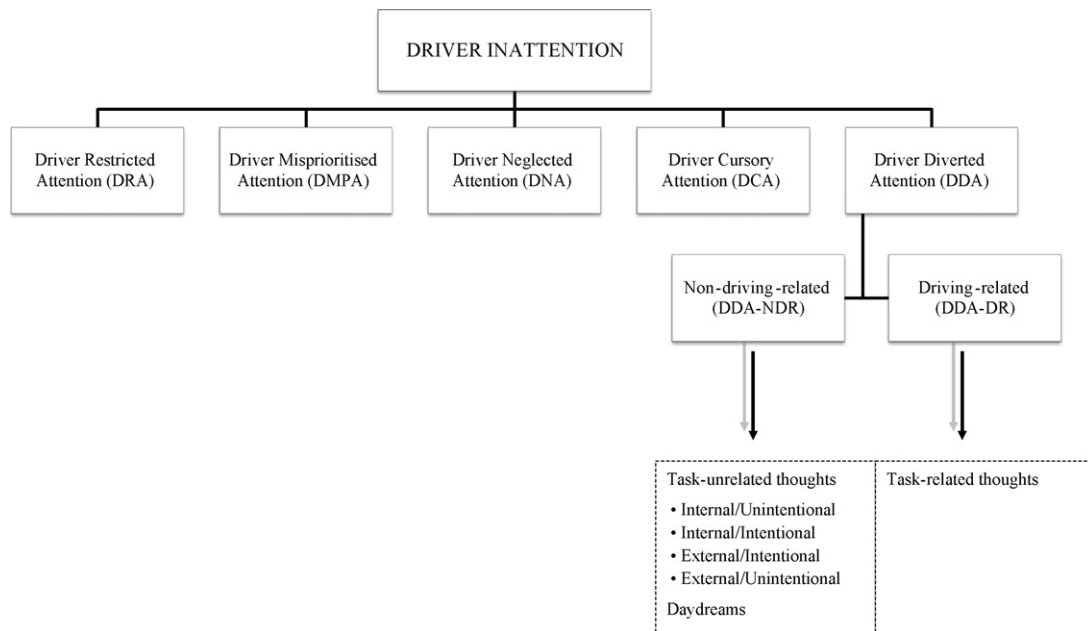


Fig. 1. Taxonomy of driver inattention.

- 2) Internal distraction—“whenever a driver is delayed in the recognition of information needed to safely accomplish the driving task, because some event, activity, object, or person within his vehicle, compelled or tended to induce the driver’s shifting of attention away from the driving task” (pp. 21).
- 3) External distraction—“whenever a driver is delayed in his recognition of information needed to safely accomplish the driving task, because some event, activity, object or person outside his vehicle compelled, or tended to induce, the driver’s shifting of attention away from the driving task” (pp. 22).
- 4) Inadequate or improper lookout—“whenever a driver is delayed in his recognition of information needed to safely accomplish the driving task, because he encountered a situation requiring a distinct visual surveillance activity (for safe completion of the driving task), but either did not look or did look, but did so inadequately” (pp. 22). For instance, pulling out to pass without first checking for traffic in the passing lane or pulling out from a parking place without checking for traffic.

3.2. Summary

This limited review serves to highlight the various ways in which driver inattention has been conceptualised in the literature and the lack of agreement about what it means. Driver inattention seems to encompass many elements: a lack of attention, insufficient attention, cursory attention, the selection of irrelevant information, the orienting of attention on internalised thoughts and daydreams, engagement in activities secondary to driving, drowsiness, and looking away from the forward roadway. Senders makes the logical point that definitions of driver inattention are speculative accounts resulting from a belief, quite possibly mistaken, that if a driver were to pay attention all the time there would be no accidents (Senders, J.W., personal communication, 28th September 2010). Furthermore, he underscores the point that it is only with the benefit of hindsight that one can determine whether at a particular moment in time someone had been “inattentive”. These are important insights to which we shall return. For now, we continue to try to disentangle the state-of-the-art. In the following section, we consider the distinction between “driver distraction” and “driver inattention”.

4. Distinguishing between driver distraction and driver inattention

There are essentially two points of view in the consideration of the relationship between driver distraction and driver inattention. One asserts that driver distraction is a form of driver inattention; that, conceptually, the two constructs exist taxonomically at different levels. The other asserts that driver distraction is different from driver inattention; that the constructs exist taxonomically at the same level.

Several authors assert that driver distraction is a form of driver inattention. Victor et al. (2008), for example, define driver distraction as “the inappropriate selection of information to the extent that safety-relevant information is missed. Thus, distraction is here defined as a subset of inattention, referring to all instances when attention is *misallocated*, but excluding cases when attention is not allocated at all” (pp. 137). Stutts et al. (2005) state that “it is the presence of a triggering event that distinguishes distraction from other forms of driver inattention” (pp. 1094). Pettitt et al. (2005) state that “the result of distraction is inattentive driving, however inattention is not always caused by distraction” implying that inattention can arise without the presence of a distractor (pp. 4).

Others assert that driver distraction is different from driver inattention. Lee et al. (2008) assert that the critical factor distinguishing driver distraction from driver inattention is the absence (in the case of driver inattention) of a competing activity. Caird and Dewar (2007) argue, similarly, that “the essential distinction between inattention and distraction is that inattention is internal to the driver and non-compelling, whereas distraction is external to the driver and compelling” (pp. 196). For Treat, the essential difference between driver inattention and driver distraction is that inattention does not involve an “event, activity, or object [that] compels or tends to induce... a shift” of “attention from the driving task” (pp. 21). For Hoel et al. (2010), the critical difference between driver inattention and driver distraction is the nature of the competing activity—for inattention, it is preoccupation in internalised thought and for driver distraction it is any external (i.e., to the mind) non driving-related activity.

Those who argue that driver distraction and driver inattention are fundamentally different constructs imply that there are certain characteristics of driver distraction that distinguish it from driver inattention. In the case of driver distraction, there is a triggering event, there is a competing activity, the competing activity may compel and tend to induce an attentional shift, and the competing activity is externally generated (i.e., is not generated from within the mind; however this point is debated). The trouble with this way of thinking is that it focuses on the differences between the two constructs rather than on the properties that they share. Pettitt et al. (2005), as noted, state that “. . . the result of distraction is inattentive driving, however inattention is not always caused by distraction” (pp. 4). This is an important insight; they assert that driver distraction may lead to driver inattention. If one believes that driver distraction may lead to driver inattention then, taxonomically, there is no logic in seeking to differentiate between driver inattention and driver distraction as separate constructs. To take the field further, it is more fruitful to think about the relationship between them.

As previously mentioned, Van Elslande and Fouquet (2007a) delineated five types of human functional failures (labelled P1–P5) that appear to be contributing factors in accident causation. In Fig. 1 (see below), we have attempted to decompose driver inattention into what might be its constituent forms, by thinking about their work and that of others reviewed up to this point. The taxonomy proposed in Fig. 1 is different from those previously proposed by Treat (1980), Wallén Warner et al. (2008) and Hoel et al. (2010) in the sense that driver inattention is defined as a process (rather than as an activity or driver state), and the forms of driver inattention nested beneath it are defined by the psychological mechanisms that give rise to this process.

5. A taxonomy of driver inattention

5.1. Derivation and description

The critical starting point for the taxonomy is driver inattention (Fig. 1). We define driver inattention here as *insufficient, or no attention, to activities critical for safe driving*. Driver inattention, according to this definition, includes instances where (a) the driver does not pay attention to the activity (or activities) most critical for safe driving, (b) where the driver gives insufficient attention to the activity (or activities) most critical for safe driving, or (c) where the driver gives full attention to an activity (or activities) that is not the activity most critical for safe driving. We define within the taxonomy (Fig. 1) the different attentional mechanisms that may give rise to these manifestations of driver inattention. In Section 8 of this paper we discuss what is meant by “activities critical for safe driving”.

Within the taxonomy (Fig. 1) the different mechanisms by which inattention may arise define the different categories of inattention. The definition of driver inattention proposed in this paper is almost identical to that proposed by Lee et al. (2008) (pp. 34; Section 2). However, there are two important differences between the two definitions. First, the definition by Lee et al. (2008) terminates with the words “in the absence of a competing activity” (pp. 34). These words are necessary only if one is comparing driver distraction with driver inattention. However, as is illustrated in the present taxonomy, a driver can become inattentive to driving without the presence of a competing activity. Secondly, we refer in the present definition to “insufficient or no attention” to activities critical for safe driving rather than, as in the Lee et al. definition, to “diminished” attention to activities critical for safe driving. This is because the term “diminished attention” does not incorporate the case in which a driver gives full attention to an activity (or activities) that is not

the activity most critical for safe driving; and nor does the term “diminished” encapsulate the possibility that, despite being diminished, the quantum of attention allocated to activities critical for safe driving may nevertheless be sufficient.

We propose that driver inattention, as defined here, can be brought about by the following forms, or sub-categories, of driver inattention shown in Fig. 1:

- Driver Restricted Attention (DRA)—Insufficient or no attention to activities critical for safe driving brought about by something that physically prevents (due to biological factors) the driver from detecting (and hence from attending to) information critical for safe driving. This category of inattention is brought about by biological characteristics of the driver that prevent him from attending to information critical for safe driving. For instance, a driver can miss critical information and activities during moments of micro-sleep, blinks, or saccades (Victor et al., 2008). DRA can also include moments of “change blindness” (Rensink, 2000; Simons & Rensink, 2005), in which the driver fails to notice critical changes in the driving scene. Even with open eyes, drivers who are fatigued gradually withdraw the attentional resources needed for safe driving, either because less resources are available or because drivers become unable to match their resources with the demands of the task (Trick et al., 2004).
- Driver Misprioritised Attention (DMPA)—Insufficient or no attention to activities critical for safe driving brought about by the driver focusing attention on one aspect of driving to the exclusion of another, which is more critical for safe driving. This category is intended to capture a point made by Hancock et al. (2008)—that, at times, a driver can be “engaged in what is considered ‘the wrong’ aspect of the driving task at the time in question” (pp. 25). In this category, inattention arises from a failure to effectively distribute attention between multiple driving activities which are ongoing, both of which may be equally (or almost equally) critical for safe driving. As defined here, an example of misprioritised attention would be a driver who looks over their shoulder while merging and misses a lead vehicle braking. For the experienced driver, this might be a matter of inadequate prioritisation between competing demands, or a breakdown in time-sharing when the demands of time-sharing exceed the capacity of the driver. For young novice drivers, this may derive from an under-developed ability to prioritise attention (Fisher et al., 2002; Regan et al., 1998).
- Driver Neglected Attention (DNA)—Insufficient or no attention to activities critical for safe driving brought about by the driver neglecting to attend to activities critical for safe driving. This form of driver inattention relates to a P5 failure in the Van Elslande and Fouquet (2007a) paper and to some of the ‘Inadequate or Improper Lookout’ failures in the Treat (1980) taxonomy. This category might include, for example, a driver (driving on the right-hand side of the road) approaching an unsignalised T-intersection intending to turn right who does not see a cyclist on a bike path approaching from the right that intersects (just before the T-junction) the road on which the driver is travelling, because they do not look in this direction (Engstrom et al., 2009). Engstrom et al. (2009) argue that in this situation driver expectation is a relevant factor that might lead to the driver failing to attend to the cyclist: the driver’s expectation of “cars to the left” focuses their attention in the left visual field, so that the cyclist is either out of the driver’s field of view or, even if within it, is not perceived because the driver is “blind” to it, due to lack of attention. A driver who neglects to scan for trains at a railway level crossing (because they are rarely or never seen), or for oncoming motorcycles when turning left across traffic at an intersection (because they are less expected than other cars and trucks), also falls into this category; as does a driver who does

not notice a new traffic sign because of over-familiarity with the route on which the new sign has appeared. Generally, we suggest that in this sub-category of driver inattention, attention is dominated by top-down processes and is goal directed by cognitive factors such as knowledge, expectation and current goals (Victor et al., 2008).

- Driver Cursory Attention (DCA)—Insufficient or no attention to activities critical for safe driving brought about by the driver giving cursory or hurried attention to activities critical for safe driving. An example here is a driver who is in a hurry and does not complete a full head check when merging—and, in doing so, ends up colliding with a merging car. This relates to a P3 failure in the Van Elslande & Fouquet (2007a) (pp. 20) paper and to the ‘Inadequate or Improper Outlook’ failures category in the Treat (1980, pp. 22) taxonomy.
- Driver Diverted Attention (DDA)—The diversion of attention away from activities critical for safe driving toward a competing activity, which may result in insufficient or no attention to activities critical for safe driving. This category of inattention is synonymous with “driver distraction”. The definition proposed here is almost identical to that coined for driver distraction by Lee et al. (2008) (pp. 34). The Lee et al. definition seems to capture the key elements pertaining to the construct as previously distilled from the other definitions reviewed in this paper. However, unlike the definition presented here, it does not capture the important notion of insufficient or no attention being given to activities critical for safe driving. Driver Diverted Attention encompasses the P4 failure in the Van Elslande and Fouquet (2007a) paper, although we assert that it includes the diversion of attention to internalised mental activities (i.e., internalised thoughts and daydreams; Section 7). Driver Diverted Attention also encompasses what Treat (1980, pp. 21–22) refers to as “internal” and “external” distractions; that is, competing activities that derive from inside the vehicle (e.g., conversing with a passenger) or from outside the vehicle (e.g., looking at a pedestrian), respectively. The effects of the interference brought about by the diversion of attention may be “manifest” (as in a lane excursion) or “intrinsic” (i.e., unobservable; as in the loss of situational awareness) (Hancock et al., 2008, pp. 23). Additionally, we contend that the diversion of attention may interfere with activities critical for safe driving even when the vehicle is stationary (e.g., as when a driver is distracted and as a result fails to fasten their seatbelt prior to starting their journey). This possibility has not been highlighted in the literature.

We propose that DDA can be further decomposed into the following two sub-categories:

- DDA non-driving-related (DDA-NDR; between driving and non-driving – related tasks) – is the diversion of attention away from activities critical for safe driving toward a competing non-driving-related activity. In this case, the driver diverts attention away from activities critical for safe driving toward a competing activity that is non-driving-related (e.g., composing a text message to a friend). This is what Hoel et al. (2010) (pp. 596) define as “distraction”;
- DDA driving-related (DDA-DR; between driving-related tasks) is the diversion of attention away from activities critical for safe driving toward a competing driving-related activity. Here, the driver diverts attention away from activities critical for safe driving toward a competing activity that is driving-related. For example, the driver attends to the erratic behaviour of another road user, or attends to a low fuel warning light that suddenly illuminates/sounds. This is what Hoel et al. (2010) regard as “attentional competition” (pp. 596). This category of driver inattention is different from the category of inattention that we have

called “driver misprioritised attention (DMPA)”, although the difference is subtle. In the former category, inattention arises from a failure to effectively distribute attention between multiple driving activities which are ongoing, both of which may be equally (or almost equally) critical for safe driving. In the latter, inattention arises from the voluntary or involuntary diversion of attention away from activities critical for safe driving toward a competing, driving-related activity, that is less safety-critical.

The manner in which we have decomposed driver inattention into its constituent forms differs from previous thinking on the topic—although, as noted, we have borrowed in part from the work of others (e.g., Van Elslande & Fouquet, 2007a; Treat, 1980) in helping us to refine our thinking about what the various forms of inattention might be. The labels that we have given these forms of inattention are tentative, and it may be possible to group the forms distilled here into different logical groupings. This decomposition does, however, enable one to begin to make taxonomically and operationally logical distinctions between different forms of driver inattention, and between the two sub-categories of driver diverted attention proposed. It provides a starting point for the more accurate and consistent classification of crash and incident data.

The development of this taxonomy is predicated on the assumption that it is not necessary for the driver to have control over the factors that give rise to inattention; drivers can, through no fault of their own, be inattentive to activities critical for safe driving. Biological factors beyond the control of the driver, for example, may make it difficult or impossible for a driver to attend to activities critical for safe driving. In particular, for this reason, we have included the ‘Driver Restricted Attention (DRA)’ category within the taxonomy and acknowledge that, in the DMPA category, there may be circumstances in which it is impossible for drivers to give priority to activities most critical for safe driving at a given moment in time.

Fig. 1 contains two sub-categories of Driver Diverted Attention that, so far, have not been discussed—“task un-related thoughts” and “task-related thoughts” (Section 7). The former category relates to preoccupation in internalised thought that competes for driver attention that is unrelated to the driving task, whereas the latter category relates to preoccupation in internalised thought that is driving-related. We return to these sub-categories later in this paper.

5.2. Further comments on the taxonomy

5.2.1. Operationalising categories

It is pertinent to ask whether, collectively, all of the levels in the current taxonomy are necessary. Two general issues are relevant here. The first one is the pragmatic issue of whether researchers and transport safety authorities currently have the tools, methods, or sufficient information from their data collection methods to be able to code for, and differentiate between, the different categories of driver inattention proposed here. For example, current limitations in data collection methods make it difficult or impossible to determine whether someone involved in a crash was distracted by task-unrelated thoughts. Related to this is the pragmatic issue of whether it is possible, operationally, to prove the existence of some categories, even if adequate data is available. For example, in relation to Driver Cursory Attention, how is one to operationally define the ‘proper’ amount of attention that should have been given to activities critical for safe driving, even with the benefit of hindsight? This may not be an easy exercise. The second general issue relates to whether the categories proposed here can be operationally distinguished. For example, although it should be possible to extract – from video records from instrumented vehicles and from in-depth crash data – instances of Driver Neglected Attention, it may

be operationally difficult to distinguish between Driver Neglected Attention and Driver Cursory Attention. Acknowledgment of these issues, however, does not make the distinction between the different categories of driver inattention pointless. It may be that, in future, the instrumentation used in naturalistic driving studies will become increasingly sophisticated enough to prove the presence of some forms of driver inattention in the taxonomy that cannot currently be confirmed. Similarly, new algorithms may be developed to support improved analysis and interpretation of video data. Delineation of the different forms of driver inattention also provides an impetus for the creation of new research programs concerned with performance degradation and increased crash risk deriving from each of the different forms of driver inattention identified. It is fair to say that, to date, Driver Diverted Attention is the only form of driver inattention in the taxonomy presented here that has been systematically researched from a traffic safety perspective.

5.2.2. Relationship between driver inattention, driver conditions and driver states

In developing the taxonomy, we have considered the relationship between driver inattention and driver *conditions* (e.g., young, inexperienced, etc.), and between driver inattention and driver *states* (e.g., bored, sleepy, fatigued, drunk, drugged, medicated, emotionally upset, etc.). There has been some confusion in the literature about this relationship. For example, in the 100-car study driver inattention was coded as “. . .any point in time that a driver engages in a secondary task, exhibits symptoms of moderate to severe drowsiness, or looks away from the forward roadway” (Klauer et al., 2006, pp. 21). In this definition, inattention is coded both in terms of driver activity and driver state (i.e., drowsiness). Just because the driver is drowsy, however, does not mean that they are inattentive to activities critical for safe driving. It is proposed here that driver conditions and states are factors that can either (a) give rise to different forms of inattention (e.g., the young inexperienced driver who fails to effectively prioritise attention when time-sharing between competing activities critical for safe driving [DMPA]; the tired driver who experiences moments of vision loss due to blinking [DRA]; the drunk driver who is too slow in switching attention from one attribute of the driving situation to a more critical one [DMPA]) or (b) moderate the impact of a given form of inattention when it is manifest (e.g., the young driver who, as a result of inexperience, is affected more by a competing activity [DDA] because he or she has less spare attentional capacity to devote to the competing activity).

5.2.3. Moderating factors

Young et al. (2008) have asserted that whether driver distraction, when it occurs, has an impact on driving performance, depends on a number of *moderating factors* - which they have distilled into four basic categories: driver characteristics, driving task demand, competing task demand and the ability of the driver to self-regulate in response to the competing activity. Factors they cite which influence driving task demand, for example, include traffic conditions, weather conditions, road conditions, the number and type of vehicle occupants, cockpit design, and vehicle speed. Generally, the lower the demand of driving, the greater will be the residual attention available to attend to competing activities. A well ergonomically designed vehicle cockpit interface, for example, which minimises workload, will give the driver more capacity to attend to competing tasks, and hence reduce overall interference between the tasks. We have not yet established, in proposing the taxonomy presented here, what the comparable moderating factors might be for the other forms of inattention proposed. This is, however, an important area for further thinking and research.

5.3. Hindsight bias

It is acknowledged that the taxonomy in Fig. 1 suffers from “hindsight bias” (Horrey, W.J., personal communication, 7th May 2010; Senders J.W., personal communication, 28th September 2010); that is, the forms of driver inattention proposed are derived from studies of crashes and critical incidents in which judgements have been made after the fact about whether or not a driver was attentive to an activity critical for safe driving. Horrey points out that a driver might encounter the same traffic scenario and attend to the surrounding environment in exactly the same fashion a hundred times and not be involved in a single collision. Hence, “Can we fairly say that the driver is ‘attentive’ 100 times but ‘inattentive’ . . . on the 101st time—even though their behaviour is no different?” (Horrey, W.J., personal communication, 7th May 2010).

How to develop a taxonomy of driver inattention without the benefit of hindsight is an important theoretical and practical challenge beyond the scope of this paper. One approach might be to define, a priori, the various categories of attention that, from the attentional literature, are known to exist—and then to determine, on this basis, what *inattention* might mean for each of these categories. Wickens and McCarley (2008) have distinguished between five broad categories of attention: focused, selective, switched, divided and sustained. They describe focused attention, for example, as the ability to focus attention, in the face of distraction. Thus, according to this description, failures of focused attention (in so much as they relate to driving) might be regarded at a general level as being synonymous with the category of inattention we have referred to in Fig. 1 as Driver Diverted Attention (i.e., driver distraction); that is, driver distraction might be regarded as a form of driver inattention brought about by a failure of the driver to focus attention on activities critical for safe driving. Trick et al. (2004) propose a theoretical framework for studying the role of selective attention in driving which may provide a suitable starting point for classifying problems in selective attention that might lead to driver inattention. However, while Trick et al. start out by asserting that “Driver inattention is thought to cause many automobile crashes” (pp. 385), they do not in their paper delineate links between the problems of selective attention that they describe and the categories of inattention that these might bring about. Clearly the important next steps in the refinement of the taxonomy presented here are to validate it theoretically and practically—by developing a theoretical framework for understanding attentional failures in crash causation that can be used to fine tune it (perhaps along the lines alluded to here), and by applying the taxonomy to a large pool of crash and incident data. Such data might include event descriptions derived from in-depth crash investigations and video data collected from observational studies that use instrumented vehicles.

5.4. Other issues related to the taxonomy

The taxonomy proposed in this paper is useful in resolving issues such as whether inattention means a lack of attention or insufficient attention to activities critical for safe driving. From the taxonomy, it is clear that this depends on the form of inattention to which one is referring. Driver Cursory Attention will result in insufficient attention to activities critical for safe driving whereas Driver Restricted Attention may result in no attention to activities critical for safe driving. The taxonomy is also important in thinking about relationships between different forms of driver inattention. It is possible, for example, for more than one category of inattention to derive from the same activity. Sun strike (or driving into the sun), for example, may cause drivers to close their eyes momentarily. In doing so, they may miss seeing and hence attending to information critical for safe driving (DRA). If they adjust the position of the sun visor to block out the sun, and in so doing fail to attend to activities criti-

cal for safe driving, this will result in DDA-DR. Similarly, the same behavioural outcome can be generated by different forms of driver inattention. The “looked but failed to see” phenomenon, for example, might occur because a driver is fatigued (DRA) or because the driver is preoccupied in internal thought (DDA).

6. Driver diverted attention: the voluntary and involuntary selection of information

The diversion of attention away from activities critical for safe driving toward a competing activity can occur voluntarily or involuntarily. The theoretical and practical implications of this have not, to our knowledge, been considered in the literature and warrant discussion.

A cell phone that suddenly rings in the car (DDA; non-driving-related) or a low fuel warning alarm that suddenly sounds (DDA; driving-related) will invariably divert attention away from driving. These are things that are difficult, or impossible, to ignore. There are countless other examples of competing activities (driving- and non-driving-related) that compel us involuntarily to divert attention toward them: a ringing cell phone, a screaming baby, a cup of coffee spilling, a bee flying inside the vehicle, a flashing advertising billboard, the erratic behaviour of another driver, a crash scene, etc. These things, which some others might describe as “compelling”, have certain properties: they are unusual, unpredictable, irritating, unexpected, or sudden; they have physical or psychological properties that make them highly salient; they violate our expectations, and so forth. Generally, they are things that are difficult or impossible to ignore, and generally which are not initiated by the driver. They are things that provide a discernable “trigger” (Stutts et al., 2005) for the diversion of attention. It might be argued that it is only these kinds of things - that capture driver attention involuntarily - that should be regarded as sources of distraction given that, as inferred from previous definitions, they are things that are difficult or impossible to ignore and disturb concentration. However, for the purposes of the present discussion, we shall concur with the research community in assuming that the diversion of attention away from driving toward a competing activity is distraction, regardless of whether the diversion is involuntary or voluntary.

When drivers choose voluntarily to divert attention toward competing activities (e.g., when selecting a radio station), they will have some latitude to self-regulate their driving behaviour to compensate for the anticipated impact of this diversion on their driving performance and, in doing so, to maintain situational awareness. However, they may not have the same scope to self-regulate in time and space when the source of distraction is compelling, and the subsequent diversion of attention is involuntary. Thus, the psychological mechanisms involved in these two scenarios may be quite different, and may lead to different patterns of interference.

The same source of distraction may give rise over time to both the voluntary and involuntary diversion of attention. Driver Diverted Attention that arises in an involuntary manner (as when a cell phone rings), for example, may lead in turn to the voluntary diversion of attention (as when the driver looks for the phone in order to answer the call, and talk). Conversely, Driver Diverted Attention that is brought about by voluntary engagement in a competing activity (as when a driver unwraps a cheeseburger) may subsequently lead to the involuntary diversion of attention (i.e. a reflexive response, as when a cheeseburger unexpectedly falls on the driver's lap and the driver looks at it). Thus, it is possible to think about distracting events as evolving over time, from one category of engagement to another. The voluntary/involuntary distinction, although useful in thinking about the manner in which a distracting episode is initiated, unfolds and impacts on driving performance, is not a differentiating feature of the taxonomy of Driver Diverted

Attention presented in Fig. 1. However it may prove to be useful in future in thinking about interventions or problem mitigation.

7. Internalised thoughts

Caird and Dewar (2007), as noted, argue that “the essential distinction between driver inattention and driver distraction is that inattention is internal to the driver and non-compelling” (pp. 196). But what is meant by “internal to the driver”; and to which form of driver inattention are they referring? As argued earlier, it appears that several forms of driver inattention may exist. Caird and Dewar (2007) appear to suggest that driver inattention is evidenced by only one activity: the allocation of attention to internalised thoughts. There is, as previously discussed, disagreement in the literature about whether driver preoccupation in internalised thought is driver inattention or driver distraction. Some advocate the latter view (Lee et al., 2008; Smiley, 2005) while most appear to advocate the former (Caird & Dewar, 2007; Pettitt et al., 2005; Treat, 1980). In order to attempt to resolve this issue it is critical to distinguish between the different categories of internalised thought that are known to exist.

7.1. Categories of internalised thought

At the macro level, three such categories can be discerned: (1) task-related thoughts (TRTs); (2) task-unrelated thoughts (TUTs); and (3) daydreaming. Both TRTs and TUTs can include mental images. TRTs are thoughts and images directed toward goal-relevant stimuli relevant for completing the task (Lavie, 2005; McKiernan et al., 2006) or any thought related to the current task (Forster & Lavie, 2009). In the case of driving, these are thoughts that are relevant to safe driving; for example, a driver who thinks about where the nearest gas station is because their fuel gauge reads empty. TUTs are thoughts and images that are unrelated to the current task and irrelevant for task completion (Forster & Lavie, 2009; McKiernan et al., 2006). These can be triggered by internal (i.e., from within the mind) or external stimuli, and can be brought about intentionally or unintentionally.

Some examples are useful here in distinguishing between the different categories of TUTs. It is the nature of the mind to wander and if anyone doubts that the mind is regularly bombarded by intrusive thoughts, one should try meditation. To become an expert in meditation one must learn the skill of blocking out intrusive thoughts that appear to come out of nowhere and to which one is compelled to attend. An example of an internally triggered, unintentional TUT, is the intrusion of a thought unrelated to what we are doing (Forster & Lavie, 2009; McKiernan et al., 2006), such as thinking, “I wonder what is on TV tonight?” while one is driving. An example of an internally triggered, intentional, TUT is when a driver thinks while driving about what has to be done on arrival at the destination. An example of an externally triggered, intentional, TUT is when something that the driver perceives (e.g., a convenience store) reminds them of the need to pick up bread after work, and leads them to think about what else is needed from the convenience store. Finally, an example of an externally triggered, unintentional, TUT is when something just seen on an advertising billboard triggers a thought which the driver then continues to think about while driving. Unintentional TUTs have been shown to interfere with performance across various experimental and educational tasks (Smallwood et al., 2003; Smallwood et al., 2004; Smallwood et al., 2007). Research shows that the number of TUTs that participants experience is related to task complexity and demands, and stimulus rates. Colloquially speaking, it appears that the easier the task the more the ‘mind wanders’ (Kane et al., 2007; McKiernan et al., 2006).

While some researchers have failed to decouple TUTs and daydreams (Chapman & Underwood, 2000; Giambra, 1989; McGuire et al., 1996), TUTs and daydreams are qualitatively different from each other. Daydreams are typically fantasy-like in nature – unlike TUTs which more often than not reflect the person’s current concerns (e.g., “did I turn the oven off?”) (Kane et al., 2007). Daydreams also contain thoughts that are stimulus-independent and undirected (Pritzl, 2003). Daydreams are considered to be similar to night dreams (Singer, 1975) and have been shown experimentally to be related to night dreams on a neurophysiological level (see Pritzl, 2003, for more details).

Daydreaming “represents a shift of attention away from some primary physical or mental task we have set for ourselves, or away from directly looking at or listening to something in the external environment, toward an unfolding sequence of private responses made to some internal stimulus” (Singer, 1975, pp. 3). When they occur, the driver drifts into their own private world, losing self-awareness. Their attention becomes absorbed in the daydream (Pritzl, 2003).

Recent research, for example (He et al., 2009), has shown that task-unrelated thoughts (referred to as “mind-wandering”) are associated with horizontal narrowing of drivers’ visual scanning processes. This is consistent with the influence on driving of sources of cognitive distraction that do not compete for vision (e.g., Recarte & Nunes, 2000). We argue that when a driver is engaged in a *task-related thought*, that this is Driver Diverted Attention—Driving-Related. However, when the driver is engaged in daydreaming, or *task-unrelated thought(s)* (internal/unintentional; internal/intentional; external/intentional; or external/unintentional), we suggest that this is Driver Diverted Attention—Non-Driving-Related (see Fig. 1).

Treat (1980) has argued, based on the analysis of in-depth crash data, that engaging in internalised thought occurs voluntarily. We assert, however, that driver engagement in internalised thought can be voluntary or involuntary. Task-unrelated thoughts that are *unintentional* (both internally and externally generated), along with daydreams, appear to be competing activities that induce an *involuntary* diversion of attention: they are not easily ignored and the driver cannot control the impulse to attend to them. There is some limited evidence to support this (Smallwood & Schooler, 2006). In the case of a daydream, a driver may not even realise that he or she is attending to it. It is only after the daydream is over, that the driver may have awareness of its prior existence. Task-unrelated thoughts that are *intentional* (both internally and externally generated), however, appear to be competing activities that involve the voluntary diversion of attention away from activities critical for safe driving.

7.2. Summary

In summary, we concur with Caird and Dewar (2007), and with most of the research community, in believing that driver engagement in internalised thoughts leads to driver inattention. However, more precisely, we suggest that driver engagement in internalised thoughts is Driver Diverted Attention and that, depending on the kind of internal thought in which the driver is engaged, it can be classified as Driver Diverted Attention (Driving-Related), or Driver Diverted Attention (Non-Driving-Related). We do not believe, as suggested by Treat (1980), that drivers engage in thoughts for no compelling reason. Clearly, intrusive thoughts are compelling—they compel us involuntarily to want to attend to them. Similarly, we are compelled by some unknown internal stimulus to attend to daydreams. Whether or not internalised thoughts are regarded as compelling depends on the category of internal thought to which one is referring.

8. Activities critical for safe driving

There is frequent reference in this paper to “activities critical for safe driving”. Indeed all of the definitions proposed in this paper contain this phrase, which derives from previous definitions of driver distraction and driver inattention proposed by Lee et al. (2008). Exactly what activities *are* “critical for safe driving” is an unresolved issue in traffic safety. As pointed out by Trick et al. (2004), this is because “. . . it is hard to know which stimuli are selected in driving studies” (pp. 400). A search of the literature reveals that a lot of thought has gone into identifying the tasks that make up driving (McKnight & Adams, 1970; Treat, 1980), but no one to our knowledge has identified which are most critical to perform, in which traffic situations, at what moments in time. This is really not surprising. Defining a priori what these activities might be is a difficult, and perhaps impossible, task. One can certainly imagine, a priori, the kinds of activities that might be critical for safe driving (e.g., stopping at red traffic lights, braking to avoid a collision with an object; searching for vehicles in ones’ blind spot before overtaking, etc.), each of which involve various psychological processes. Some of these activities may be overt (e.g., stopping at red traffic lights) and others covert (i.e., internal processes such as information acquisition, decision making, and response selection). As Hancock et al. (2008) point out, however, there is currently no reliable method for defining a priori what a driver should be attending to:

“Defining distraction is akin to defining a negative, since distraction not only has the connotation of a negative activity but clearly implies a more important positive state of attraction. If we can specify what drivers should be attracted to then at least we can specify when and where distraction occurs, even if we are not immediately able to identify the motivation(s) behind it. Unfortunately, there is no currently assured method of specifying, a priori, what any particular driver in any particular situation should necessarily be paying attention to. . . The sources of stimulation to which the driver should be attracted always change in a very dynamic manner in the course of any journey” (pp. 18–19).

The point made by Hancock et al. (2008) underscores an important point made previously; that it is only with the benefit of hindsight that one is able to identify retrospectively what are activities critical for safe driving in a particular situation, and hence to what a driver should have attended.

Even the retrospective analyses of crash and incident data, from in-depth crash studies and naturalistic driving studies, provide little insight into what are activities critical for safe driving. It is fair to say that these studies tend to focus on what drivers fail to do in the event of a crash or incident rather than on what they should have done; in the present context, to what activity, or activities, they should have attended. Some researchers have identified retrospectively from the reports of in-depth crash investigation teams the functional failures (e.g., “diagnosis” failure) that lead to crashes, and the factors that give rise to these failures (e.g., “incorrect evaluation of a gap”) (Van Elslande & Fouquet, 2007a). It is perhaps possible from this work to derive, by working backwards, a taxonomy of activities critical for safe driving that might include, for example, “correct evaluation of time gaps”. Similarly, it should be possible from video records collected in naturalistic driving studies, in which driver inattention is coded as a contributing factor to a crash or critical incident, to code and classify for each event the activity or activities critical for safe driving to which the driver failed to attend. To our knowledge, no such exercise has yet been undertaken. Human Reliability Analysis has been used to attempt to define “correct” driving behaviour and to provide a methodology for the registration of

errors as deviations from this “standard” (Fastenmeier & Gstalter, 2010). However, as Hancock et al. (2008) argue, driving presents many ambiguous situations “in which, whatever ‘correct’ action one is actually accomplishing, there is another equally ‘correct’ action that one must neglect. What of distraction in such circumstances? Can we say the driver involved in a collision in such circumstances is distracted and is not driving with due care and attention?” (pp. 12).

Seeking to understand what activities are critical for safe driving is clearly an important activity in the study of driver inattention, and one that is central to the issues discussed in this paper. It is however an exercise beyond the scope of this paper. Based on the current state-of-the-art it would seem that the most productive way forward would be to focus on developing retrospectively a taxonomy of such activities from the outputs of crash and observational studies.

9. Conclusion

There is a lack of consensus in the literature about what is meant by the terms “driver inattention” and “driver distraction”. Definitions of these two constructs, and thinking about the relationship between the two, vary enormously.

In this paper, we have reviewed existing definitions and taxonomies of driver distraction and driver inattention deriving from selected accident databases and naturalistic driving studies, have attempted to assemble the beginnings of theoretical framework for understanding the role of inattention in crash and incident causation, and have proposed a taxonomy describing the relationship between the different forms of inattention proposed. In doing so, we have tried to distinguish, taxonomically and mechanistically, between driver inattention and driver distraction (the latter of which, we have referred to as *Driver Diverted Attention*).

We conclude that *Driver Inattention* means *insufficient or no attention to activities critical for safe driving*, and that *Driver Diverted Attention* (which is synonymous with “driver distraction”) is just one form of driver inattention. The other forms of driver inattention we have labelled tentatively as *Driver Restricted Attention*, *Driver Misprioritised Attention*, *Driver Neglected Attention* and *Driver Curiosity Attention*. Suggested definitions for each of these categories of inattention have been provided. We have also attempted to differentiate between different categories of internalised thought and to incorporate them within the taxonomy.

The important next steps in the development of this taxonomy are to validate it theoretically and practically—by developing a comprehensive theoretical framework for understanding attentional failures in crash causation that can be used to fine tune it, and by applying the taxonomy to the classification of a large pool of existing data. Such data might include event descriptions derived from in-depth crash investigations and video data collected from observational studies that use instrumented vehicles.

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