DREAM 3.0

DOCUMENTATION OF REFERENCES SUPPORTING THE LINKS IN THE CLASSIFICATION SCHEME

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SUMMARY

Both the Driving Reliability and Error Analysis Method (DREAM; Ljung, 2002) and the SafetyNet Accident Causation System (SNACS; Ljung, 2006) have been successfully used as tools for accident analysis in Sweden as well as in other European countries. While the driver-vehicle/traffic environment-organisation triad are used as frames of reference and the Contextual Control Model (COCOM; Hollnagel, 1998) is used to organise human cognition, the links in the classification schemes have not been established by referring to literature. The aim of this literature review is therefore to investigate the empirical support for the links in the classification scheme of DREAM 3.0 (an updated version of DREAM/SNACS).

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INTRODUCTION

Since the middle of the 20th century the number of human-machine-systems has grown enormously. Unfortunately, these systems sometimes fail resulting in more or less severe consequences. To prevent future failures we must either understand why human-machine systems have failed in the past or we must be able to identify ways in which they can fail in the future. A tool that helps us analyse past accidents as well as predict future ones, within process control domains such as nuclear power plants and train operation is the Cognitive Reliability and Error Analysis Method (CREAM; Hollnagel, 1998). CREAM was later adapted to suit the road traffic domain and the resulting tools were called the Driving Reliability and Error Analysis Method (DREAM; Ljung, 2002) and the SafetyNet Accident Causation System (SNACS; Ljung, 2006).

CREAM

CREAM (Hollnagel, 1998) includes three main elements: an accident model, a classification scheme and a method. The accident model uses the human-technology-organisation triad (see figure 1) as a frame of reference, which means that failures in the sharp end, as well as, in the blunt end are taken into consideration. Sharp end failures happen in close proximity to the accident (e.g. the controller pressing the wrong button) while blunt end failures can occur at other times and/or at other locations (e.g. the button was badly design by for example being too similar or in too close proximity to an other button). The *Contextual Control Model* (COCOM; Hollnagel, 1998) is then used to organise some of the categories (observation, interpretation and planning) related to "human" in the human-technology-organisation triad. COCOM recognises that cognition includes processing observations and producing reactions, as well as continuously revising goals and intentions which create a "loop" on the level of interpretation and planning. This is assumed to occur in parallel with whatever else is going on (at the same time as it in some way is also being determined by what is going on). Cognition in the context of human-machine system performance should therefore not be described as a sequence of steps and any classification scheme based on this model must represent a network rather than a hierarchy.

The classification scheme of CREAM comprises a number of observable effects in form of human actions or system events (phenotypes) and causes behind them (genotypes). The genotypes are organised according to the human-technology-organisation triad mentioned above. The human category consists of genotypes related to the specific cognitive functions observation, interpretation and planning (in accordance with COCOM) as well as more general functions such as temporary and permanent person related factors. The technology category consists of genotypes related to equipment, procedures and interface, while the organisation category consists of genotypes related to organisation, communication, training, ambient conditions and working conditions. See figure 1 for a schematic presentation of the different categories. There are also specific phenotypes and specific genotypes. The difference between general and specific phenotypes and genotypes is the degree of information where the specific phenotypes describe more specific effects than the general phenotypes and the specific genotypes describes more specific contributing factors than the general genotypes. Besides the general and specific phenotypes and the general and specific genotypes mentioned above, the classification scheme in CREAM also includes links between these different factors.

As mentioned earlier, the method in CREAM is fully bi-directional which means that the same principles can be used for analysing past failures as for predicting future ones. Furthermore, the method contains several stop rules, e.g. well defined conditions that

determine when the analysis or prediction should come to an end. These stop rules are necessary as the classification scheme represents a network (rather than a hierarchy) and the analysis or prediction could go on for ever in the absence of these rules.

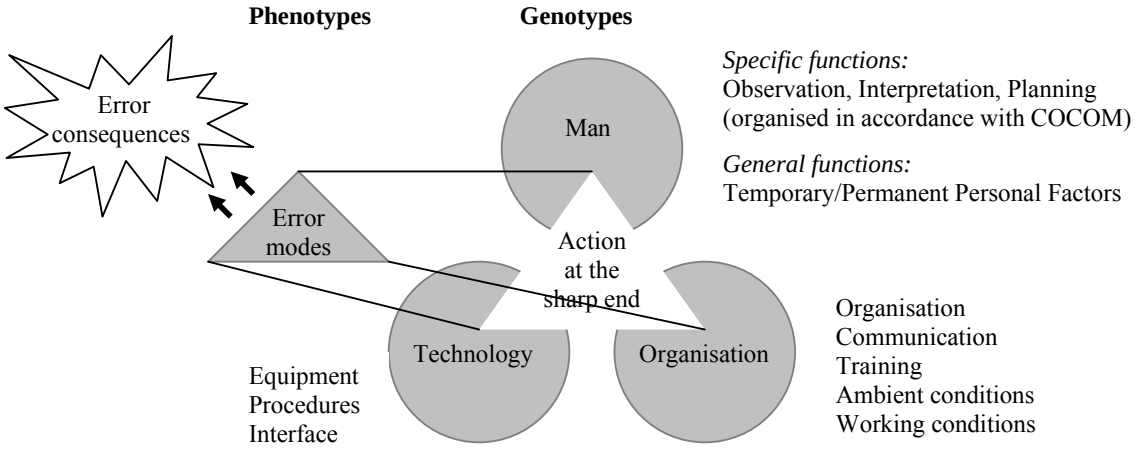

Figure 1. Overall grouping of the phenotypes and genotypes in CREAM (after Hollnagel, 1998).

As mentioned above, the phenotypes and genotypes in CREAM are application dependent which means that they may vary between different domains. While CREAM is mainly suited for analysis and predictions of failures in the process control domain the Driver Reliability and Error Analysis Method (DREAM; Ljung, 2002) is adapted to suit the road traffic domain.

DREAM and SNACS

DREAM (Ljung, 2002) is based on the same accident model and method as CREAM. The classification scheme is, however, adapted to suit the driving domain where the time available for the driver to make observations, interpretations and plans is much shorter than the time available for operators in the process control domain. When DREAM was to be used in the European project SafetyNet (for further details see http://www.erso.eu/safetynet/content/safetynet.htm) it was further adapted to suit the traffic environment in the participating countries. This adapted version is called SafetyNet Accident Causation System (SNACS; Ljung, 2006) and uses the same method, accident model and main structure of the classification system as DREAM while some of the individual genotypes have been altered.

DREAM 3.0

Both DREAM 2.1 (Ljung, Furberg and Hollnagel, n.d.) and SNACS 1.1 (Ljung, 2006) have been successfully used as a tool for accident analysis in Sweden (in the FICA project: http://web.student.chalmers.se/~mikaljun/) as well as in other European countries (in the SafetyNet project http://www.erso.eu/safetynet/content/safetynet.htm). During this practical work some suggestions for improvements have been put forward. Both DREAM 2.1 and SNACS 1.1 was therefore revised by a reference group including Henriette Wallén Warner (researcher in psychology leading the revision preceding DREAM 3.0), Gunilla Björklund (researcher in psychology representing Chalmers University of Technology in SafetyNet's accident causation analyses), Johan Engström (researcher responsible for Safety Analysis at Volvo Technology and PhD-student at Chalmers University of Technology focusing on inattention-related factors in crash causation), Emma Johansson (Human Factor specialist at Volvo Technology and part of an accident investigation team using DREAM/SNACS), Michael Ljung Aust (researcher at Volvo Cars Safety Centre and developer of

DREAM/SNACS) and Jesper Sandin (PhD-student at Chalmers University of Technology focusing on DREAM as a tool for accident analysis). The revision resulted in DREAM 3.0 - which is written in English and adapted to meet the needs of practitioners all over Europe (DREAM 3.0 can of course also be used in other parts of the world but due to country specific differences further adjustments might then be needed). DREAM 3.0 uses the same accident model as the earlier versions while the classification scheme and the method has been somewhat adjusted.

The accident model in DREAM 3.0 uses the human-technology-organisation triad as a reference - represented by the driver (human), the vehicle and traffic environment (technology) and the organisation. As in CREAM, COCOM is used to organise the categories related to driver cognition.

With regards to the classification scheme in DREAM 3.0, the majority of genotypes are left in their original form, and where needed clarified by improved definitions. A few new genotypes have been added and a few old ones have disappeared, due to merging or exclusion. The driver category consists of genotypes related to the specific cognitive functions - observation, interpretation and planning (in accordance with COCOM) - as well as more general functions such as temporary and permanent person related functions. The vehicle/traffic environment category consists of genotypes related to problems with the vehicle and the traffic environment, while the organisation category consists of genotypes related to organisation, maintenance and design. See figure 2 for a schematic presentation of different categories.

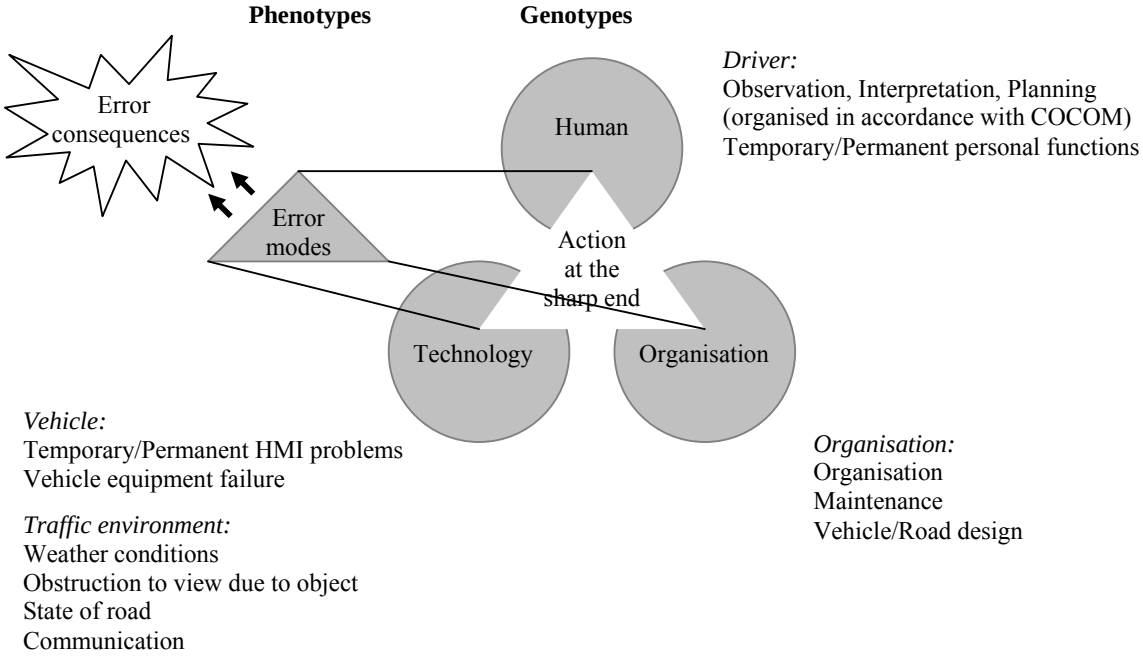

Figure 2. Overall grouping of the phenotypes and genotypes in DREAM 3.0.

The method in DREAM 3.0, as in CREAM, is fully bi-directional and includes several stop rules. Overall, general genotypes have the status of non-terminal events. If a general genotype is the most likely cause of a general consequent, that cause is chosen and the analysis must continue until one of the three stop rules below is fulfilled.

1. *Specific genotypes have the status of terminal events. Therefore, if a specific genotype is the most likely cause of a general consequent, that genotype is chosen and the analysis stops.*

2. *If there exists no general or specific genotypes that link to the chosen consequent, the analysis stops.*
3. *If none of the available specific or general genotypes for the chosen consequent is relevant, given the information available about the accident, the analysis stops.*

In DREAM 3.0, the indirect linking in DREAM 2.1 (Ljung, Furberg & Hollnagel, n.d. pp 26-27) has been abandoned. The indirect linking made it possible to choose a link from another genotype in the same category when no suitable link was available for the genotype at hand - at the same time as it made linking between genotypes in the same category impossible. Instead of indirect linking it is recommended that the classification scheme in DREAM 3.0 should be continuously updated to fit new types of accident scenarios as well as new scientific findings.

Aim of the literature review

The human-technology-organisation in CREAM (Hollnagel, 1998) as well as the driver-vehicle/traffic environment-organisation triad in DREAM (Ljung, 2002) and SNACS (Ljung, 2006) are used as frames of reference for the main categories of genotypes and COCOM is used to organise human cognition. For the links between the genotypes there are, however, no documented references to literature. The aim of this literature review is therefore to investigate the empirical support for the links between the genotypes in DREAM 3.0. It is however important to remember that, for the individual accident, even links with documented references in literature are only possible connections and that the use of a link always has to be supported by the data available.

METHOD

The literature review was based on the genotypes in DREAM 3.0. The databases used were *PsychInfo* and *Science Direct*. Depending on the number of hits, the genotypes were combined with other words (e.g. *genotype, genotype* + driv*, *genotype* + driv* performance, *genotype* + accident*, *genotype* + traffic*). In addition to the texts found in the databases, some texts were also found by following up references mentioned in the texts found in the databases.

A first selection of texts was based on titles while a second selection was based on abstracts. This resulted in approximately 185 texts which were more thoroughly read and among them 76 texts could be referred to one or more links between the genotypes in DREAM 3.0. Most of the remaining texts could be referred to links between genotypes and accident involvement. Only texts relevant for links between genotypes will, however, be presented here. In Appendix 1-2 the texts relevant for these links can be found in the linking table followed by a short summary of each text.

RESULTS AND DISCUSSION

The majority of the texts found, support links to *missed observation* and *late observation.* This emphasises the fact that driving is to a large extent a visual activity. A large portion of these links originate from *inattention, fatigue* and *under the influence of substances,* which shows the important, and often detrimental, effect these factors have on human perception. It must, however, be remembered that the texts found do not necessarily mirror the links existing in reality. Instead, the texts found are largely affected by the focus of research, which in turn is affected by the interests of the research community, as well as of practical and ethical constrains. It is, for example, much harder to measure how drivers think compared to what they perceive, which might be the reason as to why no texts supporting links to *misjudgement of time gaps* or *misjudgement of situation,* but many texts supporting links to *missed observation* and *late observation*, were found. Also, it is very hard to measure the effects (in terms of observation, interpretation and planning) of sudden *functional impairment* in real accidents and inducing *sudden functional impairment* in experimental settings would be highly unethical, which might be the reason as to why few texts supporting links originating from *sudden functional impairment* were found. Due to these constrains, the classification scheme still contains some links not supported by literature but still necessary in order to describe many of the more common traffic accidents. It should, however, be remembered that the classification scheme in DREAM 3.0 is not meant to be static, but continuously updated. Therefore, it is strongly advised that the links lacking convincing empirical support should be revised as soon as enough accident analyses have been carried out with DREAM 3.0 in order to base a new revision on real accident data in combination with new scientific findings.

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APPENDIX 1 LINKING TABLE FOR DREAM 3.0 WITH REFERENCES TO THE TEXTS SUPPORTING THE DIFFERENT LINKS

LINKING TABLE WITH GLOSSARY
FOR phenotypes (CRITICAL EVENTS) AND GENOTYPES (Causes)

PHENOTYPES (A)

General Phenotypes	Specific Phenotypes
Timing (A1)	Too early action (A1.1)
	Too late action (A1.2)
	No action (A1.3)
Speed (A2)	Too high speed (A2.1)
	Too low speed (A2.2)
Distance (A3)	Too short distance (A3.1)
Direction (A4)	Wrong direction (A4.1)
Force (A5)	Surplus force (A5.1)
	Insufficient force (A5.2)
Object (A6)	Adjacent object (A6.1)

Appendix 1

PHENOTYPES (A)

ANTECEDENTS (CAUSES)	CONSEQUENTS (EFFECTS)		
GENERAL Genotypes	**Definition of GENERAL Phenotypes**	**Definitions of SPECIFIC Phenotypes**	**Examples for SPECIFIC Phenotypes**
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Timing (A1)** The timing for initiating an action.	**Too early action (A1.1)** The action is initiated too early, before the signal is given or the required conditions are established.	*Intersection accidents* Starting from a stand still the driver passes the traffic light too early – before it has turned green. Starting from a stand still the driver passes the stop/give way sign too early - before the intersection is free. Starting from a stand still the driver enters the intersection too early - before the intersection is free (this is regardless of whether or not it is the driver's right of way). *OBS! If the driver has past a red traffic light or a stop/give way sign (see above) before entering the intersection the analysis should start by the traffic light/stop sign/give way sign.* *Leaving lane accidents* The driver leaves his own lane in order to overtake the vehicle in front of him too early – before he has free visibility of a stretch of road long enough for him to complete the manoeuvre. *Changing lane accidents* The driver leaves his own lane in order to change lane too early - before the lane he is changing into is free.
		Too late action (A1.2) The action is initiated too late.	*Intersection accidents* The driver starts to brake too late in order to stop for the red traffic light. The driver starts to brake too late in order to stop in front of the stop/give way sign. The driver starts to brake too late in order to avoid entering the intersection before it is free (this is regardless of whether or not it is the driver's right of way). *OBS! If the driver has past a red traffic light or a stop/give way sign (see above) before entering the intersection the analysis should start by the traffic light/stop sign/give way sign.*

Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**		***Continuation*** **Too late action (A1.2)**	*Leaving lane accidents* The driver starts to brake and/or make an avoidance manoeuvre too late to avoid an accident when a car (e.g. making an overtaking manoeuvre) is coming towards the driver in his own lane. *Changing lane accidents* The driver starts to brake and/or make an avoidance manoeuvre too late in order to avoid an accident with the car changing into his lane. *Catching up accidents* The driver starts to brake and/or make an avoidance manoeuvre too late in order to avoid an accident with the slow driving/still standing car in front of him.
		No action (A1.3) No action is initiated.	*Intersection accidents* The driver passes the red traffic light without doing anything (e.g. does not brake in order to stop). The driver passes the stop/give way sign without doing anything (e.g. does not brake in order to stop). The driver enters the intersection without doing anything (e.g. does not brake in order to avoid entering the intersection before it is free; this is regardless of whether or not it is the driver's right of way). *OBS! If the driver has past a red traffic light or a stop/give way sign (see above) before entering the intersection the analysis should start by the traffic light/stop sign/give way sign.* *Leaving lane accidents* The driver does nothing (e.g. does not brake and/or make an avoidance manoeuvre to avoid an accident) when a car (e.g. making an overtaking manoeuvre) is coming towards the driver in his lane. *Changing lane accidents* The driver does nothing to avoid an accident with the car changing into his lane (e.g. the driver might not have seen the car in order to act).

		Continuation **No action (A1.3)**	*Catching up accidents* The driver (e.g. caught in a car queue) does not do anything to avoid being hit from behind (this is regardless of whether or not he has the time and/or space to act). The driver does nothing to avoid an accident with the slow driving/still standing car in front of him (e.g. the driver might not have seen the car in order to act). The driver brakes softly in order to stop in time (for the traffic light, give way sign, traffic in intersection or car queue in front) but does not make any manoeuvres in order to avoid being hit from behind.
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Speed (A2)** The travelling speed.	**Too high speed (A2.1)** Driving too fast.	*Intersection accidents* The driver approaches the intersection faster then what can be expected by other drivers. *Leaving lane accidents* The driver approaches the meeting car (e.g. making an overtaking manoeuvre) faster then what can be expected by the overtaking driver. The driver drives too fast to take the curve, and stay within his own lane, under the prevailing conditions. *Changing lane accidents* The driver approaches the car changing lane faster then what can be expected by the lane changing driver. *Catching up accidents* The driver catches up with a slower car due to excessive speed.
		Too low speed (A2.2) Driving too slowly.	*Catching up accidents* The driver is caught up because he drives slower than what can be expected by other drivers.
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Distance (A3)** The space between objects.	**Too short distance (A3.1)** The distance between the vehicle and other objects is kept too short.	*Catching up accidents* The driver keeps a too short distance to the car in front of him.
Misjudgement of time gaps (C1)	**Direction (A4)**	**Wrong direction (A4.1)**	*Intersection accidents: Illegally turning etc.*

Misjudgement of situation (C2) **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	The direction of the vehicle.	The manoeuvre is made in the wrong direction.	The driver initiates an illegal left/right turn. *Leaving lane accidents* The driver leaves his own lane on a straight road or in a curve. *One-way lane/street accidents* The driver enters a lane or a one-way street against the traffic flow.
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Force (A5)** The force with which an action is conducted.	**Surplus force (A5.1)** Too much force is used.	*Leaving lane accidents* The driver steers too hard resulting in him leaving his own lane. *Catching up accidents* The driver brakes harder (e.g. emergency braking) than what can be expected by other drivers.
		Insufficient force (A5.2) Too little force is used.	*Insufficient brake accidents* The driver does not brake hard enough to stop in time (this can also be caused by insufficient brakes).
Misjudgement of time gaps (C1) **Misjudgement of situation (C2)** **Fear (E1)** **Fatigue (E3)** **Under the influence of substances (E4)** **Sudden functional impairment (E6)** **Temporary access limitation (G4)** **Equipment failure (I1)** **Strong side wind (J2)**	**Object (A6)** An item or a control.	**Adjacent object (A6.1)** An item/control in close proximity of the correct item is wrongly chosen.	*Unintentional acceleration accidents* The driver mistakes the accelerator pedal for the brake pedal.

GENOTYPES (B-Q)

HUMAN (B-F)

Driver

B: Observation
Missed observation (B1)
Late observation (B2)
False observation (B3)

C: Interpretation
Misjudgement of time gaps (C1)
Misjudgement of situation (C2)

D: Planning
Priority error (D1)

E: Temporary Personal Factors
Fear (E1)
Inattention (E2)
Fatigue (E3)
Under the influence of substances (E4)
Excitement seeking (E5)
Sudden functional impairment (E6)
Psychological stress (E7)

F: Permanent Personal Factors
Permanent functional impairment (F1)
Expectance of certain behaviours (F2)
Expectance of stable road environment (F3)
Habitually stretching rules and recommendations (F4)
Overestimation of skills (F5)
Insufficient skills/knowledge (F6)

TECHNOLOGY (G-M)

Vehicle (G-I)

G: Temporary HMI problems
Temporary illumination problems (G1)
Temporary sound problems (G2)
Temporary sight obstructions (G3)
Temporary access limitations (G4)
Incorrect ITS-information (G5)

H: Permanent HMI problems
Permanent illumination problems (H1)
Permanent sound problems (H2)
Permanent sight obstruction (H3)

I: Vehicle equipment failure
Equipment failure (I1)

Traffic environment (J-M)

J: Weather conditions
Reduced visibility (J1)
Strong side winds (J2)

K: Obstruction of view due to object
Temporary obstruction of view (K1)
Permanent obstruction of view (K2)

L: State of road
Insufficient guidance (L1)
Reduced friction (L2)
Road surface degradation (L3)
Object on road (L4)
Inadequate road geometry (L5)

M: Communication
Inadequate transmission from other road users (M1)
Inadequate transmission from road environment (M2)

ORGANISATION (N-Q)

Organisation

N: Organisation
Time pressure (N1)
Irregular working hours (N2)
Heavy physical activity before drive (N3)
Inadequate training (N4)

O: Maintenance
Inadequate vehicle maintenance (O1)
Inadequate road maintenance (O2)

P: Vehicle design
Inadequate design of driver environment (P1)
Inadequate design of communication devices (P2)
Inadequate construction of vehicle parts and/or structures (P3)
Unpredictable system characteristics (P4)

Q: Road design
Inadequate information design (Q1)
Inadequate road design (Q2)

OBSERVATION (B)

Observation includes detection as well as recognition of information that should have been the start of an action.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Fear (E1) [B1.I]	**Tunnel vision (B1.1)** The driver's peripheral vision is limited.	When the driver experiences high speed, the peripheral vision diminishes from 180 degrees to as little as 20-30 degrees thus reducing awareness of, or possibility to detect, objects to the side of the road.	**Missed observation (B1)** Some information (signal, sign or event) is missed. The reason for this can either be that the information is hidden (e.g. behind something) or that it is not noticed by the driver (e.g. as the driver predicts that the driver coming from the left will give way he does not look that way).
Inattention (E2) [B1.II]			
Fatigue (E3) [B1.III]			
Under the influence of substances (E4) [B1.IV]			
Sudden functional impairment (E6) [B1.V]			
Psychological stress (E7)			
Permanent functional impairment (F1) [B1.VI]			
Expectance of stable road environment (F3) [B1.VII]			
Insufficient skills/knowledge (F6) [B1.VIII]			
Temporary illumination problem (G1) [A]			
Temporary sound problems (G2) [A]			
Temporary sight obstruction (G3) [A]			
Permanent illumination problem (H1) [A]			
Permanent sound problems (H2) [A]			
Permanent sight obstruction (H3) [B1.IX]			
Equipment failure (I1) [A]			
Reduced visibility (J1) [A]			
Temporary obstruction to view (K1) [A]			
Permanent obstruction to view (K2) [A]			
Inadequate road geometry (L5) [B1.X]			
Inadequate transmission from other road users (M1) [A]			
Inadequate transmission from road environment (M2) [B1.XI]			

[A] Obvious links

Fear (E1) [B2.I]	**Tunnel vision (B2.1)** The driver's peripheral vision is limited.	When the driver experiences high speed, the peripheral vision diminishes from 180 degrees to as little as 20-30 degrees thus reducing awareness of, or possibility to detect, objects to the side of the road.	**Late observation (B2)** The observation of some information (signal, sign or event) is correct but late, i.e. when the observation is made there is insufficient time to act in an optimal way (e.g. brake to avoid a collision).
Inattention (E2) [B2.II]			
Fatigue (E3) [B2.III]			
Under the influence of substances (E4) [B2.IV]			
Sudden functional impairment (E6) [B2.V]			
Psychological stress (E7)			
Permanent functional impairment (F1) [B2.VI]			
Expectance of stable road environment (F3) [B2.VII]			
Insufficient skills/knowledge (F6) [B2.VIII]			
Temporary illumination problem (G1) [A]			
Temporary sound problems (G2) [A]			
Temporary sight obstruction (G3) [A]			
Permanent illumination problem (H1) [A]			
Permanent sound problems (H2) [A]			
Permanent sight obstruction (H3) [B2.IX]			
Equipment failure (I1) [A]			
Reduced visibility (J1) [A]			
Temporary obstruction to view (K1) [A]			
Permanent obstruction to view (K2) [A]			
Inadequate road geometry (L5) [B2.X]			
Inadequate transmission from other road users (M1) [A]			
Inadequate transmission from road environment (M2) [B2.XI]			
Inattention (E2)	**None defined**		**False observation (B3)** Some information (object, signal, sign or event) is misunderstood / misinterpreted as something else (e.g. the driver mistakes a motorcycle for a moped or thinks it is green because of looking at the wrong traffic light).
Fatigue (E3)			
Under the influence of substances (E4) [B3.I]			
Sudden functional impairment (E6) [B3.II]			
Psychological stress (E7)			
Permanent functional impairment (F1) [A]			
Temporary illumination problem (G1) [A]			
Temporary sound problems (G2) [A]			
Temporary sight obstruction (G3) [A]			
Equipment failure (I1) [A]			
Reduced visibility (J1) [A]			

[A] Obvious links

Appendix 1

B1.I	Taylor, Deane & Podd, 2007 (indirect)
B1.II	Hancock, Lesch & Simmons, 2003; Kass, Cole & Stanny, 2007; Lee, Caven, Haake & Brown, 2001 (indirect); Miura, Shinohara, Kimura & Ishimatsu, 2005; Patten, Kircher, Östlund & Nilsson, 2004; Strayer & Drews, 2006:II; Strayer & Johnston, 2001; Anttila & Luoma, 2005 (indirect); Consiglio, Driscoll, Witte & Berg, 2003 (indirect); Dingus et al. 2006 (indirect); Engström, Johansson & Östlund, 2005 (indirect); Harbluk, Noy, Trbovich & Eizenman, 2007 (indirect); Hatfield & Murphy, 2007 (indirect); Horrey & Wickens, 2004 (indirect); Liu & Lee, 2005 (indirect); Morita, Mashiko & Okada, 2000 (indirect); Strayer & Drews, 2006:I (indirect); Summala, Lamble & Laakso, 1998 (indirect)
B1.III	Åkerstedt & Kecklund, 2000; Baulk, Biggs, van den Heuvel, Reid & Dawson, 2006; Friswell & Williamson, in press 2007; Åkerstedt, Peters, Anund & Kecklund, 2005 (indirect); Haraldsson, Carenfeldt, Laurell & Törnros, 1990 (indirect); Lenné, Triggs & Redman, 1997 (indirect)
B1.IV	De Waard & Brookhuis, 1991 (indirect); Kuypers, Samyn & Ramaekers, 2006 (indirect); Lenné, Dietze, Rumbold, Redman & Triggs, 2003 (indirect); Leung & Starmer, 2005 (indirect); Logan, 1996 (indirect); Robbe, 1998: Study IV (indirect); Schifano, 1995 (indirect); Silber et al., 2005 (indirect)
B1.V	Vårdguiden, Epilepsi [Epilepsy], 2007 (indirect); Vårdguiden, Slaganfall [Stroke], 2007 (indirect); Vårdguiden, Yrsel [Dizziness], 2007 (indirect)
B1.VI	Wood, 1999; Cohen, Wells, Kimball & Owsley, 2003 (indirect); Fitten et al. 1995 (indirect); Lamble, Summala & Hyvärinen, 2002 (indirect); Wild & Cotrell, 2003 (indirect)
B1.VII	Martens & Fox, 2007
B1.VIII	McKnight & McKnight, 2003 (indirect); Summala, 1998 (indirect); Underwood, Chapman, Berger & Crundall, 2003 (indirect)
B1.IX	Sivak, Schoettle, Reed & Flannagan, 2006 (indirect)
B1.X	Easa, 1994
B1.XI	Laurie et al. 2004; Ward & Wild (indirect)

B2.I	Taylor, Deane & Podd, 2007 (indirect)
B2.II	Hancock, Lesch & Simmons, 2003; Horrey & Wickens, 2004; Lee, Caven, Haake & Brown, 2001; Liu & Lee, 2005; Miura, Shinohara, Kimura & Ishimatsu, 2005; Morita, Mashiko & Okada, 2000; Patten, Kircher, Östlund & Nilsson, 2004; Strayer & Drews, 2006:I; Strayer & Johnston, 2001; Summala, Lamble & Laakso, 1998; Anttila & Luoma, 2005 (indirect); Consiglio, Driscoll, Witte & Berg, 2003; Dingus et al. 2006 (indirect); Engström, Johansson & Östlund, 2005 (indirect); Harbluk, Noy, Trbovich & Eizenman, 2007 (indirect); Hatfield & Murphy, 2007 (indirect); Kass, Cole & Stanny, 2007 (indirect)
B2.III	Åkerstedt & Kecklund, 2000; Baulk, Biggs, van den Heuvel, Reid & Dawson, 2006; Haraldsson, Carenfeldt, Laurell & Törnros, 1990; Åkerstedt, Peters, Anund & Kecklund, 2005 (indirect); Friswell & Williamson, in press 2007 (indirect); Lenné, Triggs & Redman, 1997 (indirect)
B2.IV	De Waard & Brookhuis, 1991; Kuypers, Samyn & Ramaekers, 2006; Lenné, Dietze, Rumbold, Redman & Triggs, 2003; Leung & Starmer, 2005; Robbe, 1998: Study IV; Silber et al. 2005; Logan, 1996 (indirect); Schifano, 1995 (indirect)
B2.V	Vårdguiden, Epilepsi [Epilepsy], 2007 (indirect); Vårdguiden, Slaganfall [Stroke], 2007 (indirect); Vårdguiden, Yrsel [Dizziness], 2007 (indirect)
B2.VI	Lamble, Summala & Hyvärinen, 2002; Wood, 1999; Cohen, Wells, Kimball & Owsley, 2003 (indirect); Fitten et al. 1995 (indirect); Wild & Cotrell, 2003 (indirect)
B2.VII	Martens & Fox, 2007
B2.VIII	McKnight & McKnight, 2003 (indirect); Summala, 1998 (indirect); Underwood, Chapman, Berger & Crundall, 2003 (indirect)
B2.IX	Sivak, Schoettle, Reed & Flannagan, 2006 (indirect)
B2.X	Easa, 1994
B2.XI	Laurie et al. 2004 (indirect); Ward & Wild (indirect)

B3.I	Schifano, 1995
B3.11	Vårdguiden, Epilepsi [Epilepsy], 2007 (indirect); Vårdguiden, Slaganfall [Stroke], 2007 (indirect); Vårdguiden, Yrsel [Dizziness], 2007 (indirect)

Appendix 1

INTERPRETATION (C)

Interpretation includes, for all but novice drivers, quick and automated (routine) procedures where typical situations and their associated actions are recognized and acted upon (script choice). Mistakes in interpretation occur at the sharp end - within the local event horizon.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Late observation (B2) **False observation (B3)** **Inattention (E2)** [C1.I] **Fatigue (E3)** **Under the influence of substances (E4)** [C1.II] **Psychological stress (E7)** **Permanent functional impairment (F1)** [C1.III] **Expectance of certain behaviours (F2)** **Habitually stretching rules and recommendations (F4)** **Overestimation of skills (F5)** **Insufficient skills/knowledge (F6)** **Incorrect ITS-information (G5)** **Reduced visibility (J1)** **Insufficient guidance (L1)** **Reduced friction (L2)** **Inadequate road geometry (L5)** [C1.IV] **Inadequate transmission from road environment (M2)** [C1.V] **Unpredictable system characteristics (P4)**	**Misjudgement of time gap due to incorrect speed estimate (C1.1)** The driver misjudges the time gap due to a misjudgement of the approaching vehicle's speed.	*Intersection* The driver is waiting to cross a street and assumes that the approaching car is keeping the 50 km/h speed limit. The car is, however, approaching at 70 km/h and as a result the driver overestimates the time gap he has to the approaching car. *Overtaking* The driver is overtaking another car when he suddenly realise that he has underestimated the meeting car's speed and therefore also overestimated the available gap for the overtaking. *Catches up from behind* The driver is changing lanes when he suddenly realise that he has underestimated the speed of the car catching up from behind (in the lane he is changing into), and therefore he has also underestimated the available time gap. *Approaches from behind* The driver underestimates the time gap to the car in front of him because he overestimates its speed.	**Misjudgement of time gaps (C1)** The estimation of time gaps (e.g. time left to approaching vehicle, stop sign, traffic lights etc.) is incorrect. In order to misjudge a time gap the object (e.g. approaching vehicle, stop sign, traffic lights etc.) must have been observed!

C1.I Cooper & Zheng, 2002; Cooper et al. 2003; Friswell & Williamson, in press 2007; Hancock, Lesch & Simmons, 2003; Hatfield & Murphy, 2007; Horberry, Anderson, Regan, Triggs & Brown, 2006; Harbluk, Noy, Trbovich & Eizenman, 2007 (indirect); Jamson & Merat, 2005; Anttila & Luoma, 2005 (indirect); Liu & Lee, 2005 (indirect)

C1.II Logan, 1996; Brookhuis, De Waard & Samyn, 2004 (indirect); Ramaekers, Kuypers & Samyn, 2006 (indirect); Robbe, 1998: Study IV (indirect)

C1.III Cohen, Wells, Kimball & Owsley, 2003 (indirect); Cox, Quillian, Thorndike, Kovatchev & Hanna, 1998 (indirect); Wild & Cotrell, 2003 (indirect)

C1.IV Oxley, Fildes, Corben & Langford, 2006; Yan & Radwan, 2007 (indirect)

C1.V Oxley, Fildes, Corben & Langford, 2006; Easa, 1994 (indirect)

Missed observation (B1)	**None defined**		**Misjudgement of situation (C2)** The situation is misjudged (e.g. the driver thinks that it is safe to enter the intersection as he/she has not noticed the traffic lights turning red or the vehicle approaching).
Late observation (B2)			
False observation (B3)			
Priority error (D1)			
Inattention (E2) [C2.I]			
Fatigue (E3)			
Under the influence of substances (E4) [C2.II]			
Psychological stress (E7) [C2.III]			
Permanent functional impairment (F1) [C2.IV]			
Expectance of certain behaviours (F2)			
Habitually stretching rules and recommendations (F4)			
Overestimation of skills (F5)			
Insufficient skills/knowledge (F6) [C2.V]			
Incorrect ITS-information (G5)			
Reduced visibility (J1) [C2.VI]			
Insufficient guidance (L1)			
Reduced friction (L2)			
Road surface degradation (L3)			
Object on road (L4)			
Inadequate road geometry (L5)			
Inadequate transmission from road environment (M2) [C2.VII]			
Unpredictable system characteristics (P4)			

C2.I Cooper & Zheng, 2002; Cooper, Zheng, Richard, Vavrik, Heinrichs & Siegmund, 2003; Hancock, Lesch & Simmons, 2003; Hatfield & Murphy, 2007; Horberry, Anderson, Regan, Triggs & Brown, 2006; Jamson & Merat, 2005; Kass, Cole & Stanny, 2007; Anttila & Luoma, 2005 (indirect); Friswell & Williamson, in press 2007 (indirect); Harbluk, Noy, Trbovich & Eizenman, 2007 (indirect); Horrey & Wickens, 2004 (indirect); Liu & Lee, 2005 (indirect)

C2.II Logan, 1996; Schifano, 1995; Brookhuis, De Waard, Samyn, 2004 (indirect)

C2.III Simon & Corbett, 1996; Van der Hulst, Meijman & Rothengatter, 2001

C2.IV Cox, Quillian, Thorndike, Kovatchev & Hanna, 1998; Wild & Cotrell, 2003

C2.V McKnight & McKnight, 2003; Summala, 1998; Wallis & Horswill, 2007; Hatfield, Fernandes, Job & Smith, 2007 (indirect)

C2.VI Broughton, Switzer & Scott, 2007

C2.VII Ward & Wild, 1995

PLANNING (D)

Planning includes fairly conscious and time consuming processes covering upcoming situations and eventualities beyond the local event horizon. Planning is a less frequent event than interpretation.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Fear (E1)	**None defined**		**Priority error (D1)** The driver prioritizes something else above safe arrival at the destination (e.g. uses the bus lane to save time or drives very fast to impress friends).
Excitement seeking (E5)			
Psychological stress (E7) [D1.I]			
Habitually stretching rules and recommendations (F4)			

D1.I Beilock, 1995 (indirect)

TEMPORARY PERSONAL FACTORS (E)

Temporary personal factors includes temporary, or short-term, factors influencing driver's perception, interpretation, planning etc.

ANTECEDENTS			CONSEQUENTS)
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Sudden functional impairment (E6) [E1.I]	**Previous experience (E1.1)** The driver has previously experienced a similar traffic situation in which it was a negative outcome.	The driver is anxious about a particular situation due to previous bad experience or accident.	**Fear (E1)** Being afraid of something or being scared by a sudden event (e.g. the lead vehicle making an emergency brake or an animal jumping onto the road in front of you).
Under the influence of substances (E4) [E2.I] **Inadequate design of driver environment (P1)** [E2.II]	**Driving-related distracters inside vehicle (E2.1)** The driver is distracted by a driving-related object or event inside the vehicle.	The driver focuses his attention on the instructions given by a navigation system.	**Inattention (E2)** Any condition, state or event that causes the driver to pay less attention than required for the driving task.
	Driving-related distracters outside vehicle (E2.2) The driver is distracted by a driving-related object or event outside the vehicle.	The driver focuses his attention on road signs or an animal standing dangerously close to the road.	
	Non driving-related distracters inside vehicle (E2.3) The driver is distracted by a non driving-related object or event inside the vehicle.	The driver speaks to a passenger or on the mobile phone.	
	Non driving-related distracters outside vehicle (E2.4) The driver is distracted by a non driving-related object or event outside the vehicle.	The driver looks at a friend walking past on the pavement.	
	Thoughts/Daydreaming (E2.5) The driver is distracted by his/her own thoughts – including thoughts about how to for example find the best route.	The driver daydreams, thinks about a personal problem or how to find the best route.	

Under the influence of substances (E4) [E3.I] **Reduced visibility (J1)** [E3.II] **Time pressure (N1)** [E3.III] **Irregular working hours (N2)** [E3.IV] **Heavy physical activity before drive (N3)** [E3.V] **Inadequate design of driver environment (P1)** [E3.VI]	**Sleep disorders (E3.1)** The driver suffers from a sleep disorder.	The driver suffers from sleep apnoea syndrome, of which the symptoms are heavy snoring and sleep disturbance resulting in daytime sleepiness.	**Fatigue (E3)** Being sleepy, tired or exhausted (mentally or physically).
None defined	**Alcohol (E4.1)** The driver is under the influence of alcohol.	The driver's performance is impaired as a result of being influenced by alcohol.	**Under the influence of substances (E4)** Being affected by different sorts of substances.
	Drugs (E4.2) The driver is under the influence of non-prescribed drugs.	The driver's performance is impaired as a result of taking ecstasy.	
	Medication (E4.3) The driver is under the influence of prescribed drugs.	The driver's performance is impaired as a result of taking strong sedatives.	
None defined	**None defined**		**Excitement seeking (E5)** Looking for adrenaline-kicks (e.g. by driving in high speed)
None defined	**Epilepsy (E6.1)** The driver suffers an epileptic seizure.	The driver is unresponsive or unconscious due to an epileptic seizure.	**Sudden Functional Impairment (E6)** Sudden onset of functional impairment due to illness. Does not include different kinds of sleep disorders!
	Diabetes (E6.2) The driver suffers a critically low concentration of insulin in the blood.	The driver is sweating and shivering before becoming unconscious due to low concentration of insulin in the blood.	
	Stroke (E6.3) The driver suffers a stroke.	The driver is sweating and shivering before becoming unconscious due to a stroke.	
Fatigue (E3) [E7.I] **Reduced visibility (J1)** [E7.II] **Inadequate road maintenance (O2)** [E7.III]	**Peer pressure (E7.1)** The driver experiences stress due to peer pressure.	The driver is feeling stressed because the car is full of passengers he wants to impress.	**Psychological stress (E7)** Different mental factors putting a strain on the driver.
Time pressure (N1) [E7.IV] **Irregular working hours (N2)** [E7.V] **Inadequate road design (Q2)** [E7.VI]	**Stressful life events (E7.2)** The driver experiences stress due to stressful life events (e.g. receiving bad news, newly divorce, recent loss of a loved one).	The driver is experiencing stress as he has just filed for divorce.	

Appendix 1

E1.I Svenska Diabetesförbundet, Insulinkänning [Insulin reaction] 2007; Vårdguiden, Hjärtinfarkt [Heart attack], 2007

E2.I Logan, 1993; Roehrs, Zwyghuizen-Doorenbos, Knox, Moskowitz & Roth, 1992
E2.II Wittmann et al. 2006; Summala, Lamble & Laakso, 1998 (indirect)

E3.I Arnedt, Wilde, Munt & MacLean, 2001; Friswell & Williamson, in press 2007; Landaur & Howat, 1983; Roehrs, Zwyghuizen-Doorenbos, Knox, Moskowitz & Roth, 1992
E3.II Friswell & Williamson, in press 2007 (indirect)
E3.III Arnold, Hartley, Corry, Hochstadt, Penna & Feyer, 1997; Friswell & Williamson, in press 2007; Williamson, Feyer, Coumarelos & Jenkins, 1992
E3.IV Arnold, Hartley, Corry, Hochstadt, Penna & Feyer, 1997; Miller & Mackie, 1980; Williamson, Feyer, Coumarelos & Jenkins, 1992
E3.V Arnold, Hartley, Corry, Hochstadt, Penna & Feyer, 1997; Friswell & Williamson, in press 2007; Miller & Mackie, 1980; Williamson, Feyer, Coumarelos & Jenkins, 1992
E3.VI Friswell & Williamson, in press 2007

E7.I Dinges et al. 1997
E7.II Hill & Boyle, 2007; Beilock, 1995 (indirect)
E7.III Hill & Boyle, 2007
E7.IV Meijman & Kompier, 1998: Study IV; Van der Hulst, Meijman & Rothengatter, 2001 (indirect)
E7.V Miller & Mackie, 1980
E7.VI Hill & Boyle, 2007

Appendix 1

PERMANENT PERSONAL FACTORS (F)

Permanent personal factors includes permanent, or long-term, factors influencing driver's perception, interpretation, planning etc.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**Reduced vision (F1.1)** The driver's ability is impaired due to reduced vision.	The driver finds it difficult to drive at night due to reduced vision.	**Permanent functional impairment (F1)** Permanent or long term, functional impairment due to, for example, ageing, chronic illness or injury.
	Reduced hearing (F1.2) The driver's ability is impaired due to reduced hearing.	The driver finds it difficult to hear another road user honking his horn due to reduced hearing.	
	Reduced motor skills (F1.3) The driver's ability is impaired due to reduced motor skills.	The driver finds it difficult to look around properly when reversing due to reduced mobility.	
	Reduced cognitive capacity (F1.4) The driver's ability is impaired due to reduced cognitive capacity.	The driver finds it difficult to make decisions in complex traffic environments due to reduced cognitive capacity.	
None defined	**None defined**		**Expectance of certain behaviours (F2)** Expecting other road users to behave in certain ways following praxis (e.g. brake gently, stop for stop signs and red-lights, give way when driving on a non-priority or minor road and comply with the speed limits). This expectancy is still present even if no other road users are in view (e.g. when approaching a blind corner drivers expect oncoming traffic to keep to their lane).
None defined	**None defined**		**Expectance of stable road environment (F3)** Expecting no changes to the road environment (e.g. no new road signs or roundabouts) on familiar roads.
None defined	**None defined**		**Habitually stretching rules and recommendations (F4)** Habitually stretching rules and recommendations (e.g. habitually speeding or not stopping at stop signs or red traffic lights) as previous performance has not resulted in any negative consequences

Appendix 1

Under the influence of substances (E4) **Insufficient skills/knowledge (F6)** [F5.1]	**None defined**		**Overestimation of skills (F5)** Overestimating one's own driving skills (e.g. overestimating the speed in which one is able to keep control over the vehicle).
Inadequate training (N4) [F6.1]	**Insufficient geographical knowledge/experience (F6.1)** The driver has insufficient knowledge or experience about the local area.	The driver, who is a visitor from a country with left-hand traffic, ends up, by mistake, on the wrong side of the road in a country with right-hand traffic.	**Insufficient skills/knowledge (F6)** Lack of practical skills (e.g. having to look down in order to change gear) and/or theoretical knowledge (e.g. not knowing the give-way rules or the meaning of a road sign).

[F5.1] Gregersen, 1996, McKnight & McKnight, 2003; Wallis & Horswill, 2007 (indirect)

[F6.1] Gregersen, 1996; Wallis & Horswill, 2007; Hatfield, Fernandes, Job & Smith, 2007 (indirect); McKnight & McKnight, 2003 (indirect); Summala, 1998 (indirect); Underwood, Chapman, Berger & Crundall, 2003 (indirect)

TEMPORARY HMI PROBLEMS (G)

Temporary HMI problems include temporary, or short-term, problems with human-machine-interfaces related to the vehicle.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Equipment failure (I1) [A]	**None defined**	.	**Temporary illumination problems (G1)** The light inside the vehicle is too strong (e.g. causing reflexes) or too weak (e.g. causing reduced colour vision).
Equipment failure (I1) [A]	**None defined**		**Temporary noise problems (G2)** Noise levels surrounding the driver are too high (e.g. the driver cannot hear the sirens on the ambulance as music is played at high volume).
Equipment failure (I1) [A]	**Dirty windows and/or dirty mirrors (G3.1)** Dirty windows or dirty mirrors obstruct the driver's view.	The driver cannot see the car ahead clearly because of dirt on the wind screen.	**Temporary sight obstruction (G3)** The view is temporarily obstructed.
	Luggage (G3.2) Luggage or other objects obstruct the driver's view.	The driver cannot see out of the rear window because of bags obstructing the view.	
	Passengers (G3.3) People or pets inside the vehicle obstruct the driver's view.	The driver can not see out of the rear window because a tall passenger seated in the middle of the back seat obstructs the view.	
Equipment failure (I1) [A]	**Temporary obstruction (G4.1)** Temporary obstruction makes it difficult for the driver to reach one or more items/controls in the driver environment.	The driver finds it difficult to reach the brake pedal because he did not adjust the seat before starting to drive.	**Temporary access limitations (G4)** Temporary problems for the driver to reach or find items/controls in the driver environment.
Equipment failure (I1) [A] **Inadequate design of driver environment (P1)** [A]	**None defined**		**Incorrect ITS-information (G5)** Information given by an ITS-device is ambiguous, incorrect or missing.

[A] Obvious links

PERMANENT HMI PROBLEMS (H)

Permanent HMI problems include permanent, or long-term, problems with human-machine-interfaces related to the vehicle.

ANTECEDENTS			CONSEQUENTS)
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Inadequate design of driver environment (P1) [A]	**Weak light (H1.1)** The light inside the vehicle is too weak.	The driver has difficulty seeing the speedometer as the illumination of the dashboard is too weak.	**Permanent illumination problems (H1)** The light, on e.g. the dashboard, is too strong (causing glare) or too weak.
Inadequate design of driver environment (P1) [A]	**Low sound signal (H2.1)** The signals from different driver support systems inside the vehicle are too low.	The driver has difficulty hearing the warning signal of the speed warning device as the signal is too low.	**Permanent sound problems (H2)** The sound signals inside the vehicle are too high (causing startle) or too low.
Inadequate design of driver environment (P1) [H3.I]	**None defined**		**Permanent sight obstruction (H3)** The view is permanently obstructed by parts of the vehicle.

[A] Obvious links

[H3.I] Sivak, Schoettle, Reed & Flannagan, 2006 (indirect)

VEHICLE EQUIPMENT FAILURE (I)

Vehicle equipment failure includes failures of the vehicle or any equipment or system related to it.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Inadequate vehicle maintenance (O1) [A]	**None defined**		**Equipment failure (I1)** Some piece of equipment (e.g. tyres, steering, brake system or lighting) does not perform as intended or does not work at all (because it has broken).
Inadequate design of communication devices (P2) [A]			
Inadequate construction of vehicle parts and/or structures (P3) [A]			

[A] Obvious links

WEATHER CONDITIONS (J)

Weather conditions include reduced visibility and stability due to environmental factors.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**Low sun (J1.1)** Low sun facing the driver makes it difficult to see.	The driver cannot see the brake lights on the car in front as the low sun is shining directly in his eyes.	**Reduced visibility (J1)** The visibility is reduced due to low sun, fog, darkness etc.
None defined	**None defined**		**Strong side wind (J2)** The stability of the vehicle is affected by strong side wind

OBSTRUCTION OF VIEW DUE TO OBJECT (K)

Obstruction to view due to objects includes all temporary and permanent objects, in the traffic environment, obstructing the drivers' view.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**None defined**		**Temporary obstruction of view (K1)** Objects (e.g. driven or parked vehicles, gatherings of people) in the traffic environment cause temporary obstruction of view.
Inadequate information design (Q1) [A]	**None defined**		**Permanent obstruction of view (K2)** Objects (e.g. buildings, fences, signs, vegetation) in the traffic environment cause permanent obstruction of view.
Inadequate road design (Q2) [A]			

[A] Obvious links

STATE OF ROAD (L)

State of the road includes problems with the road itself and its surface as well as the friction between the surface and tyres.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
Inadequate road maintenance (O2) [A] **Inadequate road design (Q2)** [A]	**None defined**		**Insufficient guidance (L1)** The road guidance (painted lane markings, cat's eyes, roadside reflectors etc.) is insufficient.
Equipment failure (I1) [A] **Inadequate road maintenance (O2)** [A] **Inadequate road design (Q2)** [A]	**Low noise tarmac in rain (L2.1)** Low noise tarmac, that has become wet, makes the road surface very slippery.	The driver finds a road with low noise tarmac very slippery after a light drizzle.	**Reduced friction (L2)** The friction is reduced due to ice, snow, oil, gravel etc. on the road or due to bad tyres on the vehicle.
Inadequate road maintenance (O2) [A] **Inadequate road design (Q2)** [A]	**None defined**		**Road surface degradation (L3)** The road surface has degraded (e.g. have potholes or deep ruts). Does not include problems resulting in reduced friction!
Inadequate road maintenance (O2) [A]	**Animals (L4.1)** Animals, dead or alive, are on the road.	The driver's progression is hindered by a dead badger lying in the middle of the road or wild dears crossing the road.	**Object on road (L4)** The road is partly, or completely, blocked by objects other than vehicles (e.g. stones, exploded tires, lost cargo, animals).
Inadequate road design (Q2) [L5.I]	**None defined**		**Inadequate road geometry (L5)** The road geometry (e.g. curves, camber, road shoulder) is inadequate.

[A] Obvious links

[L5.I] Easa, 1994; Oxley, Fildes, Corben & Langford, 2006 (indirect); Yan & Radwan, 2007 (indirect)

COMMUNICATION (M)

Communication includes failures to transmit correct information from other road users or from the traffic environment to the driver.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**None defined**		**Inadequate transmission from other road users (M1)** Other road users fail to transmit information (e.g. not using the indicator when turning) or the information transmitted is ambiguous or incorrect.
Inadequate information design (Q1) [M2.I]	**None defined**		**Inadequate transmission from road environment (M2)** The road environment fails to transmit information to the driver and/or the vehicle (e.g. traffic lights or transmitters to ITS systems are out of order, warning signs or signals are missing) or the information transmitted is ambiguous or incorrect.

[A] Obvious links

[M2.I] Easa, 1994; Laurie et al. 2004; Ward & Wild, 1995; Oxley, Fildes, Corben & Langford, 2006

ORGANISATION (N)

Organisation includes structures in social- or working life which might impede the private- or professional driver's driving performance.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**Being late (N1.1)** Being late for a professional or private appointment makes the private driver experience time pressure.	The private driver experiences time pressure as he is late for work, nursery pick-up, a party or some other professional or private appointment.	**Time pressure (N1)** Private or professional obligations resulting in time pressure.
	Inadequate time schedule (N1.2) Working under tight time margins for pick-ups and deliveries makes the professional driver feel pressured to exceed the legal speed limit and/or the legal number of working hours.	The professional bus driver experiences time pressure as his time table is very tight.	
None defined	**Night shift (N2.1)** Working night shift forces the private driver to drive home during the circadian morning dip.	The private driver is driving home early in the morning after having worked at a hospital all night.	**Irregular working hours (N2)** Irregular working hours makes it difficult to follow the circadian rhythm.
	Scheduled night driving (N2.2) Night driving makes it hard for the professional driver to follow the circadian rhythm.	The professional truck driver drives all night in order to deliver his goods on time.	
None defined	**Heavy physical activity for private drivers (N3.1)** Heavy physical activity precedes the private driver's drive.	The private driver drives home after a heavy days work in the forest or after having participated in an important football match.	**Heavy physical activity before drive (N3)** Heavy physical activity or work before the private or professional driver's drive.
	Heavy physical work for professional drivers (N3.2) Heavy physical work precedes the professional driver's drive.	The professional driver drives after having performed heavy physical work in order to load his truck.	
None defined	**None defined**		**Inadequate training (N4)** Insufficient training to acquire the skills and knowledge needed for the task.

MAINTENANCE (O)

Maintenance includes maintenance of the vehicle as well as the traffic environment.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**None defined**		**Inadequate vehicle maintenance (O1)** The vehicle, or parts of it (e.g. tyres, steering, brake system, lighting), has been inadequately or incorrectly maintained.
None defined	**None defined**		**Inadequate road maintenance (O2)** The road, or parts of it, has been inadequately or incorrectly maintained.

VEHICLE DESIGN (P)

Vehicle design includes problems with the design of one or more parts of the vehicle.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**None defined**		**Inadequate design of driver environment (P1)** One or more parts of the driver environment are inadequately designed from an HMI or ergonomic point of view (e.g. ITS-system is very distracting, driver's seat is hard to adjust, pillar obstructs the view).
None defined	**None defined**		**Inadequate design of communication devices (P2)** One or more of the communication devices (e.g. indicators, brake lights, reverse lights) are inadequately designed.
None defined	**None defined**		**Inadequate construction of vehicle parts and/or structures (P3)** The vehicle has been insufficiently built or the construction has been insufficiently considered resulting in suboptimal performance (e.g. poor road friction, large steering radius, limited braking power, insufficient head light) or complete equipment failure (e.g. balks breaking, seats becoming loose, head lights failing).
None defined	**Load (P4.1)** Heavy load makes the vehicle behave unpredictably.	The driver experiences the car behaving unusually (e.g. under steering) when the boot is heavily loaded.	**Unpredictable system characteristics (P4)** The characteristics of the vehicle become unpredictable under certain circumstances (e.g. a vehicle that is normally under-steered might become over-steered when taking sharp curves in high speed).

ROAD DESIGN (Q)

Road design includes problems with the design of road information or the road itself.

ANTECEDENTS			CONSEQUENTS
GENERAL Genotypes	**SPECIFIC Genotypes (with definitions)**	**Examples for SPECIFIC Genotypes**	**GENERAL Genotypes (with definitions)**
None defined	**None defined**		**Inadequate information design (Q1)** The design of the traffic guidance or control is inadequate (e.g. road signs are too many, ambiguous or inappropriately placed, traffic lights are inappropriately timed or inappropriately placed; lines on the tarmac supporting stop/give way signs or traffic lights are inappropriately placed).
None defined	**None defined**		**Inadequate road design (Q2)** The planning and/or the construction of the road are inadequate (e.g. inadequate road surface, curve, camber, road shoulder, vertical/ horizontal alignment or inadequately placed guard rails).

APPENDIX 2 SHORT SUMMARY OF EACH TEXT REFERRED TO IN THE LINKING TABLE INCLUDING A REFERENCE LIST

Åkerstedt & Kecklund, 2000
Fatigue (E3) => Missed observation (B2), Late observation (B2)

Study:	Literature overview
Inducer:	-
Participants:	-
Results:	Translated from Swedish: "Sleepiness is measured by … changes in the eye's pattern of activity which characterise sleep (tendencies for long blinks, half open eye lids, slow wavy movements by the eye globe and closed eyes". From this follows that "missed observation" and "delayed observation" is likely.

Åkerstedt, Peters, Anund & Kecklund, 2005
Fatigue (E3) => Missed observation (B1) indirect, Late observation (B2) indirect

Study:	Simulator with a rural two-lane road
Inducer:	Night shift
Participants:	10 (5 males, 5 females), M = 37 years They received approximately €110
Results:	Simulator driving after completing a night shift resulted in increased eye closure duration

Anttila & Luoma, 2005
Inattention (E2) => Missed observation (B1) indirect, Late observation (B2) indirect, Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2) indirect

Study:	Instrumented vehicle on test rout in real traffic (urban)
Distract:	A visual and an auditory (cognitive) surrogate in-vehicle information system (S-IVIS), each including 3 different levels of difficulty
Participants:	24 (19 males, 5 females), M = 37 years (25-59)
Results:	Visual task resulted in: - increased number of times when vulnerable road users were forced to give way - increased number of sudden brakes - increased number of short gaps accepted when turning Cognitive (auditory) task resulted in: - increased number of times when vulnerable road users were forced to give way - increased number of sudden brakes - increased number of times where driver signalled too late

Arnedt, Wilde, Munt & MacLean, 2001
Under the influence of substances (E4) => Fatigue (E3)

Study:	Simulator with motorway route
Substance:	Alcohol
Participants:	18 males, M = 19.9 years (19-35) They received $30 or a 5% addition to their course mark
Results:	Alcohol resulted in increased rating of sleepiness

Arnold et al. 1997
Time pressure (N1) => Fatigue (E3)
Irregular working hours (N2) => Fatigue (E3)
Heavy physical activity before drive (N3) => Fatigue (E3)

Study:	Interview
Inducer:	-
Participants:	638 truck drivers
Results:	Contributors to fatigue are: - long driving hours - tight delivery schedule - delays in loading - irregular trip schedules - irregular rest hours on road - driving between 2-5 a.m. - loading/unloading

Baulk, Biggs, van den Heuvel, Reid & Dawson, 2006
Fatigue (E3) => Missed observation (B1), Late observation (B2)

Study:	The Psychomotor Vigilance Test (PVT) + Driving simulator task
Inducer:	Extended wakefulness (26 hours) in laboratory setting
Participants:	15 (7 males, 8 females), M = 33.6 years (22-56) They received a monetary reward
Results:	Extended wakefulness resulted in: - increased number of missed visual stimulus - increased reaction time to a visual stimuli

Beilock, 1995
Time pressure (N1) => Psychological stress (E7) indirect => Priority error (D1)

Study:	Interview
Inducer:	Violation-inducing schedules
Participants:	498 long-distance drivers
Results:	Assuming average legal speed limits of 55 mph: 26 % of the drivers had to exceed the legal speed limit and/or the legal maximum of driving hours and/or total working hours in order to keep to their schedule

Brookhuis, De Waard & Samyn, 2004
Under the influence of substances (E4) => Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2) indirect

Study:	Simulator
Substance:	MDMA (ecstasy), Multi-drugs
Participants:	33 participants including: 20 (15 males, 5 females), M = 27 years 13 participants in a control group (not taking any drugs), M = 24 years
Results:	MDMA resulted in: - acceptance of smaller gaps when crossing a priority road with traffic coming from both directions and when making a left turn crossing traffic Multi-drugs resulted in: - acceptance of smaller gaps when crossing a priority road with traffic coming from both directions and when making a left turn crossing traffic

Broughton, Switzer & Scott, 2007
Reduced visibility (J1) => Misjudgement of situation (C1)

Study:	Simulator with lead vehicle under three visibility conditions and two different speeds
Visibility:	Clear (493 m visibility) Moderate fog (93 m visibility) Dens fog (41 m visibility)
Participants:	47 undergraduates (13 males, 34 females) evenly distributed over the 6 conditions
Results:	The dense fog at high speed (50 MPH) condition separated the drivers into two groups One group lagged beyond the visibility range of the lead vehicle The other group stayed within visible range of the lead vehicle even though that violated the NHTSA 3-second time headway recommendation

Cohen, Wells, Kimball & Owsley, 2003
Permanent functional impairment (F1) => Missed observation (B1) indirect, Late observation (B2) indirect, Misjudgement of time gaps (C1) indirect

Study:	Structured interview based on the "Driving Habits Questionnaire"
Illness/Impairment:	Dizziness caused by vestibular disorders
Participants:	169 participants including: 118 patients with vestibular disorders (38 males, 80 females), M = 53 years 51 controls (24 males, 27 females), M = 51.9 years
Results:	Patients reported significantly more difficulty than controls when: - checking for traffic before pulling into an intersection - making left turns across traffic

Consiglio, Driscoll, Witte & Berg, 2003
Inattention (E2) => Missed observation (B1) indirect, Late observation (B2)

Study:	Laboratory setting with accelerator and brake pedal, together with a simulated brake light on lead vehicle
Distracter:	Radio, Passenger, Hand-held mobile, Hands-free mobile
Participants:	22 (11 males, 11 females), M = 21 years (18-27)
Results:	Conversation (with passenger or on hand-held or hands-free mobile) increased reaction time for braking when the red light (simulated brake light on car in front) was activated

Cooper & Zheng, 2002
Inattention (E2) => Misjudgement of time gaps (C1)

Study:	Instrumented vehicle on test track with left turn crossing traffic
Distracter:	Complex verbal message that required a response
Participants:	39 (28 males, 11 females), 19-70 years, They received $150 + chance to win $1000 proportional to the speed in which they responding to the message as well as turned left
Results:	Drivers who were distracted when driving on wet tarmac (17 drivers) doubled the numbers of times they accepted a too short gap (=> potential collisions) when turning left (crossing traffic)

Cooper et al. 2003
Inattention (E2) => Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2) indirect

Study:	Instrumented vehicle on test track with 3 different driving situations (traffic light turning red, pop-up targets to avoid, left turn crossing traffic)
Distracter:	Hands-free mobile
Participants:	41 (30 males, 11 females), M = 39.0 (19-70) They received $150 + chance to win $1000 proportional to the speed in which they responding to the message as well as the driving tasks
Results:	Distraction resulted in: - decreased time to collision (TTC) when weaving through the pop-up targets - increased acceptance of shorter gaps (distance and time) when turning left - decreased time to collision (TTC) when turning left on wet tarmac

Cox, Quillian, Thorndike, Kovatchev & Hanna, 1998
Permanent functional impairment (F1) => Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2)

Study:	Simulator study with a typical grade 2 US highway
Illness/Impairment:	Alzheimer's disease
Participants:	50 participants including: 29 Alzheimer patients (45% males, 55% females), M = 72.0 years 21 controls (62% males, 38% females), M = 70.1 years
Results:	Alzheimer patients (compared with controls): - spent more time negotiating left turns - spent more time driving considerable slower than the speed limit

De Waard & Brookhuis, 1991
Under the influence of substances (E4) => Missed observation (B1) indirect, Late observation (B2)

Study:	Instrumented vehicle in real traffic
Substance:	Alcohol
Participants:	20 males (25-40 years)
Results:	Alcohol resulted in increased time before responding to lead vehicles deceleration

Dinges et al. 1997
Fatigue (E3) => Psychological stress (E7)

Study:	Experiment (not related to driving)
Inducer:	Restricted sleep during 7 days
Participants:	16 (8 males, 8 females), M = 22.9 years
Results:	Restricted sleep during 7 days results in increased levels of self-reported stress

Dingus et al. 2006
Inattention (E2) => Missed observation (B1) indirect, Late observation (C2) indirect

Study:	Instrumented vehicles in real traffic, 12-13 months data collection, 100 vehicles
Distracter:	Recording of natural distractions
Participants:	241 (109 primary and 132 secondary – family and friends to the primary driver), Selection on high risk exposure by young drivers (under 25) and high mileage. M = approx. 35 years (60.6% males, 39.4% females). Own vehicle (78): $125/months + end-bonus Leased vehicle (22): free vehicle + end-bonus
Results:	The driver looked away from the forward roadway at least once in a 4 seconds window surrounding the events (3 seconds prior and 1 second post-event onset) in almost 80 percent of the crashes and 65 percent of the near-crashes

Easa, 1994
Inadequate information design (Q1) => Inadequate transmission from road environment (M2) => Misjudgement of time gaps (C1)
Inadequate road design (Q2) => Inadequate road geometry (L5)=> Missed observation (B1), Late observation

Study:	An analytical method for evaluation of sight-hidden dip profiles
Design:	Sight-hidden dips
Participants:	-
Results:	By using this analytical method for sight-hidden dip profiles, sight-hidden dips can be avoided or appropriately signed in order to warn drivers – thus reducing passing manoeuvre accidents

Engström, Johansson & Östlund, 2005
Inattention (E2) => Missed observation (B1) indirect, Late observation (B2) indirect

Study:	Simulator (fixed and moving base) + Instrumented vehicle in real traffic (motorway)
Distracter:	A visual and an auditory (cognitive) surrogate in-vehicle information system (S-IVIS), - each including 3 different levels of difficulty
Participants:	Simulator (fixed base): 48 (37 males, 11 females), M = 40.6 years (25-62) Simulator (moving base): 48 (30 males, 18 females), M = 38.0 years (25-53) Instrumented vehicle: 24 (12 males, 12 females), M = 34.0 years (25-46)
Results:	Cognitive distraction resulted in increased gaze concentration towards the road centre

Fitten et al. 1995
Permanent functional impairment (F1) => Missed observation (B1) indirect, Late observation (B2) indirect

Study:	Driving course in low-level real traffic
Illness/Impairment:	Alzheimer's disease and Vascular dementia
Participants:	80 participants including: 13 Alzheimer patients (100% males, 0% females), M = 70.0 years (56-93) 12 Vascular dementia patients (92% males, 8% females), M = 71.8 years (65-79) 15 diabetes controls (93% males, 7% females), M = 71.7 years (60-78) 24 older controls (42% males, 58% females), M = 71.8 years (60-92) 16 younger controls (50% males, 50% females), M = 27.6 years (20-35)
Results:	Alzheimer patients had lower mean lateral eye movement (compared with vascular dementia patients and younger controls)

Friswell & Williamson, in press 2007
Under the influence of substances (E4) => Fatigue (E3)
Reduced visibility (J1) => Fatigue (E3)
Time pressure (N1) => Fatigue (E3)
Irregular working hours (N2) => Fatigue (E3)
Heavy physical activity before drive (N3) => Fatigue (E3)
Inadequate design of driver environment (P1) => Fatigue (E3)
Fatigue (E3) => Missed observation (B1), Late observation (B2) indirect, Misjudgement of time gaps (C1), Misjudgement of situation (C2) indirect

Study:	Questionnaire
Inducer:	-
Participants:	321 light and short haul truck drivers 98.1% males, M = 43.3 years
Results:	Contributors to fatigue are: - use of alcohol - stimulant after effects - poor weather conditions - long driving hours - insufficient rest breaks - irregular eating - dawn driving - dusk driving - night driving - loading/unloading - poor cab design - vehicle vibration - poor vehicle ventilation Effects on driving while fatigue: - poor attention to signs - follow too closely - speeding - poor signalling

Gregersen, 1996
Inadequate training (N4) => Insufficient skills/knowledge (F6) => Overestimation of skills (F5)

Study:	Training with “skid car” equipment on a driving practice area
Skills/Knowledge	Skill training versus Insight training
Participants:	53 learner drivers (18-24 years) including: 24 drivers receiving skill training 29 drivers receiving insight training
Results:	The skill groups estimated their skills higher than the insight group There were no difference in actual skills between the two groups Skill training resulted in more false overestimation of skill than insight training did

Hancock, Lesch & Simmons, 2003
Inattention (E2) => Missed observation (B1), Late observation (B2), Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2) indirect

Study:	Instrumented vehicle on test track with stop lights
Distracter:	Mobile
Participants:	36 (19 males, 17 females) including: 19 younger: M = 30.1 years (25-36), 17 older: M = 60.2 years (55-65)
Results:	Distraction resulted in: - 15% increase in no response to light change - slower response to light change - harder braking

Haraldsson, Carenfelt, Laurell & Törnros, 1990
Fatigue (E3) => Missed observation (B1) indirect, Late observation (B2)

Study:	Simulator with a one-lane narrow curved road at twilight The driver had to react on light-stimuli seen through the front window
Inducer:	Sleep apnoea syndrome
Participants:	25 participants including: 15 patients with sleep apnoea syndrome (15 males, 0 females), M = 54 years (30-69) 10 controls (15 males, 0 females), M = 55 years (30-69)
Results:	Sleep apnoea syndrome resulted in increased brake reaction time to the light stimuli

Harbluk, Noy, Trbovich & Eizenman, 2007
Inattention (E2) => Missed observation (B1) indirect, Late observation (B2) indirect, Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2) indirect

Study:	Instrumented vehicle on test route in real traffic (city)
Distracter:	Hands-free mobile (easy + difficult cognitive task)
Participants:	21 (12 males, 9 females), M = 26.50 years (21-34) Rewarded with $50
Results:	Increased complexity of task resulted in: - increased time looking straight ahead - reduced time looking to the right periphery - reduced time checking instruments and mirrors (some drivers not at all) - fewer glances at traffic lights when approaching intersection (some drivers not at all) - reduced time scanning of the intersect area to the right - increased number of hard braking

Hatfield, Fernandes, Job & Smith, 2007
Inadequate training (N4) => *Insufficient skills/knowledge (F6) indirect =>*
Misjudgement of situation (C2) indirect

Study:	Observation in real traffic (4-way intersections) + Interviews
Skills/Knowledge:	Lack of knowledge about the right-of-way rules for pedestrians
Participants:	2854 pedestrians were observed (49.1% males, 50.9% females) 574 pedestrians and drivers were interviewed
Results:	Lack of knowledge about the right-of-way rules for pedestrians created conflicts in situations where both pedestrian and driver took their right-of-way

Hatfield & Murphy, 2007
Inattention (E2) => Missed observation (B1) indirect, Late observation (B2) indirect, Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2) indirect

Study:	Observation at 6 pedestrian crossing in real traffic
Distracter:	Hands-held mobile, Hands-free mobile
Participants:	546 pedestrians (276 males, 270 females)
Results:	Females talking on the mobile: - were less likely to look at traffic before or during crossing - were less likely to wait for traffic to stop

Hill & Boyle, 2007
Reduced visibility (J1) => Psychological stress (E7)
Inadequate road maintenance(O2) => Psychological stress (E7)
Inadequate road design (Q2) => Psychological stress (E7

Study:	Questionnaire
Stressorr:	-
Participants:	914 (553 males, 361 females),
Results:	The majority of drivers reported some level of stress due to the following four factors: - limited visibility conditions (night driving, driving next to trucks) - weather-related conditions (icy roads, rain, sleet or snow) - conditions related to driving task (driving through, or making left hand turns, in unregulated intersections, moving across lanes to exit, making right hand turns, merging into heavy traffic, driving on mountain roads)

Horberry, Anderson, Regan, Triggs & Brown, 2006
Inattention (E2) => Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2) indirect

Study:	Simulator (simple + complex road environments) with speed signs and 3 types of hazards (pedestrian standing on the roadway near the edge, car reversing down a driveway towards the road, pedestrian crossing the road)
Distracter:	In-vehicle entertainment/information system (e.g. radio), Hands-free mobile
Participants:	31 participants including: 10 younger: M = 21 years (>25) 11 middle age: M = 37 years (30-45) 10 older: M = 66 years (60-75)
Results:	In-vehicle entertainment/information system resulted in: - higher minimum speeds when approaching a hazard Hands-free mobile resulted in: - higher minimum speeds when approaching a hazard

Horrey & Wickens, 2004
Inattention (E2) => Missed observation (B1) indirect, Late observation (B2), Misjudgement of situation (C2) indirect

Study:	Meta-Analysis
Distracter:	Mobile, Passenger
Participants:	16 studies including 37 analysis
Results:	Distraction resulted in delayed response to critical road hazards

Jamson & Merat, 2005
Inattention (E2) => Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2) indirect

Study:	Simulator with lead vehicle in rural environment
Distracter:	A visual and an auditory (cognitive) surrogate in-vehicle information system (S-IVIS), - each including 3 different levels of difficulty
Participants:	Visual task: 24 participants, M = 31.7 years Auditory task: 24 participants, M = 37.8 years
Results:	Visual distraction resulted in: - trend towards reduced time to collision (TTC) Cognitive distraction resulted in: - reduced time to collision (TTC)

Kass, Cole & Stanny, 2007
Inattention (E2) => Missed observation (B1), Late observation (B2) indirect, Misjudgement of situation (C2) indirect

Study:	Simulator
Distracter:	Hands-free mobile
Participants:	49 participants including: 24 (12 males, 12 females), M = 14.7 years (14-16) 25 (12 males, 13 females), M = 29.0 years(21-52)
Results:	Distraction resulted in: - increased number of missed stop signs - increased number of missed turns (following instructions when to turn) - increased number of collisions with other vehicles - increased number of striking pedestrians - increased number of speeding occasions

Kuypers, Samyn & Ramaekers, 2006
Under the influence of substances (E4) => Missed observation (B1) indirect, Late observation (B2)

Study:	Laboratory test: - critical Tracking Task (CTT) - object movement estimation under divided attention (OMEDA) Instrumented vehicle in real traffic: - road tracking test - car-following test
Substance:	MDMA (ecstasy), Alcohol
Participants:	18 (9 males, 9 females), M = 26.6 years (21-39) They received a monetary reward
Results:	Alcohol resulted in increased brake reaction time

Lamble, Summala & Hyvärinen, 2002
Permanent functional impairment (F1) => Missed observation (B1) indirect, Late observation (B2)

Study:	Instrumented vehicle in real traffic
Illness/Impairment:	Impaired central visual field acuity
Participants:	10 (10 males, 0 females), 40-50 years old including: 5 drivers with impaired central visual field acuity 5 normal vision controls
Results:	Drivers with impaired central visual field acuity were significantly slower at detecting the onset of the brake lights of the car in front than the normal vision drivers

Landaur & Howat, 1983
Under the influence of substances (E4) => Fatigue (E3)
Study: Experiment
Substance: Alcohol
Participants: 26 (18 males, 8 females), Md = 21 years (18-35)
Results: Increased blood alcohol concentration resulted in increased drowsiness

Laurie et al. 2004
Inadequate information design (Q1) => Inadequate transmission from road environment (M2) => Missed observation (B1), Late observation (B2) indirect
Study: Simulator
Design: Different design on signs to stop wrong entry
Participants: 3 experiments all including students
Results: Depending on the design of the signs the number of missed observations differed

Lee, Caven, Haake & Brown, 2001
Inattention (E2) => Missed observation (B1) indirect, Late observation (B2)
Study: Simulator with a lead vehicle
Distracter: Speech-based e-mail system with 2 levels of difficulty
Participants: 24 participants, 18-24 years
They received $6.50 an hour
Results: Distraction resulted in an 30% increase in reaction time to start braking when the lead vehicle decelerate

Lenné, Dietze, Rumbold, Redman & Triggs, 2003
Under the influence of substances (E4) => Missed observation (B1) indirect, Late observation (B2)
Study: Simulator with a rural 2-lane highway
Substance: Methadone, Buprenorphine, LAAM, Alcohol
Participants: 55 participants divided as follows:
10 methadone treatment (67% males, 33% females), M = 33.4 years
13 LAAM treatment (48% males, 52% females), M = 31.2 years
11 buprenorphine treatment (73% males, 28% females), M = 31.4 years
21 controls (41% males, 59%females), M = 34.1 years
Results: Methadone/Buprenorphine/LAAM/no medication + Alcohol resulted in increased reaction time to a secondary task (the drivers should press the foot pedal when the symbols in the top corners of the simulator screen changed shape)

Lenné, Triggs & Redman, 1997
Fatigue (E3) => Missed observation (B1) indirect, Late observation (B2) indirect
Study: Simulator with a two-lane rural highway
Inducer: Circadian rhythm
Participants: 11 males, M = 23.6 years (21-26)
Results: Early afternoon, late evening and early morning driving resulted in prolonged reaction time

Leung & Starmer, 2005
Under the influence of substances (E4) => Missed observation (B1) indirect, Late observation (B2)

Study:	Simulator
Substance:	Alcohol
Participants:	32 (18 males, 14 females), M = 24 years (18-35) They received monetary reward + bonus for maintaining a clear experimental driving record
Results:	Alcohol increased time to detect an approaching vehicle

Liu & Lee, 2005
Inattention (E2) => Missed observation (B1) indirect, Late observation (B2), Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2) indirect

Study:	Instrumented vehicle (with a sign stating this + parking lights constantly lit) in real traffic
Distracter:	Hands-free mobile
Participants:	12 participants including: 6 aggressive (3 males, 3 females) 6 non-aggressive (3 males, 3 females) M = 35.2 years (25-45)
Results:	Distraction resulted in: - delayed response to red light - increased number of hard brakings - increased number of times exceeding the stop line before stopping - increased number of times running the amber light

Logan, 1996
Under the influence of substances (E4) => Missed observation (B1) indirect, Late observation (B2) indirect, Misjudgement of time gaps (C1), Misjudgement of situation (C2); Inattention (E2)

Study:	Accident/driver behaviour analysis including blood screens (from living and deceased drivers) for methamphetamine Reports from the arrests or fatalities
Substance:	Methamphetamine (and multi-drugs)
Participants:	28 (19 males, 9 females) driving in a way that resulted in arrest/fatality, M = 29 years
Results:	Accidents resulted from the driver inappropriately trying to enter a traffic flow, failing to stop at stop signs, generally erratic driving, weaving and speeding (due to error of judgement) Accident also resulted from the driver allowing the vehicle to drift out of the lane of travel on to the shoulder, into fixed objects, or into oncoming traffic (due to inattention)

Martens & Fox, 2007
Expectance of stable road environment (F3) => Missed observation (B1), Late observation (B2)

Study:	Simulator with intersections
Inducer:	The participants drove 23 identical drives on five successive days (5 drives a day) and 1 drive (the 4th drive on day 5) where one priority situation had been changed to a give way situation
Participants:	36 participants (males and females), 21-46 years including: 12 test drivers 24 controls
Results:	With repeated exposure participants' glances at traffic signs became shorter 1 out of 12 test rivers responded to the fact that the priority situation had been changed to a give way situation - and he only responded after having crossed the priority road markings

McKnight & McKnight, 2003
Inadequate training (N4) => Insufficient skills/knowledge (F6) indirect =>
Missed observation (B1) indirect, Late observation (B2) indirect, Misjudgement of situation (C2), Overestimation of skills (F5)

Study:	Accident reports
Skills/Knowledge:	Novice drivers (16-17 year-olds compared with 18-19 year-olds)
Participants:	2128 accident reports including: 979 16-17 year-olds (556 males, 423 females) 1149 18-19 year-olds (705 males, 444 females)
Results:	Younger and less experienced drivers had a significantly greater proportion of their accidents due to: - lack of visual search prior to left turns - not watching the car ahead - driving too fast for the conditions - failure to adjust to wet roads

Meijman & Kompier, 1998: Study IV
Time pressure (N1) => Psychological stress (E7)

Study:	Bus drivers in real traffic
Inducer:	Many passengers and other factors outside the driver's control affect the spare time available (maximum 7 minutes) between consecutive trips
Participants:	21 bus drivers (21 males, 0 females), 30-40 years
Results:	*Number of passengers* (positive correlation) and *Spare time between trips* (negative correlation) correlated with *Perceived effort in dealing with time pressure* *Perceived effort in dealing with time pressure* correlated with psycho-physiological stress factors such as increased *adrenaline concentration in the urine* and *higher systolic blood pressure*

Miller & Mackie, 1980
Irregular working hours (N2) => Fatigue (E3)
Irregular working hours (N2) => Psychological stress (E7)
Heavy physical activity before drive (N3) => Fatigue (E3)

Study:	Professional drivers in real traffic
Inducer:	Working at or near the legal duty-time limits
Participants:	18 professional truck and bus drivers
Results:	Management issues: - irregular schedules caused greater subjective fatigue, physiological stress, and performance degradation than regular schedules - pairs of truck drivers engaging in round-the-clock sleeper operations showed earlier and/or greater signs of fatigue than single drivers - during irregular operations the driver had to, at some time, drive during those hours of the night when circadian reduction in physiological arousal are substantial - heavy cargo handling as well as long driving stints increased fatigue

Miura, Shinohara, Kimura & Ishimatsu, 2005
Inattention (E2) => Missed observation (B1), Late observation (B2)

Study:	Experiment with 2 slides The second slide sometimes included hazards: lighting of braking lights of a preceding vehicle, shortening of head way to a preceding vehicle, jutting out of an oncoming vehicle towards the participants
Distracter:	Navigation system (to be observed before or after the second slide)
Participants:	4 undergraduate students, 2640 trials
Results:	Distraction resulted in: - increased reaction times (navigation system: 812 ms, control 716 ms) - increased number of missed observation (navigation system: 7.57 %, control 3.35 %)

Morita, Mashiko & Okada, 2000
Inattention (E2) => Missed observation (B1) indirect, Late observation (B2)

Study:	Instrumented vehicle following a lead vehicle on a test track The experimenter in the lead vehicle manually lit the brake lights at random times
Distracter:	Looking at a display screen as long as possible
Participants:	12 (8 males, 4 females), M = 31.9 years
Results:	Increased time looking at the display => Increased time to notice brake lights being lit Increased time looking at the display => Increased time to apply brakes

Oxley, Fildes, Corben & Langford, 2006
Inadequate information design (Q1) => Inadequate transmission from road environment (M2) => Misjudgement of time gaps (C2)
Inadequate road design (Q2) => Inadequate road geometry (L5) => Misjudgement of time gaps (C1)

Study:	Older driver crash "black-spot" site analysis
Design:	Intersections of different design
Participants:	62 sites including over 400 accident involving drivers aged 65 years or over
Results:	Depending on the design of the intersections (e.g. controlled by "stop" or "give-way" signs with, or without, restricted sight distance) the likelihood of misjudgement of gap size differed

Patten, Kircher, Östlund & Nilsson, 2004
Inattention (E2) => Missed observation (B1), Late observation (B2)

Study:	Instrumented vehicle in real traffic (motorway)
Distracter:	Hand-held mobile, Hands-free mobile - each including 2 different levels of difficulty
Participants:	40 professional drivers (32 males, 8 females), M = 39.6 years (21-60) They received 100 €
Results:	Hand held mobile resulted in: - increased reaction time to a light stimulus in a peripheral detection task - increased number of misses to a light stimulus in a peripheral detection task Hands-free mobile resulted in: - increased reaction time to a light stimulus in a peripheral detection task - increased number of misses to a light stimulus in a peripheral detection task

Ramaekers, Kuypers & Samyn, 2006
Under the influence of substances (E4) => Misjudgement of time gaps (C1) indirect

Study:	Instrumented vehicle in real traffic: - road tracking test - car-following test
Substance:	MDMA (ecstasy), Methylphenidate
Participants:	18 (9 males, 9 females), M = 26.6 years (21-39) They received a monetary reward
Results:	MDMA resulted in increased "gain" of their response to the lead vehicles deceleration (normally larger speed reduction than desired)

Robbe, 1998: Study IV
Under the influence of substances (E4) => Missed observation (B1) indirect, Late observation (B2); Misjudgement of time gaps (C2) indirect

Study:	Instrumented vehicle in real traffic with a lead vehicle
Substance:	Marijuana, Alcohol, Marijuana + Alcohol
Participants:	18
Results:	Marijuana + Alcohol increased reaction time when lead vehicle decelerated Marijuana contributed to increased headway variability to the lead vehicle

Roehrs, Zwyghuizen-Doorenbos, Knox, Moskowitz & Roth, 1992
Under the influence of substances (E4) => Inattention (E2), Fatigue (E3)

Study:	Experiment not related to traffic or driving
Substance:	Alcohol
Participants:	12 males, 21-45 years Received a monetary reward
Results:	Alcohol resulted in: - significantly increased sleepiness (as measured by sleep latency) when the basal level of sleepiness was already high (due to circadian rhythm) - increased impairing effects on attention by distraction (as measured by a divided attention task) - reduced vigilance (as measured by a auditory vigilance test)

Schifano, 1995
Under the influence of substances (E4) => Missed observation (B1) indirect, Late observation (B2) indirect, False observation (B3), Misjudgement of situation (C2)

Study:	Case histories (driving in real traffic after attending rave parties)
Substance:	MDMA (ecstacy) - sometimes in combination with other drugs
Participants:	5 patients at the Addiction Treatment Unit in Padova, Italy
Results:	In total, the 5 patients had caused 11 serious car accidents due to: - skipping red traffic lights - "bizarre" behaviour (e.g. trying to escape the elephants, driving a space voyager astroboat) due to hallucination - not being able to distinguish between motorway lanes which were in regular use or closed for "work in progress" - not caring at all about red traffic lights, stop signs, sharp bends etc. - speeding

Silber et al. 2005
Under the influence of substances (E4) => Missed observation (B1) indirect, Late observation (B2)

Study:	Simulator with: - freeway traffic driving at day/night - city traffic driving at day/night
Substance:	Dexamphetamine
Participants:	20 (10 males, 10 females), M = 25.4 years (21-32)
Results:	Dexamphetamine resulted in: - reduced visual acuity in the left eye - reduced ability to stop at a red traffic light (possible due to tunnel vision) - increased reaction time - reduced number of correct signalling

Simon & Corbett, 1996
Psychological stress (E7) => Misjudgement of situation (C2)

Study:	Postal questionnaire
Stressor:	Stressful feelings and events
Participants:	422 drivers from the Transport Research Laboratory (TRL) database (54% males, 46% females)
Results:	Both stressful feelings and events were positively related to offending Index of offending: - driving with defective brakes - driving through amber (even though there is time to stop) and red traffic lights - speeding - overtaking on the wrong side - driving an vehicle without an MOT - crossing into a hatched white line while overtaking - drunk-driving - not giving way to traffic on major road - failing to use indicator

Sivak, Schoettle, Reed & Flannagan, 2006
Inadequate design of driver environment (P1) => Permanent sight obstruction (H3) indirect => Missed observation (B1) indirect), Late observation (B2) indirect

Study:	North Carolina crash data 2000-2003
Design:	B-pillar position in 2-door versus 4-door cars
Participants:	2-door: 740 accident during lane change, 15898 accidents going straight ahead 4-door: 2126 accidents during lane change, 38911 accidents going straight ahead
Results:	4-door models are more likely to be involved in a lane change accident than 2-door models of the same vehicle model This suggests that lateral visibility out of the vehicle cabin affects safety

Strayer & Drews, 2006: Study I
Inattention (E2) => Missed observation (B1) indirect, Late observation (B2)

Study:	Observation of 4-way intersections in real traffic
Distracter:	Hand-held mobile
Participants:	1748 drivers not aware of being observed
Results:	When using a mobile the odds ratio for failing to stop before the white line in the 4-way intersection increased from 0.27 to 2.93

Strayer & Drews, 2006: Study II
Inattention (E2) => Missed observation (B1)

Study:	Simulator with a lead vehicle on a highway
Distracter:	Hands-free mobile
Participants:	32 undergraduates
Results:	When using a hands-free mobile the initial encoding of information in the driving environment is impaired. Even when participants looked directly at objects in the driving scene, they were less likely to create a durable memory of those objects if they were conversing on a cell phone. These results suggest "inattention blindness" (showed by measuring the event-related brain potential, ERP).

Strayer & Johnston, 2001
Inattention (E2) => Missed observation (B1), Late observation (B2)

Study:	Computer simulation with lead vehicle and red (stop)/green (continue) lights
Distracter:	Mobile, Radio
Participants:	48 (24 males, 24 females), M = 21.3 years (18-30)
Results:	Mobile resulted in: - the probability of missing a red light more than doubled - increased reaction time (when red light went on)

Summala, 1998
Inadequate training (N4) => Insufficient skills/knowledge (F6) indirect =>
Missed observation (B1) indirect, Late observation (B2) indirect, Misjudgement of situation (C2)

Study:	Instrumented vehicle in real traffic
Skills/Knowledge:	American visitors without knowledge about the European signing policy for uncontrolled intersections
Participants:	3 American professors (3 males, 0 females), 40-60 years
Results:	In comparison to a control group (22 Finnish drivers from another study) all three showed unsafe driving practice at uncontrolled intersections After they had been informed about the European rule of crossroad priority the drivers improved their speed control as well as visual search

Summala, Lamble & Laakso, 1998
Inadequate design of driver environment (P1) => Inattention (E2) indirect =>
Missed observation (B1) indirect, Late observation (B2)

Study:	Instrumented vehicle on new freeway not yet opened
Design:	Display at three different positions (above dashboard, at the level of the speedometer, on the mid console)
Participants:	28 undergraduates (8 males, 20 females), M = 25 years (20-43)
Results:	The reaction time to brake onset (when lead vehicle braked) increased as a function of the lead-vehicle eccentricity (forced by the different positions of the display)

Svenska Diabetesförbundet: Insulinkänning [Insuline reaction], 2007
Sudden functional impairment (E6) => Fear (E1)

Study:	Patient information about diabetes
Illness/Impairment:	Diabetes
Participants:	-
Symptoms:	Too low insulin concentration in the blood can result in anxiety

Taylor, Deane & Podd, 2007
Fear (E1) => Missed observation (B1) indirect, Late observation (B2) indirect

Study:	Standardised on-road assessment in real traffic
Inducer:	Driving
Participants:	100 participants including: 50 fearful female drivers, M = 43.6 years 50 females in control group, M = 41.4 years
Results:	Fearful drivers made more errors than controls when it comes to search technique (e.g. in intersections) as well as moving the vehicle (e.g. entering the traffic flow, holding on the road and maintaining position in traffic stream)

Underwood, Chapman, Berger & Crundall, 2003
Inadequate training (N4) => Insufficient skills/knowledge (F6) indirect =>
Missed observation (B1) indirect, Late observation (B2) indirect,

Study:	Video-based experiment
Skills/Knowledge:	Novice drivers
Participants:	30 undergraduate students including: 15 novice drivers (≤ 1 years full driving licence, approx. 1 500km) 15 experienced drivers (≥ 4 years full driving licence, approx. 100 000km) They received £5
Results:	When looking at video recordings taken from a moving vehicle, novice drivers had a smaller effective perceptual field than that of more experienced drivers

Van der Hulst, Meijman & Rothengatter, 2001
Time pressure (N1) => Psychological stress (E7) indirect => Misjudgement of situation (C2)

Study:	Simulator with a lead vehicle for part of the time
Inducer:	Time schedule instructions
Participants:	24 participants including: 12 drivers with a time schedule (7 males, 5 females), M = 33.4 years 12 controls (7 males, 5 females), M = 32.3 years
Results:	Drivers who had received time schedule instructions maintained a shorter headway to the lead vehicle than the drivers in the control group

Vårdguden, Epilepsi [Epilepsy], 2007
Sudden functional impairment (E6)) => Missed observation (B1) indirect, Late observation (B2) indirect, False observation (B3) indirect

Study:	Patient information about epilepsy
Illness/Impairment:	Epilepsy
Participants:	-
Symptoms:	Seizures can result in unresponsiveness and muteness. Can be combined with visual/auditory experiences and repeated movements (e.g. chewing or swallowing)

Vårdguden, Hjärtinfarkt [Heart attack], 2007
Sudden functional impairment (E6)) => Fear (E1)

Study:	Patient information about heart attack
Illness/Impairment:	Heart attack
Participants:	-
Symptoms:	Heart attack can result in anxiety and fear

Vårdguden, Slaganfall [Stroke], 2007
Sudden functional impairment (E6)) => Missed observation (B1) indirect, Late observation (B2) indirect, False observation (B3) indirect

Study:	Patient information about stroke
Illness/Impairment:	Stroke
Participants:	-
Symptoms:	Stroke can result in sudden visual impairment

Vårdguden, Yrsel [Dizziness], 2007
Sudden functional impairment (E6)) => Missed observation (B1) indirect, Late observation (B2) indirect, False observation (B3) indirect

Study:	Patient information about dizziness
Illness/Impairment:	Dizziness
Participants:	-
Symptoms:	Dizziness is defined by impaired hearing

Wallis & Horswill, 2007
Inadequate training (N4) => *Insufficient skills/knowledge (F6) => Misjudgement of situation (C2)*

Study:	Video-based experiment (analysed with fuzzy signal detection technique)
Skills/Knowledge:	Novice drivers
Participants:	69 (34 males, 36 females) including: 27 novice drivers (< 4 years driving 25 especially trained novice drivers (< 4 years driving, watched a 17-min video) 17 experienced drivers (≥ 10 years driving, M (distance) > 8000km/year)
Results:	Novice drivers, compared with especially trained novice drivers and experienced drivers, required a higher threshold of danger to be present before they noticed a situation is hazardous or before they were willing to classify a situation as hazardous.

Ward & Wild, 1995
Inadequate information design (Q1) => Inadequate transmission from road environment (M2) => Missed observation (B1) indirect, Late observation (B2) indirect, Misjudgement of situation (C2)

Study:	Observation of drivers in real traffic: - at one railway crossing where a series of warning signs were added - at one similar railway crossing where nothing were altered
Design:	Signs providing advanced warning of a railway crossing with restricted lateral visibility as well as advising drivers to come to a full stop.
Participants:	59-66 observations during the pre-installation period 33-40 observations during the first post-installation period 27-42 observations during the second post-installation period
Results:	The series of signs resulted in: - increased visual search at some points in the approach - decreased approaching speeds

Wild & Cotrell, 2003
Permanent functional impairment (F1) => Missed observation (B1) indirect, Late observation (B2) indirect, Misjudgement of time gaps (C1) indirect, Misjudgement of situation (C2)

Study:	Evaluation by certified rehabilitation specialist while driving in real traffic
Illness/Impairment:	Alzheimer's disease
Participants:	30 participants including: 15 Alzheimer patients (11 males, 4 females), M = 71.4 years 15 controls (8 males, 7 females), M = 73.9 years
Results:	The evaluation of Alzheimer patients showed that they performed significantly worse than controls with regards to: - using mirrors appropriately - managing intersections - following at safe distance - responding to road conditions - signalling in time

Williamson, Feyer, Coumarelos & Jenkins, 1992
Reduced visibility (J1) => Fatigue (E3)
Time pressure (N1) => Fatigue (E3)
Irregular working hours (N2) => Fatigue (E3)
Heavy physical activity before drive (N3) => Fatigue (E3)

Study:	Questionnaire
Inducer:	-
Participants:	960 truck drivers
Results:	Contributors to fatigue are: - poor weather - long driving hours -dawn driving - loading/unloading

Wittmann et al. 2006
Inadequate design of driver environment (P1) => Inattention (E2)

Study:	Simulator with lane keeping task and reaction to activation of brake lights Secondary task projected onto a display at one of seven different positions
Design:	Seven different positions for onboard display
Participants:	30 (15 males, 15 females), M = 26.7 years (20-40)
Results:	Driving disturbance (measured by behavioural data, eye movements, subjective rating scale) was exponential as a function of distance between the line of sight to the outside primary task and the onboard display position Vertical distance had a greater effect than horizontal distance

Wood, 1999
Permanent functional impairment (F1) => Missed observation (B1) => Late observation (B2)

Study:	Closed-circuit driving course
Illness/Impairment:	Visual impairment
Participants:	62 participants including: 21 older with visual impairment, M = 70.7 years 26 older controls, M = 69.2 years 15 younger controls, M = 21.5 years
Results:	Older participants with visual impairment performed significantly worse on peripheral detection times (compared with younger controls) Older controls performed significantly worse on sign detection (compared with younger controls)

Yan & Radwan, 2007
Inadequate road design (Q2) => Inadequate road geometry (L5)
=> Misjudgement of time gaps (C1) indirect

Study:	Video filming real traffic (four-leg level intersection)
Design:	A wide median dividing highways resulting in simultaneously turning vehicles in the opposing left-turn lanes blocking drivers' views for each other
Participants:	323 left-turns (105 with sight obstruction, 323 without sight obstruction)
Results:	Drivers turning left accepted smaller gaps (leading to more conflicts) when their view were blocked

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