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D5.3

Typical human functional failure-generating scenarios: a way of aggregation

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Abstract:

This report describes the methodological work undertaken in Task 5.3 of the TRACE project. As part of Work Package 5 of this project, it presents an in-depth analysis of accident data oriented toward the definition of regularities in the context of production of human functional failure ('human error'). A Typical Scenario is defined as the typical progress with which we can connect a group of accidents which present resemblances from the point of view of the chain of the phenomena, whether they are analyzed from an historical, a functional or a causal point of view (Fleury & Brenac, 2001). The purpose of defining such typical entities is to find an intermediate level of analysis between case study and statistical analysis by showing regularities in the accident-generating processes, and not only considering their result. The Typical Human Failure-Generating Scenarios presented in this report are aimed at explaining the process of 'human error' generating. They are built under the shape of configurations which connect a task to be realized, explicative elements, a functional failure and a resultant situation leading to a crash configuration. Their construction benefits from the input coming from the other WP5 deliverables, and especially: D5.1 which proposes a classification of human functional failures and D5.2 which presents a grid for analysing the factors and situations for these failures. The operational presentation of these Typical Human Failure-Generating Scenarios should help future accident analysis, even for none 'human factors' specialists.

Keyword list: Accident aggregation – Human Error – Accident factors - Context

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1 Executive Summary

1.1 TRACE project: TRaffic Accident Causation in Europe

In spite of countless amounts of research and development, road safety is still one of the main societal concerns today. It is not only a matter of concern for the European Commission and National Governments but also for the vehicle industry, insurance companies, driving schools, non-governmental organisations and more generally for every single road user. Car manufacturers have made strong efforts and have dramatically improved passive (and also active) safety of their vehicle for the past 15 years. However, current road safety research has shown that an asymptote is about to be reached on this aspect in most countries and many experts agree that preventive (prevention of accidents) and active safety (recovery of an emergency situation) should now, particularly, be brought forward.

The TRACE project has 2 major objectives:

The first one addresses the determination and the continuous up-dating of the aetiology (i.e. analysis of the causes) of road accidents and injuries, and the definition of the real needs of the road users as they are deduced from accident and driver behaviour analyses.

The second one aims at identifying and assessing, among possible technology-based safety functions, the most promising solutions that can assist the driver or any other road users in a normal road situation or in an emergency situation.

So the purpose is first to bring a comprehensive and understandable definition of accident causation which goes further and deeper than the usual statements. It is also to provide the scientific community, the stakeholders, the suppliers, the vehicle industry and the other Integrated Safety program participants with a global overview of the road accident causation issues in Europe and promising solutions based on technology.

1.2 WP5 'Human Factors'

In order to gain new knowledge on accident causation, several methodological work packages (WP) have been defined in the structure of TRACE in order to give a support to the analyses conducted into the Operational Work Packages of the project.

As such, WP5 'Human Factors' has been defined to improve the multidisciplinary methodologies that allow the analysis of the role of 'human factors' in road accident production. In brief, WP5 is oriented toward the diagnosis of the difficulties met by road users which lead them to an accident, toward the identification of the contexts in which they take place, and toward the definition of the origins of these difficulties whether they are human in nature otherwise.

The methods aim at standardising accident analysis in order to bring validated and comparable results from one study to the other, without loosing the scientific and academic background required for a comprehensive research work.

Four tasks compose this Work Package. The first three are oriented toward the elaboration of an operational model permitting a comprehensive analysis and classification of 'human error' generating processes. The fourth one is devoted to a further and wider view on the influence of the social and societal context on accident occurrence.

- Task 5.1 A model for human functional failure analysis

The objective of this task is to define and characterize the different types of human errors, violations and difficulties which are involved in the accident generating process. Such modelling work is based both on scientific literature dealing with human error analysis, and on truly in-depth accident data. The purpose is to build an operational grid for human functional failures, consistent with ergonomics concepts and specifically adapted to the driving task.

- Task 5.2 A comprehensive grid of factors and situations for human functional failure

Human failures are explained by factors characterizing the state of system, i.e. the defects of its components (human and other) and of their interactions. These factors are then considered as the explanatory elements of the road users' incapacity to adapt to the situation in hand. A grid of all the relevant elements contributing to human failures has been compiled, and differentiates those factors coming from the 'human' part of the system, from those coming from the layout, the traffic interaction and the vehicle.

- Task 5.3 Typical failure-generating scenarios

The purpose of this third task is to combine the results from T5.1 and T5.2 in order to build a methodological frame allowing the aggregation of accident data under the form of generic accidental processes, viewed as an integration of the parameters characterizing the accident generation: which situation and context, which human failure, which explicative elements, which consequence, etc. They will allow putting forward the typical specificities of the difficulties encounters by different types of road users, in different types of situations.

- Task 5.4 Social and cultural aspects of human factors

The purpose of this task is more prospective. It is to analyze the socio-economic/socio-cultural dimension of human activity, its interaction with the driving system, to build a framework of analysis aimed at completing the accident analysis framework proposed in T5.3 by putting forward broader 'upstream' factors of its production process.

1.3 Typical failure-generating scenarios: a way of aggregation. Summary of TRACE report D5.3

The scope of the present report refers to the possibilities of aggregating accidents data in order to go further than the usual classification of accidents cases according to a single criterion (such as the type of collision, the layout configuration, the driving situation, etc.). It describes the operational work on accident data undertaken in Task 5.3 of the TRACE project. As part of the Work Package 5 of this project, it is dedicated to the analysis of 'human factors' inside the accident production process. So this report is aimed at defining a way of classifying different generic processes behind the production of human functional failures.

The classification proposed tries to avoid the drawbacks of the two classical methods that are statistical analysis (with the tendency of disaggregating data) and monographic analysis (which are difficult to generalize). This method is based upon the concept of 'typical scenarios' describing regular patterns of accident-generating processes. A Typical Scenario is defined as the typical progress with which we can connect a group of accidents which present resemblances from the point of view of the chain of the phenomena, whether they are analyzed from an historical, a functional or a causal point of view (Fleury & Brenac, 2001). The purpose of defining such typical entities is to find an intermediate level of analysis between case study and statistical analysis by showing regularities in the accident-generating processes, and not only considering their result. The interest of such a conception comes from the fact that accidents are the result of a process involving the various, more or less complex, malfunctions that occur in different driving situations, and which need not to be lost in the analysis.

So, the typical human failure-generating scenarios presented in this report are aimed at explaining the process of 'human error' generating. This formalization integrates the results gained from the tasks 5.1 (relating the classification of human functional failures) and 5.2 (related to the classification of factors and situations for these failures) of the TRACE project. The principle behind these typical scenarios is that they aggregate 'similar' accidents processes, allowing to combine different cases which are produced along the same chain of events, involving the same type of human failure and showing the same patterns of factors. The development of the scenarios presented in this report is based on the

analysis of accident cases from the INRETS-MA 'ultra-depth'[1] data bank. By showing some generic accident patterns in which human functional failures are inscribed, these typical scenarios should help classifying accidents cases even for less detailed data (e.g. from police procedures) on a basis of similarity recognizing. Being both simply presented and well documented these scenarios may even be used by none 'human factors' specialists. They should help accident analysts to put forward some generic tendencies in the process of human failure producing, considering different populations of road users, different types of layout configurations, the role of different factors, etc.

To summarize, the double operational purpose of these typical human failure-generating scenarios is:

1) To show the most occurring pathologies of the driving system which put the drivers' capacities to their limits.

2) To open to countermeasures, as far as these diagnosed generic pathologies are thought to be solved by similar means.

[1] The so-called "ultra" in-depth data are extracted from accident survey performed by INRETS (France) and are based not only on the reconstruction of physical parameters, but also on detailed interviews performed by a psychologist to apprehend the precise difficulties met by the drivers.

2 Introduction

TRACE project has the objective to promote a comprehensive view of accident causation in order to find the most promising solution able to help road users to perform their task securely.

In line with this objective, Work Package 5 is dedicated to a transversal work aimed at providing operational models and methodological support to the other Work Packages of TRACE, concerning 'human factors' aspects involved in road accidents.

The purpose of Task 5.3 is to combine the results from T5.1 devoted to human functional failures and T5.2 dedicated to the factors and situations of these failures, in order to build a methodological frame allowing the aggregation of accident data under the form of generic accidental processes.

As part of this task, the present report investigates in-depth accident data taking advantage of the methodological input of TRACE deliverables D5.1 (Van Elslande & Fouquet, 2007) and D5.2 (Naing, Bayer, Van Elslande, Fouquet, 2007) in order to build operational 'Typical Failure-Generating Scenarios' (TFGS) showing the inscription of human functional failures in the context of their production.

2.1 TRACE project: TRaffic Accident Causation in Europe

In spite of countless amounts of research and development, road safety is still one of the main societal concerns today. It is not only a matter of concern for the European Commission and National Governments but also for the vehicle industry, insurance companies, driving schools, non-governmental organisations and more generally for every single road user. Car manufacturers have made strong efforts and have dramatically improved passive (and also active) safety of their vehicle for the past 15 years. However, current road safety research has shown that an asymptote is about to be reached on this aspect in most countries and many experts agree that preventive (prevention of accidents) and active safety (recovery of an emergency situation) should now, particularly, be brought forward.

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2.3 Typical failure-generating scenarios: a way of aggregation.

The current development of detailed databases collected on the scene of road accidents, notably at the European level (e.g. Safetynet project, the project of an European observatory, etc.), puts back to the agenda accident classification works, and notably asks for an adjustment of the conceptions according to the progress of the knowledge on drivers functioning and the inscription of this functioning inside the overall accident process. The purpose of this report is to contribute to this objective as part of methodological advancements supported by TRACE project.

A dilemma which is met in the exploitation of a set of descriptions of accidents results from the triple necessity of: 1) reporting the complexity of the phenomenon, 2) showing the variety of the circumstances of its occurrence, and 3) arriving nevertheless at results of a certain degree of generality. In the purpose of finding a way to overcome these difficulties, Task 5.3 on TRACE is devoted to the definition of typical human failure-generating scenarios aimed at showing the regularities behind 'human error' production.

Work done in this task is described below, insisting one the operational presentation of the results of the analysis based on in-depth accident data. It is strongly connected with two other reports belonging to TRACE WP5: D5.1 which presents a classification model of the different types of Human functional

failures found in road accident (Van Elslande & Fouquet, 2007), and D5.2 which presents a grid of factors leading to these failures along with a grid of pre-accident driving situations in which they occur (Naing *et al*, 2007).

The typical human failure-generating scenarios presented in this report are built under the shape of configurations which connect a driving task to be realized, some combinations of explicative elements, a functional failure, and a resultant situation leading to a crash configuration. By showing some generic accident patterns in which human functional failures are inscribed, these typical scenarios should help classifying accidents cases even for less detailed data (e.g. from police procedures) on a basis of similarity recognizing.

This report first presents the interest of the method in comparison with more classical methods of accidents classification. Then the accent is put on the presentation of the recurring scenarios resulting from the extensive analysis of an in-depth database (n=1637 drivers). Conclusions are drawn toward the usefulness of these typical scenarios. And the annex illustrates in detail the different parameters which are at the basis of their construction.

3 Interest of typical accident-generating scenarios

The complexity of the phenomena in set in the production of an accident, explains the difficulty finding a level of aggregation of the data that allows a classification of the cases integrating the sequential and interaction aspects of mechanisms involved. This is the reason why accident data tend to be analysed according one criterion or several but considered in a disaggregated way.

Our contribution to this objective will consist in trying to define a level of description of the 'accident' phenomenon organized around the micro-regulating element of the system (i.e. the driver) and which is intermediate between case study and the statistical analysis. The generic configurations of human functional failure-producing described in this report should help classifying accident cases in a more comprehensive way, on a simple basis of recognition of the accident history.

3.1 Advantages / drawbacks of classical methods

Indeed, case study presents the advantage to report in its entirety peculiarities every 'history' of accident by integrating essential dimensions such as the dynamics, the sequentiality and the multi-causality of mechanisms into play. But one of its inconveniences lies in the weak generalizing power of empirical data which stick too much to the 'real world', to the point to make of every accident a particular case only analyzable in an *ad hoc* way. In line with the complexity of the accident phenomenon, retaining a too important level precision for event description may compromise the comparison between different cases.

By contrast, the interest of statistical analysis of accidents data lies in the possibility of quantifying the importance of the problems on dimensions defined *a priori*, such as certain descriptive properties of the driver (age, fatigue, alcohol level, etc.) or of the environment (characteristics of infrastructure, weather conditions, etc.). It so allows estimating the interest of the actions to be led for an improvement of the road safety. However, the major inconvenience of this type of exploitation deals with the difficulty of reporting the complexity of the mechanisms of an accident from variables which are disaggregated, generally descriptive and loosened of any temporality. An analysis in term of statistical proximity allows with difficulty a real understanding of the processes of production of the accidents.

Between monographs (case studies) and the causal chains (statistical analyses), we tried to exceed the descriptive character of these two tendencies by proposing an explanatory approach underlined both by the contemporary cognitive models and by the analysis of driving task and its specific difficulties.

3.2 Toward an aggregation of accident processes to analyse human error

As far as the accident is the result of processes of varied and more or less complex dysfunctions, taking place in diverse driving situations, it seemed interesting to build an intermediate level of description of the phenomenon. It was done by formalizing the processes tracked down in the detailed analysis of accidents under the shape of typical dysfunctions-generating scenarios of accidents, which allow explaining the emergence of human functional failures (cf. TRACE report D.5.1, Van Elslande & Fouquet, 2007), as a function of the factors and situations which generate them (cf. TRACE report D5.2, Naing *et al*, 2007).

The apparently unlimited variety of the road situations does not allow categorizing the accidents on the basis of exclusive criteria. It is thus around these typical scenarios that we tried to build accidents profiles presenting a 'family look' from the point of view of the mechanism of 'human error' generation.

The appeal to the concept of typical scenario allows to progress from the point of view of the aggregation of similar accidents in their progress. A typical scenario of accident is defined as the typical progress with which we can connect a group of accidents which present resemblances from the point of view of the chain of the phenomena, whether they are analyzed from an historical, a functional or a causal point of view. Such a typical progress construction corresponds to a prototype, that is: a construction established from a set of similar accidents and not the particular progress of one of them (Fleury and Brenac, 2001).

With regard to this global conception, the specificity of the present analysis will consist in emphasizing the human component by defining scenarios of generation of the 'error', expressing itself under the shape of chains which connect a task to be realized, explicative elements, a human functional failure and a resultant situation leading to a crash configuration.

Moving the scope of analysis from the system in general to driver functioning does not mean denying the pluricausal character of the accident. It is simply a question of decomposing this multicausality to enlighten it under a particular angle: that of the cognitive processing which was not able to prevent the situation conditions from degenerating. The option taken for the analysis of the difficulties met by the driver justifies itself by the central position of this operator from the point of view of the micro-regulation of the road system. As stated in TRACE report D5.1, the driver is indeed not only a component of this system; he is above all the regulating element. It is by him that is going all the input and the output of this system, and he is the element to whom we tend to attribute causalities, sometimes abusively.

3.3 Method of Human Functional Failure-Generating Scenarios

A first phase of analysis consisted in exploiting for every case individually, the totality of the information contained in every accident case, in order to identify the basic malfunction process in cause in the accident and all the parameters which were associated with it.

On this base of detailed analysis, we selected the generic parameters constituting the weft of the event and authorizing an aggregation of the accidents, pushing aside those who were too specific in every case to allow such an aggregation.

The federative parameters used for the constitution of typical scenarios are the following ones (Figure 1):

- The task that the human function in question was intended to perform in the pre-accident situation (i.e. the outcome the driver wanted to attain and the constraints he had to cope with). The list of these 'malfunction tasks' will be found in TRACE report D.5.2 (Naing *et al*, 2007).

- The combination of elements that explain the fact that the appropriate function failed in attaining the wanted outcome (i.e. 'factors' of HFF). The list of these explicative elements will be found in the same report as above (Naing *et al*, 2007).

- The specific type of Human Functional Failure (HFF) which put the driver in a 'rupture situation', analysed through the classification model presented in TRACE report D.5.1 (Van Elslande & Fouquet, 2007).

- The action resulting from the HFF. This parameter points out the event (manoeuvre) which the human functional failure led to (i.e. what did the driver do that he shouldn't, or didn't do, as a consequence of this failure).

- The crash configuration. This last parameter features the type of collision resulting from the 'HFF resulting action'.

This work has been done on an 'ultra' in-depth accident survey performed by INRETS (France) based not only on the reconstruction of physical parameters, but also on detailed interviews performed by a psychologist to apprehend the precise difficulties met by the drivers.

The typical human failure generating scenarios presented in the next section describe the most recurrent configurations found in this database. The interest behind the simple definition of these typical scenarios is that they represent generic configurations which can be recognized even from less detailed accident data and even for non human factors specialists.

In that purpose, they should contribute to the TRACE project by putting forward the regularities in accident processes from the angles of the different road users (Work Package 1), the different driving situations (WP2) and the different types of accident factors (WP3).

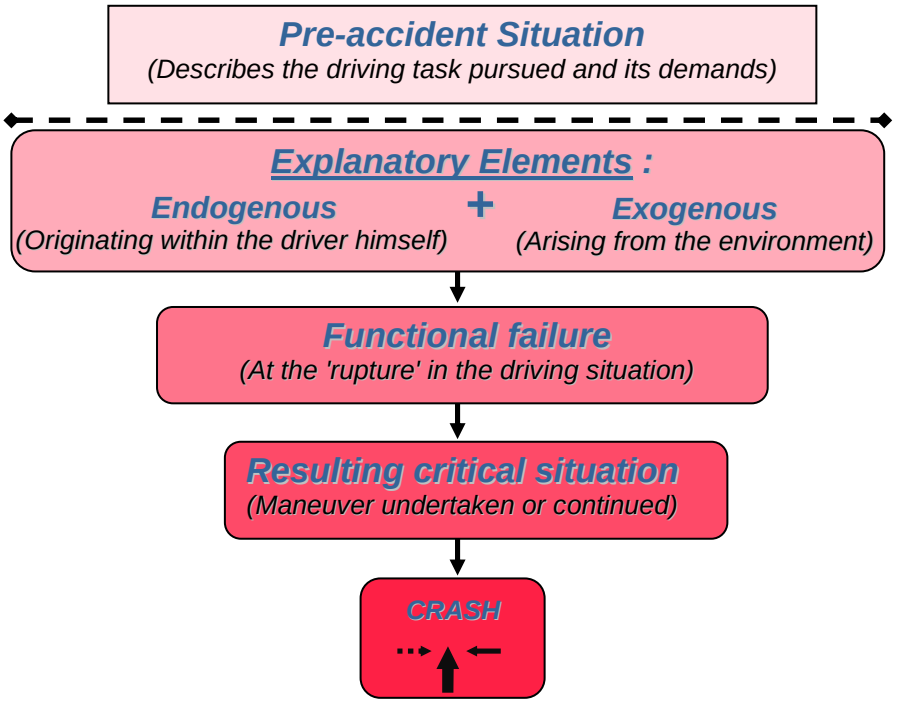

Figure 1. Structure of a typical failure-generating scenario

4 Results

The most frequent typical failure-generating scenarios (TFGS) presented below have been built from an aggregation of 1109 drivers on a total database of 1637 drivers for whom a function failure could be determined. These 'top 30' TFGS account for 67.7% of 1637 accident situations.

To make the present report more readable, the detail of the variables more or less regularly involved in the scenarios is presented for each in Annex. This gives a more precise view on the accident processes which are only summarized in the presentation given below. In the purpose of applying this classification method, it will be indispensable to consider them attentively as they are presented in the annex.

The scenarios are described below along a linear functional way: from problems of detection to 'overall' problems as it formalized in the human functional failure classification model presented in Trace report D.5.1 (Van Elslande & Fouquet, 2007). A good understanding of these scenarios implies the previous looking at this report, and also at the TRACE report D.5.2 (Naing, *et al*, 2007) dealing with the factors of these failures and the situations in which they occur.

4.1 Typical human functional failure scenarios at the information detection stage

4.1.1 P1 failure - Non-detection in visibility constraints conditions

- **Typical scenario 'P1C': Road user surprised by a pedestrian or a two-wheeler non-visible when approaching**

The accidents of this scenario do not all occur at night. But they are all directly attributable to a detectability (conspicuity) problem of the other user who realizes a manoeuvre on their trajectory: absence of visibility resulting from an ad hoc difficulty (parked vehicle), from an element of the environment (house on the side of the road) or from the absence of lighting of the area.

- **Typical scenario 'P1D': Driver surprised by the manoeuvre of a non-visible approaching vehicle**

Circulating in stabilized situation, the drivers are suddenly confronted with a vehicle on their trajectory, which they had not detected previously. This late detection is explained by limitations in visibility (ex: a HGV masking the other user in intersection) as well as by a defect of lighting of this vehicle when the accident occurs at night. We can wonder in certain cases which is the contribution of endogenous element to the functional failure, such as priority feeling (although justified) or strong experience of the site, which can have contributed to the fact that the driver did not take particular precaution in this situation without visibility. But in every case the atypical character, sometimes close to violation, of the manoeuvre engaged by the other explains the difficulty for the driver to anticipate the possible emergence of a difficulty. The drivers hit the vehicle which crosses the road, mostly having hardly the time to put the foot on the brake pedal.

4.1.2 P2 failure - Information acquisition focused on a partial component of the situation

- **Typical scenario 'P2A': Focalisation on a directional problem**

This scenario of accident intervenes essentially in two types of situations.

In the first one, the driver circulates in current section and tries to turn off for a destination on an unfamiliar route, which the directional road marking and the legibility of places do not allow him/her to identify easily. Focusing on this directional problem, the driver engages a manoeuvre without setting more of information about the environmental traffic. This brings him/her for example to not detect another user who had begun overtaking him/her, this user dealing only with the embarrassment of a hesitating vehicle.

We find a variant of this mechanism in situation of intersection crossing, the users being so occupied with looking for their direction that they forget for a moment the demands of the information acquisition task about the priority axes before starting their manoeuvre.

- **Typical scenario 'P2B': Focalisation towards a source of information as a function of driver's layout representation**

Mainly in intersection situation, whether the driver has right of way or not, he attaches more importance to one side considered as more dangerous according to his knowledge about this type of place and to the categorization he elaborated on the sources of potential danger. Preferentially looking for information on these 'zones at risk ', the user performs his manoeuvre without detecting the arrival of a vehicle on the other side and he is thus made strike

- **Typical scenario 'P2C': Focalisation towards a source of information regarding the importance of the traffic flow**

Here the focus of the drivers on a side of the intersection does not seem connected to knowledge of the site, but to an ad hoc representation of the difficulties of the crossing or insertion task they have to realize, regarding notably the relative importance of the traffic on axes. When they start moving by looking emphatically towards the right, the first set of information about the left side is expired.

- **Typical scenario 'P2D': Focalisation towards an identified source of danger**

Here the drivers meet a potentially conflicting interaction with one of the users interfering in the situation, which monopolizes their attention. Their attention being attracted towards this vehicle which they are gazing at, the drivers do not detect another one to which they are suddenly confronted.

4.1.3 P3 failure - Cursory or hurried information acquisition.

- **Typical scenario 'P3A': Cursory search for information while turning on the left (on the right for left driving countries)**

To realize a crossing manoeuvre which is very familiar to them, the drivers do not allocate enough attention in search for information dealing with the feasibility of this operation. They merely have a quick look, almost automatic, which does not allow them to identify the interference of another vehicle on the trajectory they cut. We find in certain cases the influence of the excessive confidence which the drivers confer to the signs given to others, as a marker of their procedure: the indicator sometimes becomes allocated of a priority character, thus getting the driver out of the acquisition of steady information. No exogenous element was able to be found to explain this failure, except the fact that the other driver starts overtaking...

- **Typical scenario 'P3B': Cursory search for information while crossing intersection**

In this scenario, it is the low attention paid to the search for information which seems to explain the non-detection of one of the vehicles during the intersection crossing where the driver lost the right of way. But a certain contextual difficulty for obtaining the information often comes to be added to this explanatory element (restricted visibility which would have required a steadier search for information).

4.1.4 P4 failure - Momentary interruption in information acquisition activity

- **Typical scenario 'P4A': Non-detection of the rapprochement from the vehicle ahead**

The accidents of this category are related to a relatively simple dysfunction process. All the users concerned by this type of failure interrupt for a moment the supervision of their driving environment to dedicate themselves to the realization of a secondary task (diverse activities without relation with the driving task in progress: discussion with a passenger, regulation of the radio set, gazing at something in the environment). This secondary task becomes 'primary' for them and it mobilizes both their look and their attention, making it the major explanatory element of this problem of detection. Whatever is the secondary task at the origin of this interruption of surveillance, the drivers find themselves in the incapacity to detect in due time the relevant information to identify the situation to be managed and have, consequently, the impossibility to operate a driving strategy adapted to this situation.

4.1.5 *P5 failure - Neglecting the need to search for information*

- **Typical scenario 'P5A': Late detection of the slowing down of the vehicle ahead**

For this scenario, the road users drive in stabilized traffic when they are confronted with the slowing down of the previous vehicle, due to a traffic light ahead, to the preparation of a change of direction or simply to the density of traffic. The low level of attention that these drivers allocate to their activity, often connected with a strong knowledge of the route, is directly at the origin of the late identification of the slowing down. Although their sight is oriented forwards, these drivers declare in the interviews that they were 'somewhere else', immersed in diverse preoccupations. As they suddenly become aware of the imminence of a collision, these drivers have only the time to begin a braking manoeuvre before hitting the other vehicle.

- **Typical scenario 'P5B': Late detection of a non-priority road user starting manoeuvre in intersection**

Always connected with the knowledge of the place the users have, to which can be added a priority feeling, they do not worry about what can take place on the secondary axes of an intersection which they are about to cross, behaving as if their task was limited to a situation of driving in current section. They do not detect the alarming indications (movement of the vehicle towards the intersection approach) which would have helped them to envisage the eventuality of a manoeuvre from the vehicle on their trajectory, and so to operate a regulation as a consequence.

4.2 Typical human functional failure scenarios at the diagnostic stage

4.2.1 *T1 failure - Erroneous evaluation of a passing road difficulty*

- **Typical scenario 'T1B': Under evaluation of the difficulty of an although known bend**

A weak attention, connected notably with the frequency of route practice, brings these drivers to be surprised by a bend difficult to negotiate although they know it well. The participation of an endogenous element is mostly found (fatigue, constraint of time, etc.) but exogenous parameters (diminished visibility, slight humidity) may come to modify the conditions of the journey comparatively to what they are used to.

- **Typical scenario 'T1C': Erroneous evaluation of a bend difficulty in a context of playful-driving**

This scenario concerns mostly young drivers who adopt a speed raised in a context of playful-driving (ex: exit of discotheque, making fun) which brings them to take risks by neglecting at the same moment the rule on the site and the dangerousness of the conditions of driving (ex: small sinuous road by night and rainy weather). Upstream to the evaluative failure, a more global decision-making problem intervenes, concerning the adopted driving mode.

4.2.2 *T2 failure - Erroneous evaluation of a gap size*

- **Typical scenario 'T2B': Erroneous evaluation of a merging gap connected to the low attention paid to the manoeuvre**

Drivers represented in this scenario are characterized by their over practice of the manoeuvre they are about to undertake. Often in connection with a poor vigilance state linked to fatigue, this familiarity lead them to engage their manoeuvre on the trajectory of a vehicle, not paying enough attention to the approaching speed of this vehicle that they had nevertheless undoubtedly detected.

4.2.3 *T3 failure - Mistaken understanding of how a site functions*

- **Typical scenario 'T3A': Mistaken understanding leading to a stopping failure in intersection**

Approaching a complex, poorly legible intersection which is not well foretold by the road marking, the drivers do not understand where they have to stop and cross all at once the nearest carriageway on which a priority vehicle collides them.

4.2.4 *T4 failure - Mistaken understanding of another user's manoeuvre*

- **Typical scenario 'T4B': Mistaken understanding of the other's manoeuvre related to the polysemy of their signals**

Confronted with a vehicle which gets ready to start a diverse manoeuvre (forking, about to turn or stop), the driver is taken in by the polysemous (ambiguous) character of the indications that he/she has at his/her disposal and expects a manoeuvre different from the one that the other vehicle realizes effectively. Three types of situations and associated indications seem ambiguity-generating:

- Overtaking on a double lane behind a vehicle which gets ready to turn: the indicator of the other one is only interpreted in the sense of an overtaking signalisation and the driver is not prepared for the slowing down of the other one.

- The drift of a vehicle (for example a bus) on one side to turn on the other one: the driver expects that the other vehicle turns in the direction of the drift and by-passes this vehicle on the opposite site, as it forks in front of him.

- The stop of a vehicle at an unexpected place: the stop lights activation of the previous vehicle is interpreted as a simple slowing down while it announces an intention to stop on the road.

Although they are based on situational ambiguities, these errors of interpretation often bring in a low degree of attention from the part of the driver who limits his analysis to the most evident and adopts a way of driving which does not allow any latitude to a possible regulation.

- **Typical scenario 'T4C': Mistaken understanding of other's manoeuvre related to cursory processing of the interaction**

Contrary to previous both scenarios, it is difficult for these cases to find the origin of the understanding problem in a situational ambiguity. Bothered by a slow vehicle, the drivers operate a very summary treatment of the situation, limiting it to the identification of an embarrassment in the progress, which they try to by-pass as quickly as possible because of a constraint of time. They thus engage an overtaking manoeuvre without having tried to see possible warning indications of a manoeuvre by the other (indicator).

4.3 Typical human functional failure scenarios at the prognostic stage

4.3.1 *T5 failure - Expecting another user not to perform a manoeuvre*

- **Typical scenario 'T5A': Expecting a non priority vehicle not to undertake a manoeuvre in intersection**

The analysis of the cases brings to light that it was very difficult for these drivers to envisage the critical interference of the other vehicle on their trajectory, in the absence of any warning indication of their manoeuvre. Hypothesis is made concerning this indication which would have been able to question the expectation of the respect for the priority in this situation. These drivers thus are 'trapped' by the unexpected manoeuvre engaged by the other. When this critical interference occurs, these users cannot face it considering a ratio distance/time too short to act, without reckoning with the effect of surprise and fear engendered by this totally unexpected operation.

4.3.2 *T6 failure - Actively expecting another user to take regulating action*

- **Typical scenario 'T6B': Erroneous expectation of the stopping of a non priority vehicle approaching intersection**

Arriving at an intersection in which they have right of way, all these drivers were confronted with a vehicle in movement on the secondary road, approaching their way. With a strong sense of their right of way status, the drivers do not pay particular attention to the situation and do not envisage the eventuality of a precaution to be taken, in spite of obvious alerting cues. Persuaded that the other vehicle in movement is going to stop, they are totally surprised at the moment when this vehicle crosses the junction just in front of them.

- **Typical scenario 'T6C': Erroneous expectation of the stopping of a non priority vehicle coming on the trajectory**

This scenario shows a high degree in the confidence that the drivers can attach to their expectations, in spite of obviously contrary indications: as they are approaching the intersection, although they see a vehicle which starts to engage on their trajectory (to cross or merge into the traffic), these users refuse to operate a regulation other than a demonstration of their right of way (flashing headlight or warning signal), convinced until it is too late that the other cannot do anything else but stopping the started manoeuvre.

4.3.3 T7 failure - Expecting no perturbation ahead

- **Typical scenario 'T7A': Expecting no vehicle ahead in a bend with no visibility**

The task of the drivers consisted in negotiating, on a portion of narrow road and without practicable shoulder, a curve limiting strongly the axial visibility. In spite of their knowledge of the site and the difficulties of passing another vehicle coming from the opposite direction, the drivers did not anticipate, when approaching the curve, the possible meeting of a user circulating the other way around. When the situation of difficult interaction appears, they are not then able to face it considering their speed and the effect of surprise (even of fear) induced by the apparition of the event. We can isolate two subgroups according to the 'more or less active' character of the anticipation:

- For a first subgroup, the origin of this expectation failure is to be found in the low attention level characterizing drivers who drive on an 'automatic' mode on a usual route, or who consider the road concerned within the framework of a 'walk'.

- A second subgroup shows a more active participation by the adopted mode of driving: performance seeking, time saving on a road taken as shortcut, etc.

4.4 Typical human functional failure scenarios at the decision stage

4.4.1 D1 failure - Violation directed by the characteristics of the situation

- **Typical scenario 'D1A': Road user directed to go ahead in order to take the information**

In this scenario, the driver has not a status of right of way and must cross an intersection or merge into the traffic flow. In every case these drivers are confronted either with a temporal visibility impairment (parked vehicle generating visibility problem in cities centre), or with a visibility limited by characteristics of the layout. They are thus forced to move forward on the way of the interfering user, in order to get the information before engaging their crossing or insertion on road. And are collided at this moment when they move to get information.

4.4.2 D2 failure - Deliberate violation of a safety rule

- **Typical scenario 'D2B': Overtaking on a zone with limited axial-visibility**

When engaging his overtaking manoeuvre, the user has not detected an interfering vehicle, yet driving in the opposite direction. The motivation of the driver is to avoid a problem in the traffic progress corresponding to the presence of slower vehicles considered as disruptive elements. In addition to this difficulty, impatience and nervousness bring the driver to make the decision to engage an overtaking in spite of the accidentogeneous characteristics of the situation: despite the very limited axial visibility, the drivers bet they won't be confronted with anybody in opposite lane. The driver only detects the presence of a user driving on the same way when the manoeuvre of overtaking is already engaged. Even there, emergency manoeuvre is unsuitable: rough braking and/or hard actions on the steering-wheel, leading to a loss of control of the vehicle.

4.4.3 *D3 failure - Violation-error*

- **Typical scenario 'D3B': Going ahead at intersection being drawn into manoeuvre**

The decision-making failure characterizing these drivers consists in crossing an intersection without trying to verify the conditions of feasibility of this operation, following a certain state of delegation of the analysis of the situation in others. The element which releases the mechanism of the operation can be the intervention of another user by a lights flash or a wave of one's hand inciting him to drive on, or simply the start of a vehicle which precedes the driver, this implicitly meaning that if the other one drives in, it is because the operation is practicable for him too. These drivers start their manoeuvre on the trajectory of users having right of way and are collided in the course of crossing.

In every case, the conditions of realization of the task are questioned: it always takes place in complex intersections, during congested rush hours, or simply from a difficulty of insertion on the main road considering the speed and the density of the traffic.

4.5 Typical human functional failure scenarios at the handling stage

4.5.1 *E1 failure - Poor control of an external disruption*

- **Typical scenario 'E1A': Sudden encounter of an external disruption**

The drivers were assuring the guidance of their vehicle on the trajectory of a rectilinear section (or an easy curve) in not always optimal conditions (rain, wind, etc.) when, they are suddenly confronted with a 'trap' situation with very strong constraints. The environmental disturbances which they have to cope with are for example: violent blast of wind, restraints of water generating an aquaplaning, a fire on the side of the road, tyre blow-out. These difficulties are so strong that they put the users in the incapacity to manage the guidance of the vehicle correctly anymore. The sensori-motor procedures carried out by the drivers to compensate for the disturbance are unsuitable. The accident results from a loss of control.

- **Typical scenario 'E1B': Sudden encounter of an external disruption, more or less expectable**

If the users were trapped by an external disturbance (slipping road, bad road surface, etc.), we shall hold upstream to the failure a certain shape of risk-taking that can be illustrated in the following way: although the weather conditions are degraded and the aquaplaning risks were high, the drivers adopted for diverse motivations a speed much too important for the situation, putting themselves in the impossibility to correct any disturbance. When they feel their vehicle slipping, they are unable to develop the sensori-motor skills adapted to face the uncontrollability of the vehicle.

4.5.2 *E2 failure - Guidance problem*

- **Typical scenario 'E2A': Guidance interruption consequently to attention orientation towards a secondary task**

Whether during a guiding task on rectilinear section or in easy curve or during the negotiation of a bend requiring a consequent adaptation of the speed and the trajectory, these drivers mobilized for a moment their attention (and their gaze) towards the realization of a secondary task (search for diverse objects in the passenger compartment, a changing gear difficulty, a discussion with a passenger on the back seat, consultation of papers, etc.). Their attention being 'caught' by this activity, the drivers interrupt for a moment the control of their guidance. When these drivers then become aware of the trajectory drift which took place during this lapse of time, they have no longer the possibility of realizing the necessary correction to avoid a loss of control or a vehicle coming in front of them.

- **Typical scenario 'E2B': Guidance interruption consequently to attention impairment**

Here the greatest part of users are tired, driving under the light influence of alcohol leading them to a drowsy state, or very familiar of the route and driving in an almost automatic way with a low level of attention. They take advantage of their familiarity with the route to think of other matters: to plan a

working day, think of personal problems…, and become aware too late of the drift of their vehicle out of the road.

4.6 Typical overall human functional failure scenarios

4.6.1 G1 failure - Loss of psycho-physiological capacities

- **Typical scenario 'G1A': Loss of psycho-physiological capacities consequently to a falling asleep or ill-health**

The drivers who compose this scenario are all victims of a loss of momentary consciousness connected to a falling asleep, provoked by a massive absorption of alcohol and other psychotropic drugs, by an excessive fatigue, or by a conjunction of these elements. The accident scenario is very simple, resulting in a total interruption of the driving activity during the more or less sudden transition from wakefulness to sleepiness.

4.6.2 G2 failure - Alteration of sensorimotor and cognitive capacities

- **Typical scenario 'G2A': Alteration of trajectory negotiation capacities**

All the users have to negotiate a curve requiring a consequent adaptation of the speed and the trajectory, whereas they are in state of big drunkenness (alcohol level above 1.5g/l). When meeting this difficult point in their route (a tighter bend) the failure becomes updated: incapable to manage the situation of driving in general, they negotiate the curve with too high speed and lose the control of the vehicle.

- **Typical scenario 'G2B': Alteration of guidance capacities**

The situation gathering these drivers is only a task of guidance of the vehicle on the road. Even there, the high alcohol/drugs intoxication contributes to the fact that these users are no longer able to manage their driving activity to such a point that they do not realize (at least not enough early) the drift of their vehicle out of the road.

4.6.3 G3 failure - Overstretching cognitive capacities

- **Typical scenario 'G3A': Overstretching processing capacities in traffic interaction situation**

Although they arrived without any trouble to the point of the accident, the drivers seem to have been completely 'overwhelmed' when meeting a specific interaction with other vehicles in intersection. We can in certain case refer to the influence of the task complexity, for example in intersections which were reorganized, containing several branches and in which the users are face to a directional problem. But it is mostly during the simple task of turning on the left that these drivers are no longer capable of making a correct phasing of the operations to be implemented (search for the information, processing, decision and execution of the manoeuvre). All the phases necessary for the realization of such an operation being affected, the users finally start their crossing on the trajectory of a user having right of way driving on the main axis.

5 Conclusion

The work presented in this report supports the overall objective of the TRACE project of developing a comprehensive analysis of accident causation mechanisms. As the other deliverables of WP5, it is aimed at presenting analytical tools that allow a better consideration of human factors inside accident production process in order to help developing solutions adapted to human functioning and its weaknesses.

TRACE report D5.1 presents a model allowing a classification of the different types of human functional failures specifically found in road accident (Van Elslande & Fouquet, 2007).

TRACE report D5.2 presents a grid of factors which could lead to these human functional failures along with a grid of pre-accident driving situations in which they occur (Naing *et al*, 2007).

The present TRACE report D5.3 integrates the results from the two previous ones[2] with the aim of finding recurring patterns in accident processes. The typical human functional failure-generating scenarios (THFFGS) presented in this report are built under the shape of configurations which connect a pre-accident driving task, some combinations of explicative elements, a functional failure and a resultant situation leading to a crash configuration. They have been built on the basis of information gained from an extensive 'ultra in-depth' accident data bank. By revealing some generic accident processes in which human functional failures are inscribed, these typical scenarios should help future classification of accidents cases, even for less detailed data (e.g. from police procedures) on a basis of similarity recognizing. Being both simply presented and well documented these scenarios may even be used by non human factors specialists, to put forward some generic tendencies in the process of human failure producing.

The most frequent typical failure-generating scenario formalized in this report can be a basis for research works aimed at showing the main difficulties encountered by such or such type of road user (e.g. the most recurring scenarios in which are involved elderly drivers, motorcyclist, etc.), in such or such type of situation (e.g. the scenarios typically found for such or such type of intersection, etc.), and involving the effect of such or such factor (e.g. in which typical scenarios are inscribed speed, alcohol, vigilance, etc.). So, they are open to exploitations in the frame of the 3 operational Work Packages of the TRACE project.

Of course such a formalization is never at its end, and the more numerous accidents will be studied the more aggregation work will be needed. THFFGS must not be seen as fixed object, but rather as moving 'models' depending on the data at disposal and the objectives pursued. Particularly, when dealing with a specific thematic study (let's say 'elderly drivers'), these typical scenarios can be reconstructed in a way of better showing the specificities of the difficulties encountered by these elderly drivers, for example by putting in more details some accident configurations in which they are more typically involved. This doesn't imply that scenarios do not have the same validity from one study to other. It means that their level of 'granularity' may be adapted to each particular study.

And of course, all accidents can't be aggregated into typical scenarios (unless becoming too general and loosing their operational utility). There are accidents which are more 'accidental' than others and for which the regularities behind their construction are not obvious. But the true purpose of this task is not the definition of a universal classification of accidents (this is more the objective of D5.1 and D5.2). It is to help accident analysts at finding the most recurrent accident pattern showing a regular construction in the production of a human functional failure. These recurrent typical scenarios represent some more or less systematic 'pathologies' inside the driving system functioning. Once identified, they should be counteracted the same way by more appropriate means.

The typical scenarios presented should promote a more comprehensive analysis of the inscription of 'human factors' in the accident production process. This analysis steers away from the road user being

[2] To mention that TRACE report D5.4 will enlarge the questioning about human factors by exploring the further upstream sociological and cultural determinants of driving behaviour and their consequence in the accident production mechanisms.

always the main instigator of the accident, but more a link in a causation chain. And by better understanding the malfunction process behind this causation chain, the typical human functional failure generating scenarios will offer a better assessment of the safety devices capacity to break this malfunction chain. By so doing, it can be considered as a valuable methodological contribution to the main objectives of the TRACE project.

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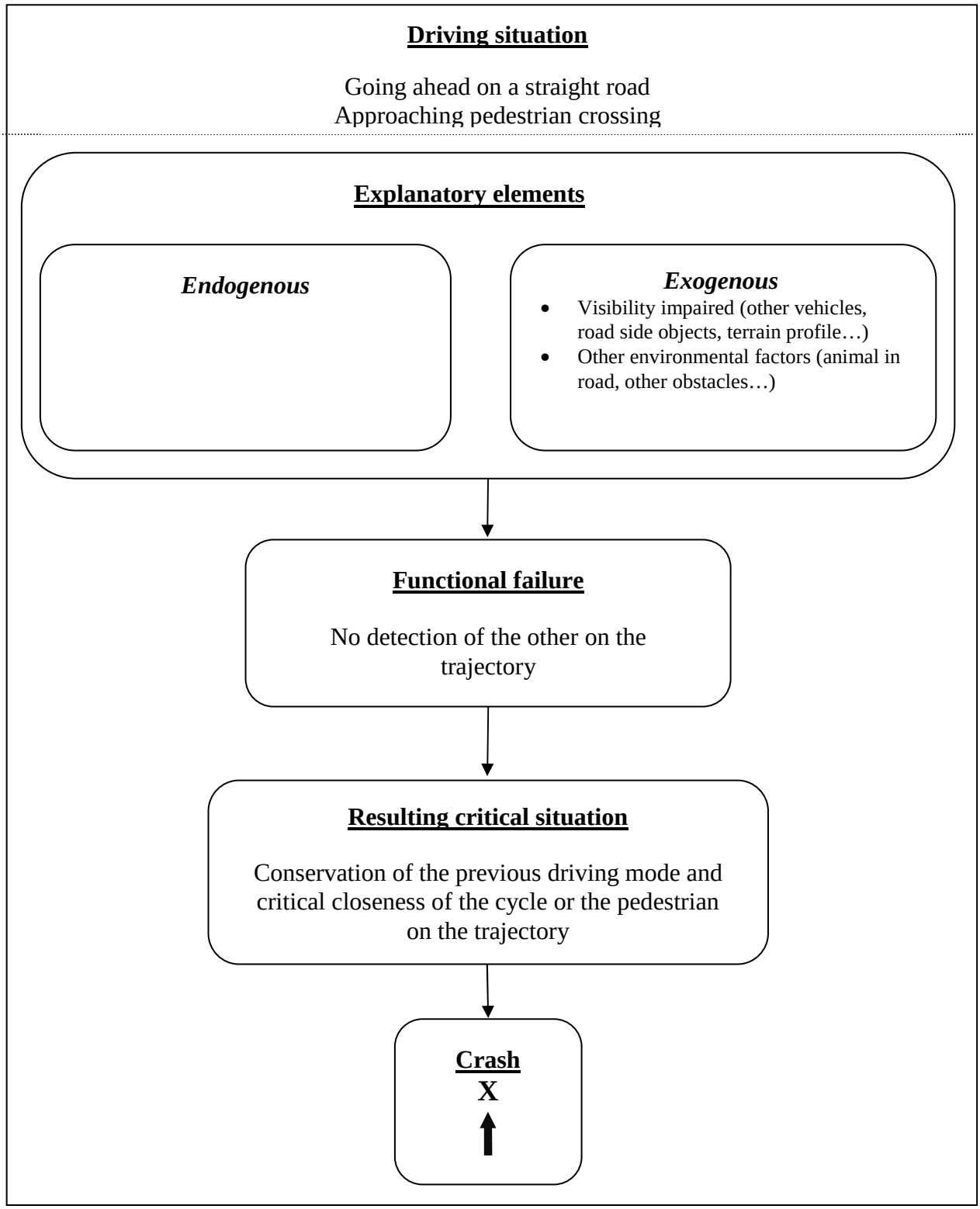
Annex

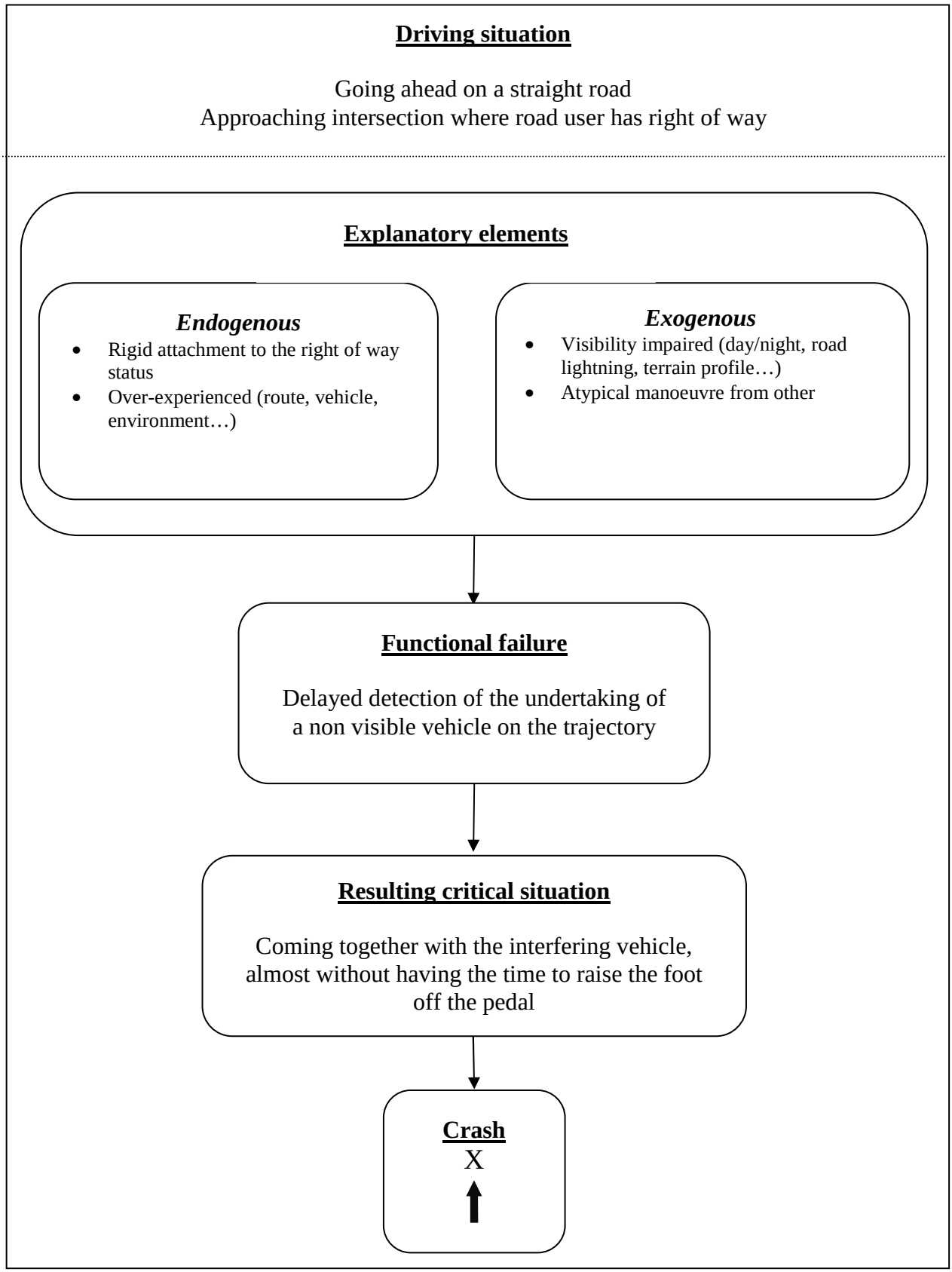
TYPICAL SCENARIO 'P1C'

Road user surprised by a pedestrian or a two-wheeler non-visible when approaching



TYPICAL SCENARIO 'P1D'

Driver surprised by the manoeuvre of a non-visible approaching vehicle



TYPICAL SCENARIO 'P2A'
Focalisation on a directional problem

Driving situation

Turning or going straight across traffic
Going ahead on a straight road
U-turn

Explanatory elements

Endogenous

- Little/None experience (route, environment)
- Pre-existing impairment
- Fatigue
- Little/None experience (driving, environment)
- Substance taken: alcohol, drugs

Exogenous

- Traffic guidance (insufficient, inappropriate…)
- Visibility impaired (day/night, terrain profile…)
- Misleading road layout
- Traffic condition (flow, density…)

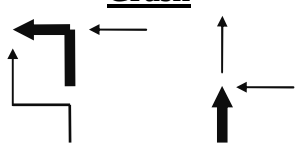
Functional failure

Focused search of information: non - detection of an interfering vehicle or of the manoeuvre undertaken bv this vehicle

Resulting critical situation

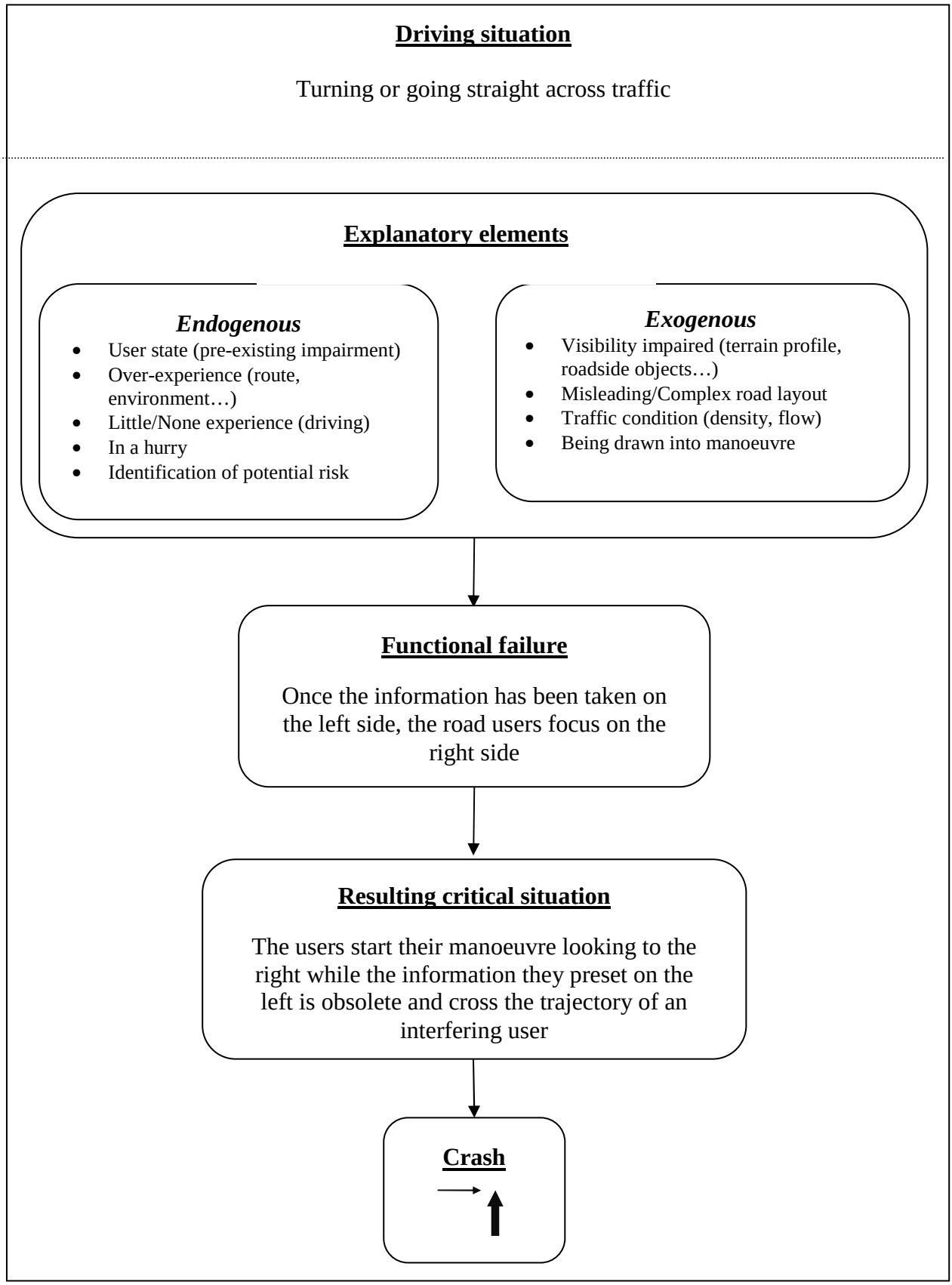
Undertaking of the manoeuvre on the trajectory of the interfering priority vehicle

Crash



TYPICAL SCENARIO 'P2C'

Focalisation towards a source of information regarding the importance of the traffic flow



TYPICAL SCENARIO 'P2D'
Focalisation towards an identified source of danger

Driving situation

Going ahead on a straight road
Turning or going ahead across traffic
Starting (not at junction)

Explanatory elements

Endogenous

- Fatigue
- Over-experience (route, environment…)
- Little/None experience (driving)
- Rigid attachment to the right of way status
- Identification of potential risk

Exogenous

- Atypical manoeuvres of the other road user

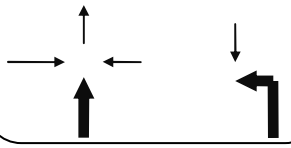
Functional failure

Focalisation towards an interfering vehicle identified as a potential danger

Resulting critical situation

Road users start their manoeuvre being preoccupied only by this source of danger and are hit by another vehicle they did not detect

Crash



TYPICAL SCENARIO 'P3A'

Cursory search for information while turning on the left (on the right for UK)

Driving situation

Turning away from traffic from main road into side road

Explanatory elements

Endogenous

- Fatigue
- Distraction (outside or within the vehicle, within user)
- Over-experience (route, driving…)
- Little/None experience (driving…)
- Excessive confidence in signs given to others

Exogenous

Functional failure

Cursory attention allocated to the search of information. No retake of information on the back to the detected vehicle before engaging their

Resulting critical situation

Do not detect the interfering vehicle that has started its overtaking and cross the trajectory of this vehicle

Crash

TYPICAL SCENARIO 'P3B'

Cursory search for information while crossing intersection

Driving situation

Going straight on at 'give-way', 'stop' or 'traffic signal' intersection
Starting (not at junction)

Explanatory elements

Endogenous

- Pre-existing impairment
- Fatigue
- Distraction (outside and within the vehicle, within user)
- Over-experience (route, environment…)
- Little/None experience (driving, route)
- In a hurry

Exogenous

- Visibility impaired (terrain profile, other vehicles, road side objects)
- Traffic condition (flow, speed, density)

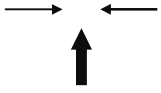
Functional failure

Cursory attention allocated to search for information, such as glance type

Resulting critical situation

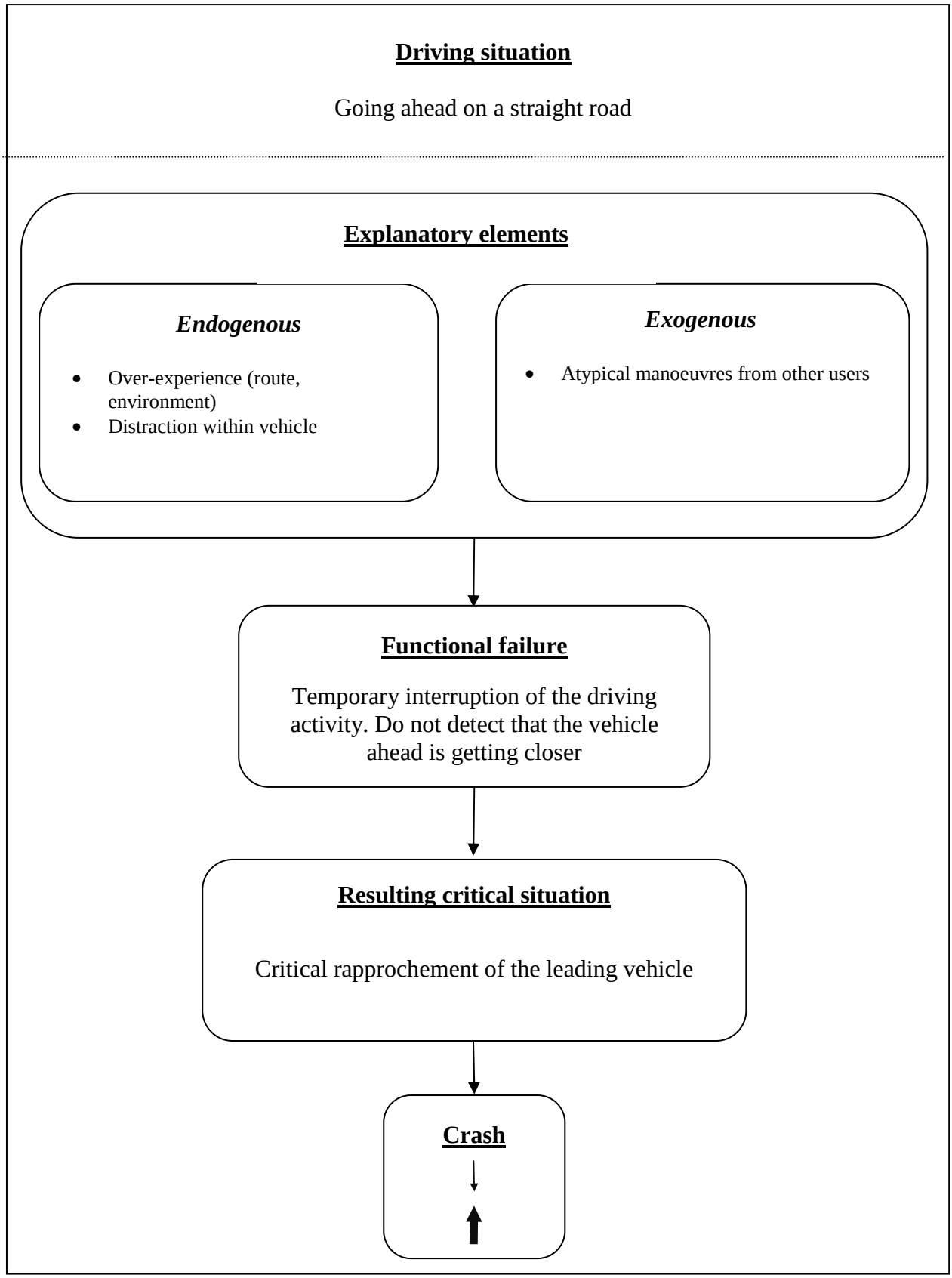
Do not detect the interfering vehicle, undertake their manoeuvre and cross the trajectory of this vehicle

Crash



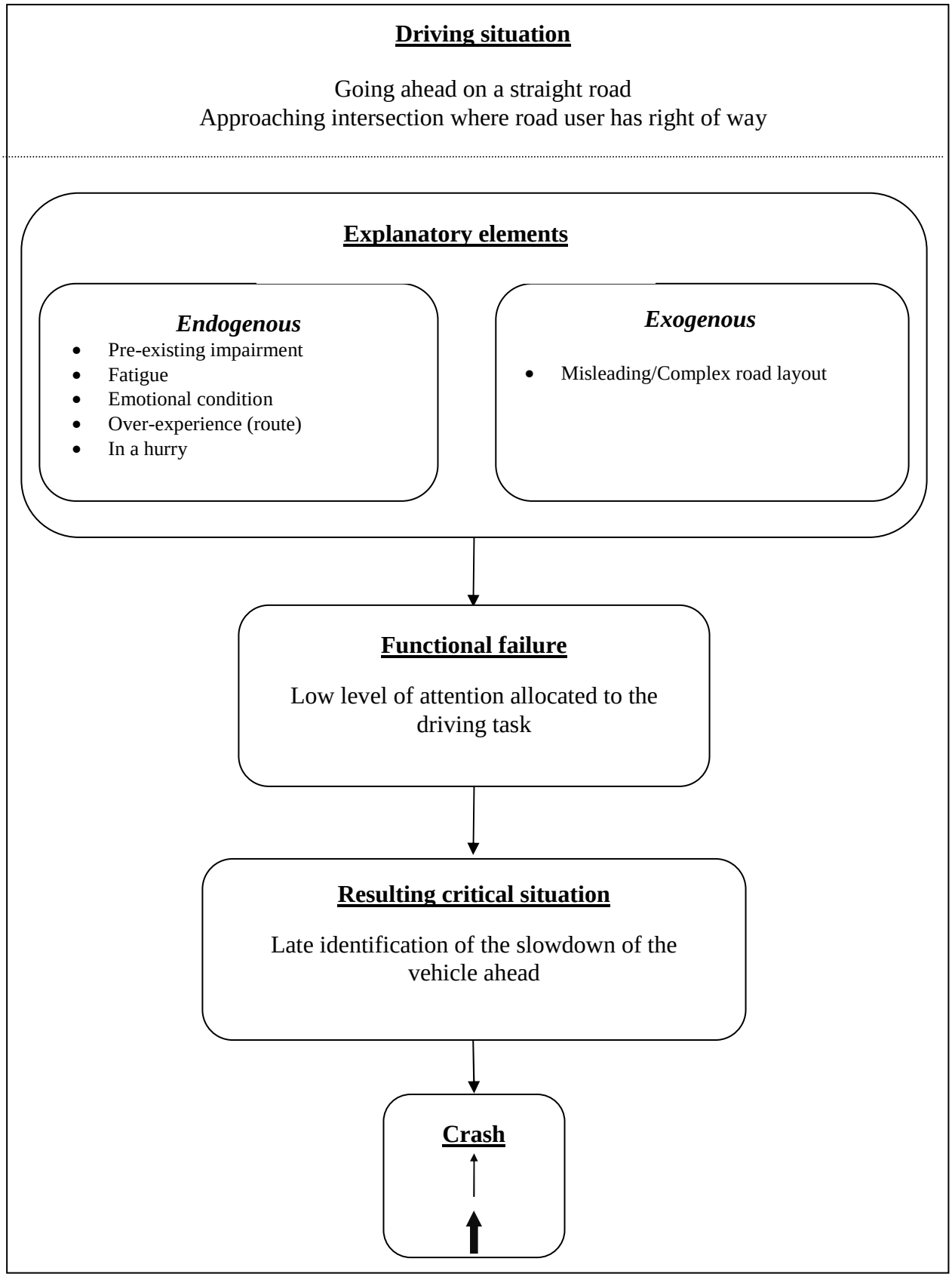
TYPICAL SCENARIO 'P4A'

Non-detection of the rapprochement from the vehicle ahead



TYPICAL SCENARIO 'P5A'

Late detection of the slowing down of the vehicle ahead



TYPICAL SCENARIO 'P5B'

Late detection of a non-priority road user starting manoeuvre in intersection

Driving situation

Approaching intersection where road user has right of way
Crossing intersection where road user has right of way

Explanatory elements

Endogenous

- Pre-existing impairment
- Substances taken (alcohol, drugs)
- Fatigue
- Distraction
- Over-experience (route, environment)
- Little/None experience (driving)
- Rigid attachment to the right of way status
- In a hurry

Exogenous

- Atypical manoeuvres from other users

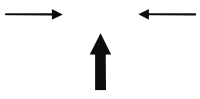
Functional failure

Late detection of the non-priority and interfering road user because of not fulfilling the demands of perception acquisition while having the right of way

Resulting critical situation

Keeps progressing with constant speed almost until the shock. Collision with the non-priority vehicle in the beginning of its crossing

Crash



TYPICAL SCENARIO 'T1B'

Under evaluation of the difficulty of a know bend

Driving situation

Going ahead on a right or left bend

Explanatory elements

Endogenous

- Substances taken (alcohol, drugs)
- Fatigue
- Distraction
- Over-experience (route)
- In a hurry
- Risk taking (speed)

Exogenous

- Traffic guidance (insufficient, maintenance, inappropriate…)
- Speed-inciting layout
- Bends, slopes…
- Visibility impaired (day/night, weather)

Functional failure

Erroneous evaluation of the difficulty of the bend related to the low attention level allowed to the task

Resulting critical situation

Negotiation of the bend at a speed superior to the one practiced usually and loss of control of the vehicle

Crash

TYPICAL SCENARIO 'T1C'

Erroneous evaluation of a bend difficulty in a context of playful-driving

Driving situation

Going ahead on a right or a left bend

Explanatory elements

Endogenous

- Substances taken
- Fatigue
- Little/None experience (driving, route)
- Risk taking (speed, vehicle positioning, traffic control…)

Exogenous

- Traffic guidance (insufficient, inappropriate, unexpected…)
- Road geometry: bend, slopes…
- Maintenance: tyres
- Speed-inciting layout

Functional failure

Erroneous evaluation of the difficulty of the bend connected to a low attention paid to the task and to the context of playful driving = > carelessness of the accident-generating parameters of the site

Resulting critical situation

Negotiation of the bend at a speed superior to the one allowed on the site and loss of control of the vehicle

Crash

TYPICAL SCENARIO 'T2B'

Erroneous evaluation of a merging gap connected to the low attention paid to the manoeuvre

Driving situation

Turning right or left at 'give-way', 'stop' or 'traffic signal' intersection
Going straight on at 'give-way', 'stop' or 'traffic signal' intersection
Turning right or left from main road into side road
Starting, leaving parking space

Explanatory elements

Endogenous

- Fatigue
- Distraction
- Over-experience (driving)
- Little/None experience (route, driving)
- Excessive confidence in the signs given to others

Exogenous

- Misleading/Complex road layout

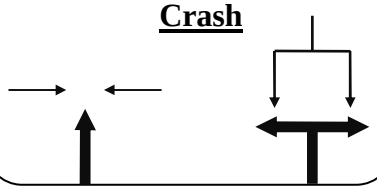
Functional failure

Hurried and cursory search for information, on "glance" type, often anticipated and not renewed => erroneous evaluation of a gap for merging or crossing

Resulting critical situation

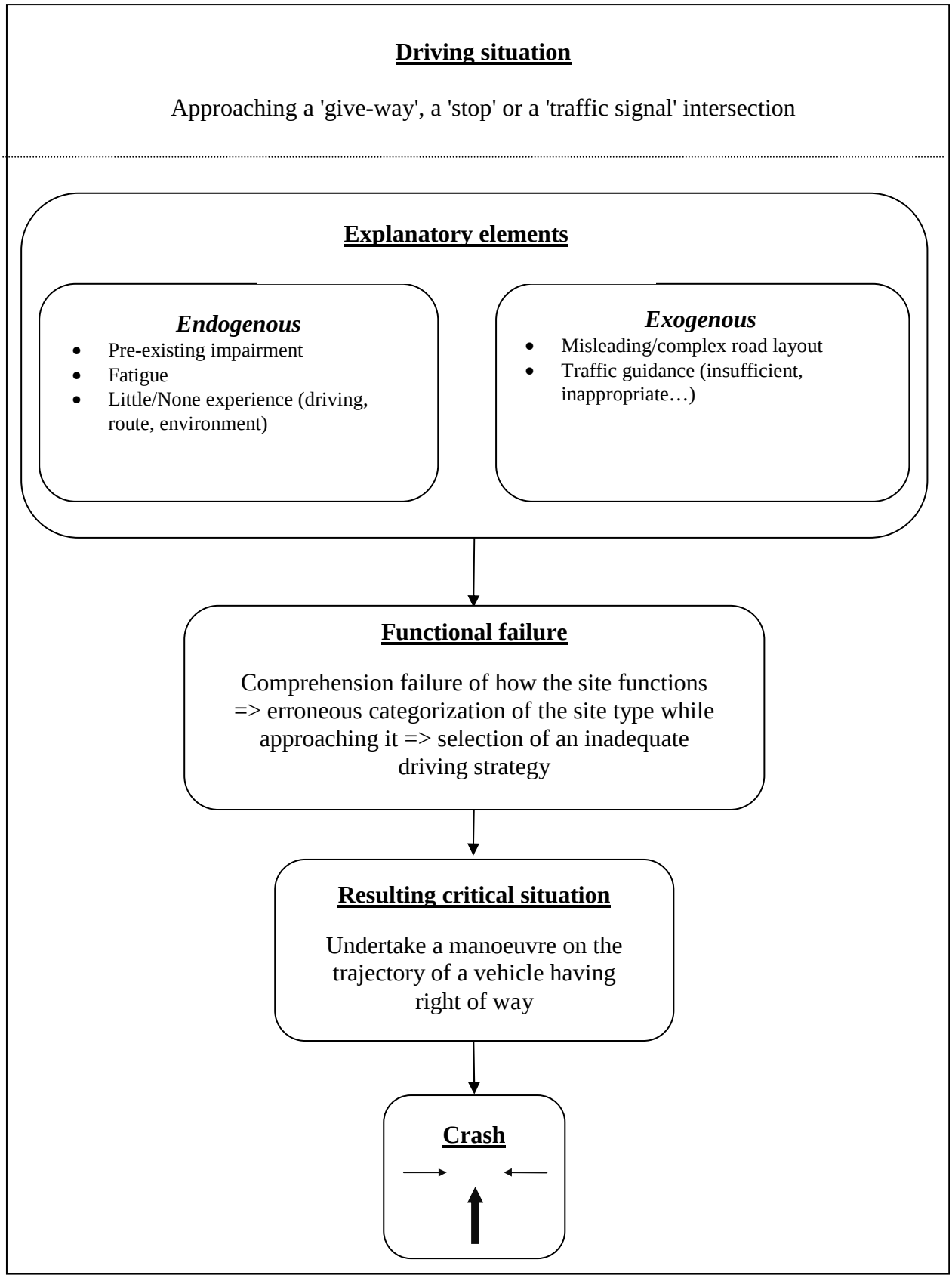
Undertaking of the manoeuvre on the trajectory of the interfering priority user

Crash



TYPICAL SCENARIO 'T3A'

Mistaken understanding leading to a stopping failure in intersection



TYPICAL SCENARIO 'T4B'

Mistaken understanding of the other's manoeuvre related to the polysemy of their signals

Driving situation

Going ahead on a straight road
Crossing intersection where road user has right of way
Overtaking moving vehicle

Explanatory elements

Endogenous

- Substances taken (alcohol, drugs)
- Fatigue
- Distraction
- Over-experience (route)
- In a hurry
- Identification of potential risk about only part of the situation

Exogenous

- Traffic guidance (insufficient…)
- Visibility impaired
- Misleading/complex road layout
- Ambiguity of clues to manoeuvre
- Atypical manoeuvre from other

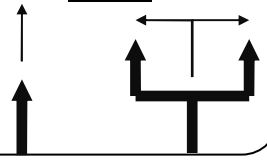
Functional failure

No comprehension of other's intentions
=> trap situation related to ambiguity of the signals given by the other

Resulting critical situation

Starts to overtake the interfering vehicle while it is changing of direction, or drives too fast to cope with the critical bringing closer of the interfering vehicle

Crash



TYPICAL SCENARIO 'T5A'

Expecting a non priority vehicle not to undertake a manoeuvre in intersection

Driving situation

Approaching or crossing intersection where road user has right of way

Explanatory elements

Endogenous

- Distraction
- Over-experience (route)
- In a hurry
- Risk taking (speed)

Exogenous

- Absence of clues to manoeuvre
- Atypical manoeuvre

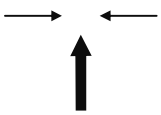
Functional failure

Does not expect that the vehicle stopped by the axis of the junction starts a manoeuvre

Resulting critical situation

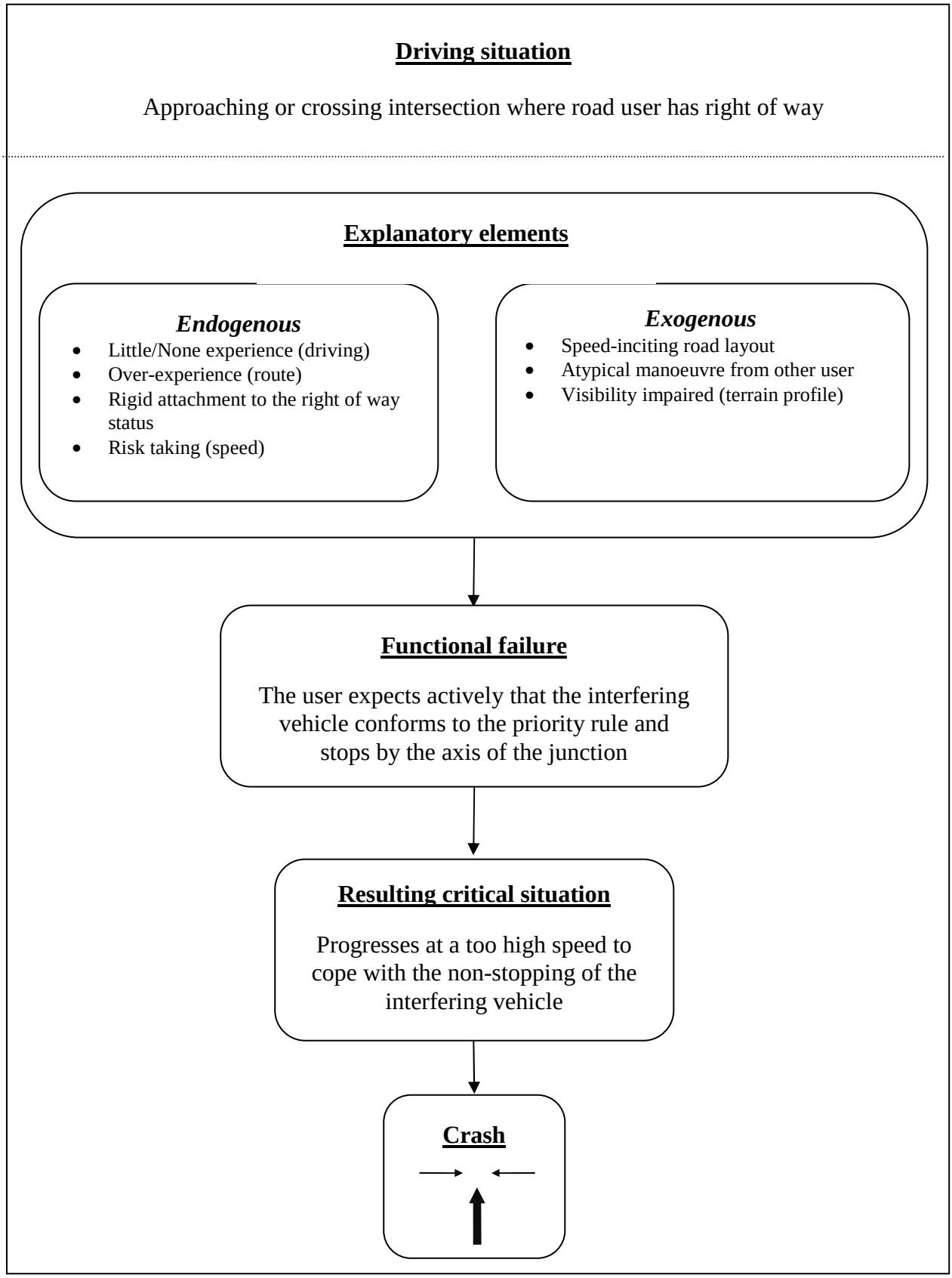
Keeps driving at a too high speed to cope with the interfering non priority vehicle that crosses trajectory

Crash



TYPICAL SCENARIO 'T6B'

Erroneous expectation of the stopping of a non priority vehicle approaching intersection



TYPICAL SCENARIO 'T6C'

Erroneous expectation of the stopping of a non priority vehicle coming on the trajectory

Driving situation

Going ahead on a straight road
Approaching or crossing intersection where road user has right of way

Explanatory elements

Endogenous

- Over-experience (route)
- Risk taking (speed)
- Rigid attachment to the right of way status
- Excessive confidence in signs given to others

Exogenous

- Atypical manoeuvres from other users

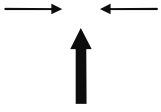
Functional failure

The user expects actively that the interfering vehicle conforms to the priority rule and stops his/her progression

Resulting critical situation

Slows down but progresses at a speed still too high to cope with the non-stopping of the interfering user

Crash



TYPICAL SCENARIO 'T7A'

Expecting no vehicle ahead in a bend with no visibility

Driving situation

Going ahead on a right or a left bend

Explanatory elements

Endogenous

- Substances taken (alcohol, drugs)
- Over-experience (route)
- Little/None experience (driving)
- In a hurry
- Risk taking (speed, 'eccentric' motives)

Exogenous

- Visibility impaired (terrain profile)
- Road geometry (road width)

Functional failure

Expecting no road user coming on the opposite carriageway

Resulting critical situation

Negotiation of the curve at a too high speed. The driver overlaps the carriageway devoted to the opposite direction and is faced to a vehicle arriving in front of him

Crash

TYPICAL SCENARIO 'D1A'

Road user directed to go ahead in order to take the information

Driving situation

Going straight or turning across traffic at 'give-way', 'stop' or 'traffic signal' intersection
Starting (not at junction) or leaving parking space (roadside)

Explanatory elements

Endogenous

- Little/None experience (environment)

Exogenous

- Visibility impaired (terrain profile, other vehicles, roadside objects)

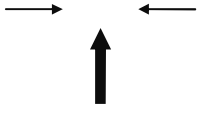
Functional failure

Forced to go ahead on the carriageway to search for lateral information

Resulting critical situation

Undertake a manoeuvre on the trajectory on an oncoming vehicle

Crash



TYPICAL SCENARIO 'D2B'

Overtaking on an axis-limited visibility zone

Driving situation

Overtaking stationary vehicle on left or right
Overtaking moving vehicle on left or right

Explanatory elements

Endogenous

- Emotional conditions (upset, happy…)
- Over-experience (route)
- Little/None experience (driving)
- In a hurry
- Risk taking ('eccentric' motives)

Exogenous

- Traffic condition (low speed of a vehicle ahead)
- Visibility impaired

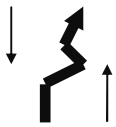
Functional failure

Decides to overtake despite the legislation of the site and the accident-generating parameters of the situation (visibility impaired)

Resulting critical situation

Overtaking of the user and loss of control of the vehicle trying to avoid another vehicle coming from the opposite direction

Crash



TYPICAL SCENARIO 'D3B'

Going ahead at intersection being drawn into manoeuvre

Driving situation

Going straight at 'give-way', 'stop' or 'traffic signal' intersection
Turning across traffic at 'give-way', 'stop' or 'traffic signal' intersection

Explanatory elements

Endogenous

- Pre-existing impairment
- Distraction
- Over-experience (route)
- Little/None experience (driving, environment, route, vehicle)

Exogenous

- Misleading/complex road layout
- Traffic condition (flow, speed, density)
- Visibility impaired (other vehicles, roadside objects…)
- Being drawn into manoeuvres

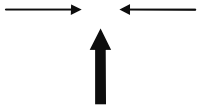
Functional failure

Because of the external pressure coming from other users the driver decides to start crossing the intersection despite the lack of lateral visibility

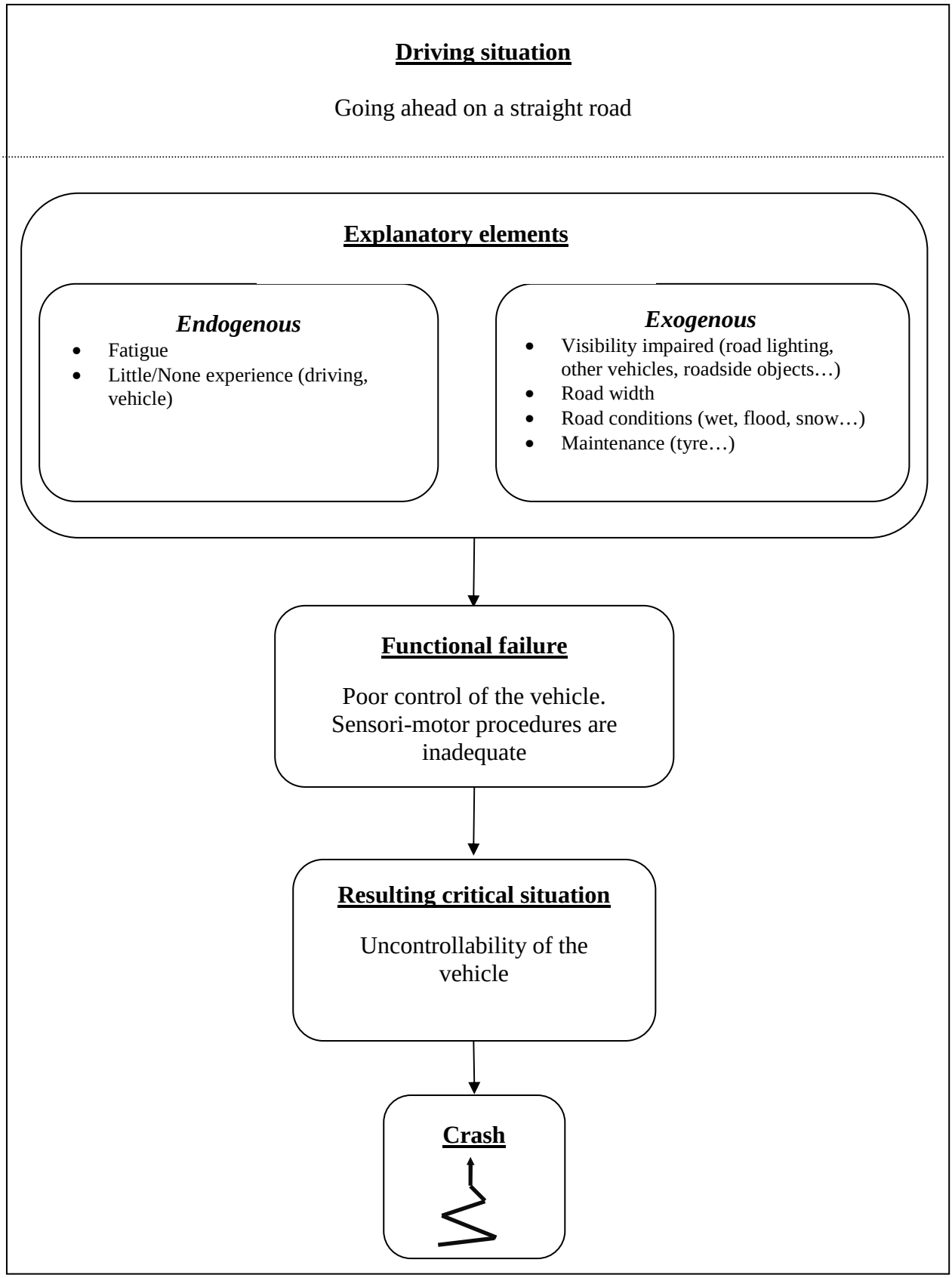
Resulting critical situation

Undertake the manoeuvre on the trajectory of the vehicle having the right of way

Crash



TYPICAL SCENARIO 'E1A'
Sudden encounter of an external disruption



TYPICAL SCENARIO 'E1B'

Sudden encounter of an external disruption, more or less expectable

Driving situation

Going ahead on a straight road
Going ahead on a left or a right bend

Explanatory elements

Endogenous

- Fatigue
- Little/None experience (driving)
- In a hurry
- Risk taking (speed, vehicle positioning, traffic control, 'eccentric motives')

Exogenous

- Road condition (wet, flood, snow…)
- Maintenance (tyre)

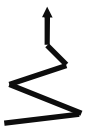
Functional failure

Poor control of the vehicle related to driving mode. Sensori-motor procedures are inadequate

Resulting critical situation

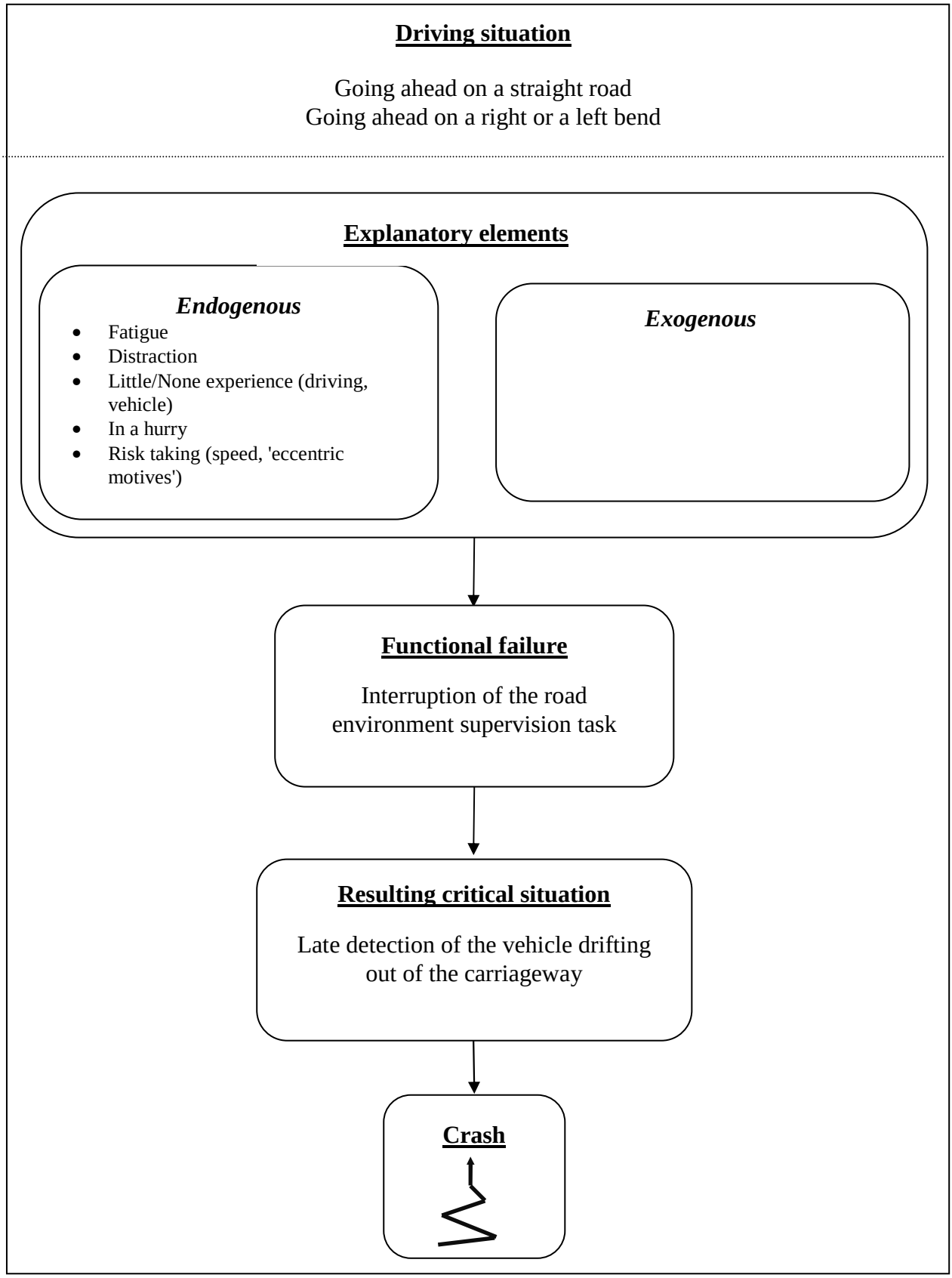
Uncontrollability of the vehicle

Crash



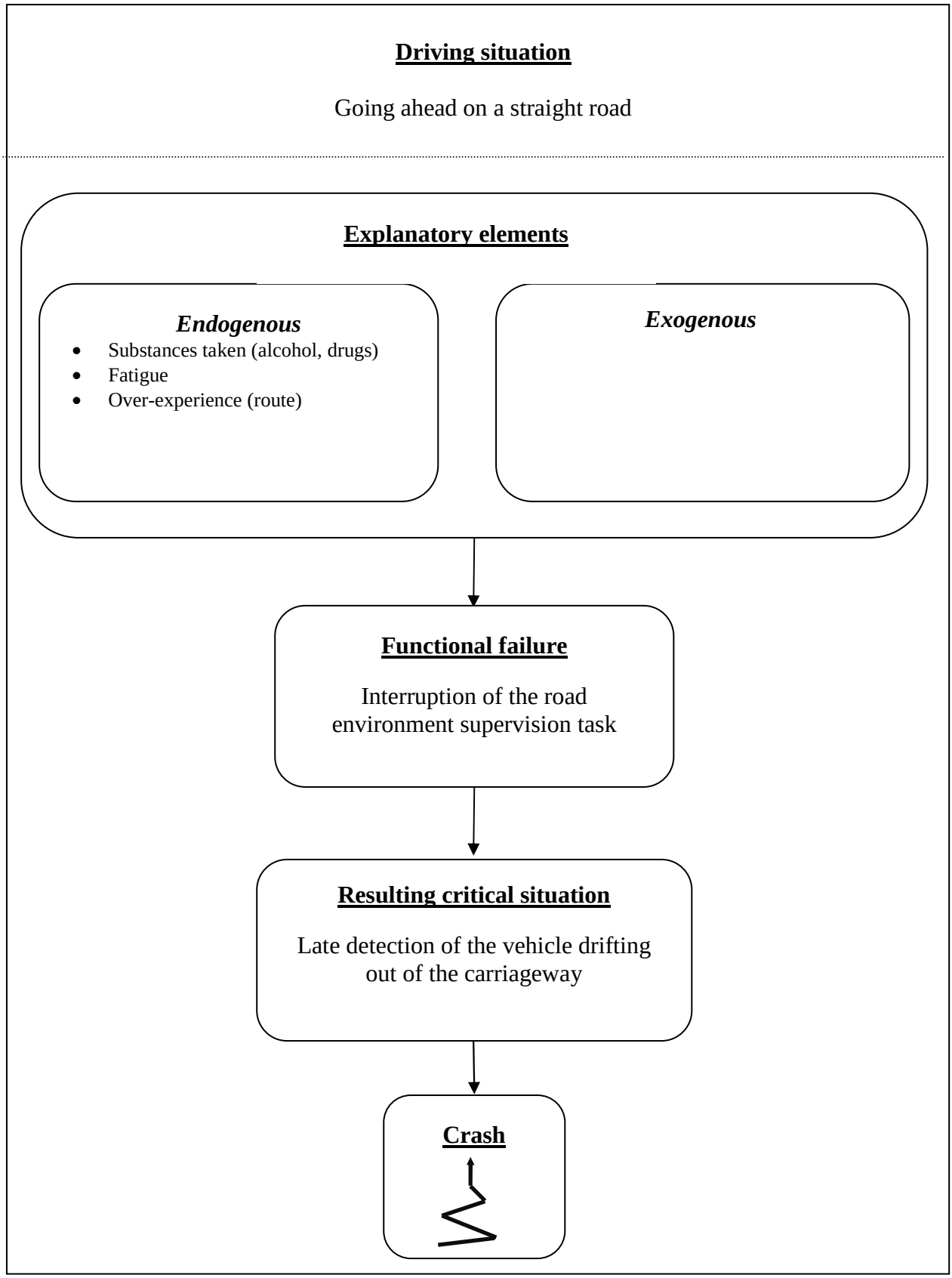
TYPICAL SCENARIO 'E2A'

Guidance interruption consequently to attention orientation towards a secondary task



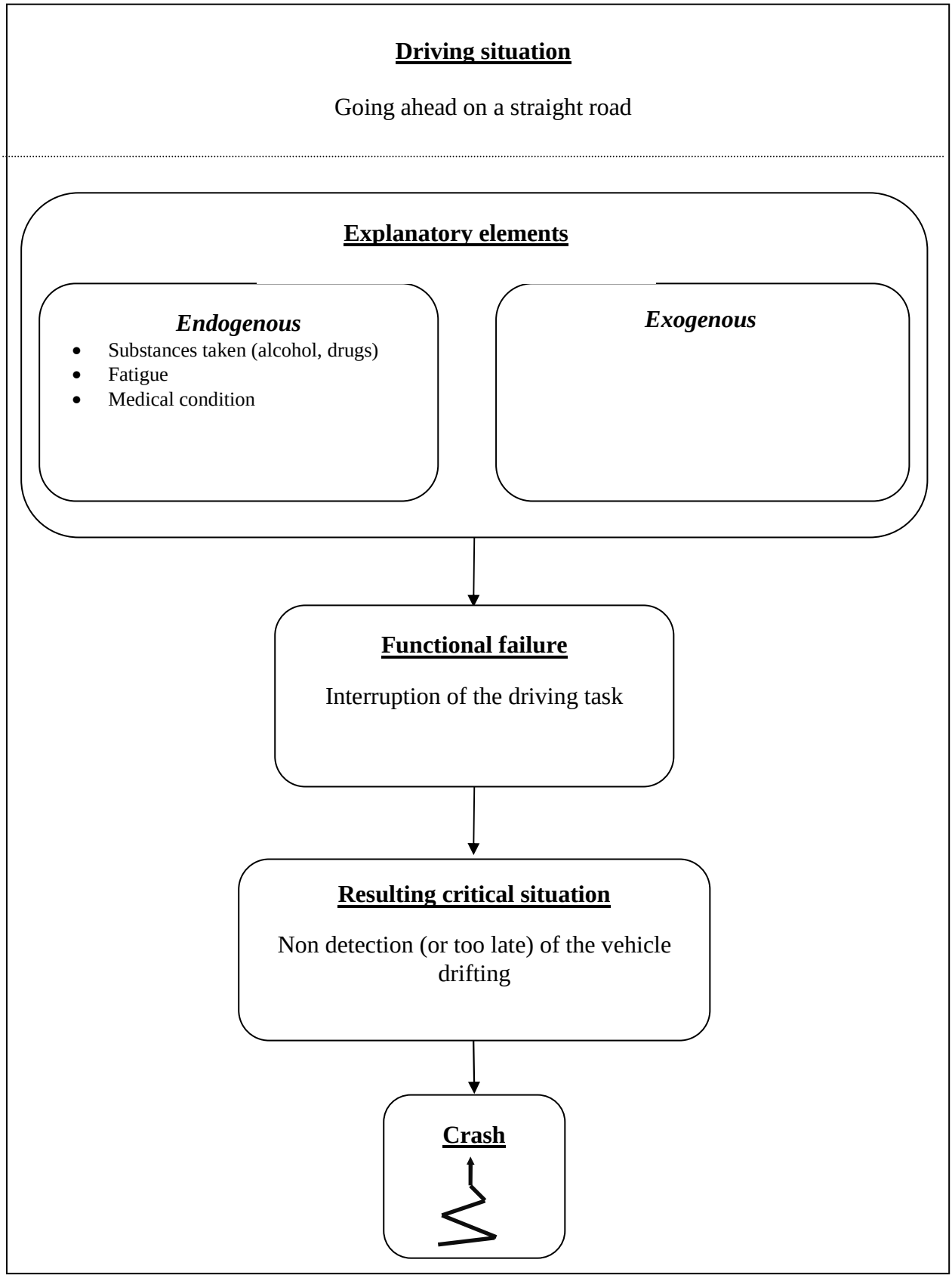
TYPICAL SCENARIO 'E2B'

Guidance interruption consequently to attention impairment



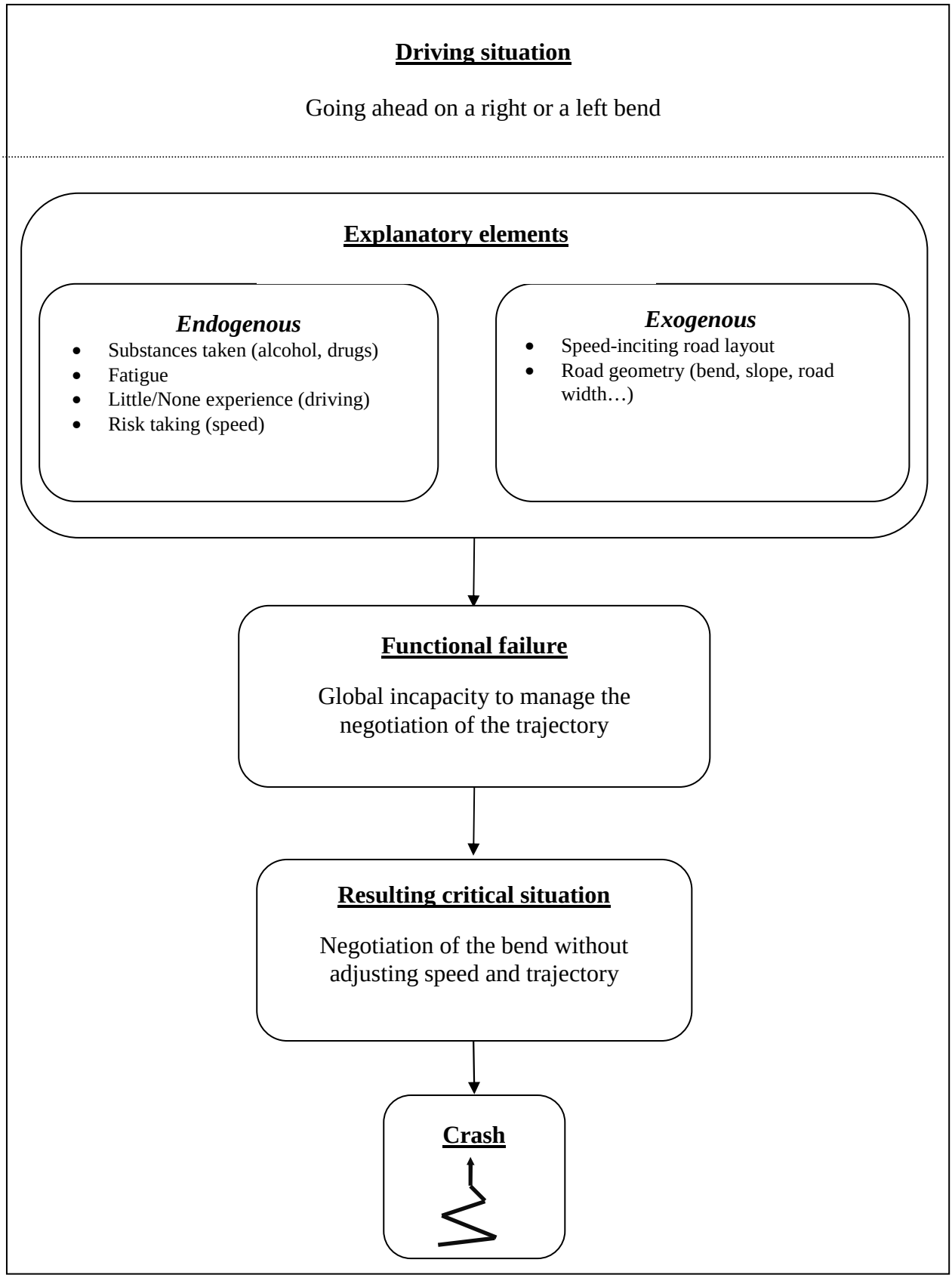
TYPICAL SCENARIO 'G1A'

Loss of psycho-physiological capacities consequently to a falling asleep or ill-health



TYPICAL SCENARIO 'G2A'

Alteration of trajectory negotiation capacities



TYPICAL SCENARIO 'G2B'
Alteration of guidance capacities

Driving situation

Going ahead on a straight road

Explanatory elements

Endogenous
- Substances taken (alcohol, drugs)
- Little/None experience (driving)
- Risk taking ('eccentric motives')

Exogenous
- Speed-inciting road layout
- Road geometry (road width)

Functional failure

Global incapacity to manage the correct guidance of the vehicle

Resulting critical situation

Late detection of the vehicle drifting out of the carriageway

Crash

TYPICAL SCENARIO 'G3A'

Overstretching processing capacities in traffic interaction situation

Driving situation

Going straight or turning across traffic at 'give-way', 'stop' or 'traffic signal' intersection
Turning away from traffic from main road into side road
Reversing, U-turn

Explanatory elements

Endogenous

- Pre-existing impairment
- Little/None experience (driving, route, environment, vehicle)

Exogenous

- Misleading/complex road layout

Functional failure

Overstretching cognitive capacities: difficulty to manage the whole driving task

Resulting critical situation

Undertake a manoeuvre on the trajectory of another road user

Crash