Bonn Institute for Forensic and Traffic Psychology

The Front Brake Light

Its conception and theoretical and experimental evidence for increasing traffic safety

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I. Goals of a Front Brake Light – Introduction

1. The number of traffic casualties

Dealing with road traffic is a daily part of life for almost all members of society. As a result, traffic safety is an ever-present issue whose importance increases in line with increases in traffic density.
According to a study by the road safety campaign "Get Off Gas", when someone dies in a traffic collision, an average of 113 other people – family members, friends, acquaintances and emergency services personnel – are affected directly and sometimes permanently.[1]

Despite the increase in road traffic, the number of deaths from traffic collisions has decreased slightly, as a result of improvements in the road infrastructure, vehicle technology and trauma care. However, a consequence of the reduced number of deaths has been an increase in the number of people who are severely injured. Such people may not always fully recover from the physical and psychological effects of such trauma and may have to live with the long-term consequences of the collision. Currently, in Germany alone, there are about 2.5 million people directly or indirectly affected by traumatic brain injury[2].

According to the World Health Organization (WHO)[3], 1.24 million people die on the roads of the world annually. Half of them are pedestrians, cyclists or motorcyclists. A further 20 to 50 million people are injured in traffic collisions.

In Germany, about 270,000 people suffer craniocerebral trauma every year. Around a third (90,000) of these cases result from traffic collisions. Most (90.9%) cases are minor; 3.9% are moderate and the remaining 5.2% are severe craniocerebral trauma, resulting in more than 7,700 deaths annually.[4]

With an annual death toll of around 25,300 on the roads of Europe in 2017, some 135,000 serious injuries and the social costs of medical care, rehabilitation and lost work amounting to about €120 billion a year, the EU has set itself the target of reducing road deaths between 2010 and 2020 to around 16,000.[5] Since 2007, the German Road Safety Council (DVR) has based its work on traffic safety on a "Vision Zero", a target which also includes seriously injured people.[6]
However, given the fact that the number of deaths and serious injuries is only declining slightly, it is questionable as to whether enough measures are being taken to improve traffic safety.[7]

Adopting and achieving the EU's objective requires the taking of every opportunity to improve traffic safety.

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[1] Representative survey by infratest dimap, Kantar Public and the Socio-Economic Panel (SOEP), according to the German Police College (DHPOL) and the German Fire Service Association (DFV), s. www.runtervomgas / press, message v. 05/16/2017.

[2] Kay Nehm, President of the German Traffic Day, in: "Information for traffic accident victims" CNS - Hannelore Kohl Foundation, Bonn 2018.

[3] World Health Organisation (2013). Global staus report on road safety 2013. http://www.who.int/violence_injury_prvention / road safety_staus/2013/en/

[4] CNS - Hannelore Kohl Foundation, 2018

[5] Violeta Bulc, EU Commissioner for Transport, in: "Commissioner relies on automatic emergency braking systems", Die Welt, 10.4.2018, www.welt.de.

[6] www.dvr.de

[7] Representation of the European Commission in Germany, press release v. 28.3.2017, www.ec.europa.eu

2. The Front Brake Light – an easily implementable contribution to more traffic safety

Given the complex triangular relationship between human, vehicle and environmental factors, advances in traffic safety will always have to encompass a variety of innovations.

One of these innovations could be the Front Brake Light, a forward-facing lighting device that, when the foot brake is applied, illuminates simultaneously with the rear brake lights and tells on-coming road users that the driver has applied the brake.
As early as 1971, a initial study was undertaken in the US on the usefulness of such a Front Brake Light. A number of private vehicles were equipped with it for about a month. Afterwards, the participants were asked about their experience of using it and rated its value. At the same time, a control group with no experience of using it was asked to evaluate the concept. Both groups considered the Front Brake Light to be useful in communicating with other drivers and pedestrians. Particular emphasis was placed on the importance of such a device under conditions of poor ambient lighting (e.g. during the night) as well as the conscious use of communicating behavioural intentions.[8]
Building on this research, a more extensive longitudinal field test was carried out at Berlin-Tegel Airport in 2017, in which both the drivers of the vehicles equipped with a Front Brake Light and other road users who had come into contact with the equipped vehicles were questioned. The results of this research also showed wide support and recognition for the concept.

(Field study) Table 12. Open comments: Examples of positive comments broad support and recognition for the concept. (***the number of comments is given in parentheses)*** [9]

Category /	*Comments (examples)*
Anticipation and reaction (13)	*“You can see quicker that the vehicle is braking"*
	“You can respond more quickly to the braking of other road users.”
General positive comments (10)	*“That was very good.“*
	“Good idea.“
Visibility (10)	*“Good. I expect it to be even more positive* in winter.”
	“The version currently used on vehicles does not dazzle, but is very clearly visible.“
Feeling of safety (7)	*“As a road user, you feel safer.”*
	“Safety has increased.“
Communication (3)	*“Improved communication among road users.”*
	“The flow of traffic has improved.”
Colour (3)	"*Colour is noticeable*."
Parking (1)	“*The Front Brake Light helped with parking*”
Other (7)	*“Vehicles of other companies should also be equipped*." "*You have to get used to it*.“

[8] S. Post, D.V. & Mortimer, R.G.: Subjective evaluation of the front-mounted braking signal. Technical Memorandum HuF-TM-1, Highway Safety Research Institute. The University of Michigan 1971, Ann Arbor.
[9] S. Banse, R., Keidel, K., Monzel, M., Kirschbaum, B., Schubert, W.: Forschungsbericht „Feldstudie zur Erprobung einer

Previously, in a laboratory study, Petzoldt, Schleinitz and Banse[10] had also highlighted the information asymmetry between motor vehicle drivers and pedestrians. Whilst drivers have information such as the direction and body language of pedestrians to help understand their intentions on the road, pedestrians, at least when facing oncoming traffic, have few indications as to the intended behaviour of drivers. For example, the absence of brake lights on the front of vehicles makes it harder for pedestrians to perceive braking. This problem is of particular importance when either using pedestrian crossings or crossing side roads in front of turning vehicles; situations in which collisions commonly occur.

Clearly, therefore, the Front Brake Light should be recognised as an additional, cost-effective and easily implementable measure to reduce traffic collisions, not least in terms of reducing the actual risk to pedestrians.

However, in common with other measures to improve traffic safety, it must be evaluated fully to determine its potential effectiveness.

II. Areas of application and potential benefits

1. Collision prevention in specific situations

The catalogue of possible applications of a Front Brake Light includes a multiplicity of cases where it would improve communication between road users and thus ensure greater traffic safety. Such applications are by no means limited to asymmetric conflicts (e.g. vehicle / pedestrian). In vehicle / vehicle conflicts, the Front Brake Light also has the potential for collision avoidance.

Typical scenarios in which a Front Brake Light would help other road users to recognize the intention of a driver and thus better assess the traffic situation include:

- Allowing drivers at the back of a queue of standing or slow-moving traffic to determine if following drivers are slowing down
- Allowing other road users (particularly pedestrians and cyclists) crossing the mouth of an intersection to determine whether turning traffic is giving way to them
- When changing lanes on multi-lane highways, allowing the driver to determine if following drivers are braking to allow the manoeuvre to take place
- Allowing drivers approaching bottlenecks to determine the braking intentions of oncoming drivers
- Allowing drivers on single-track roads to determine the braking intentions of oncoming drivers
- Allowing pedestrians at designated crossing places to determine if oncoming drivers are giving way to them
- Allowing drivers of emergency vehicles to determine whether oncoming drivers are giving precedence to them

Further situations and more detailed descriptions are provided in Appendix A - Catalogue of potential areas of application.

[10] S. Petzoldt, T., Schleinitz, K., Banse, R.: „Laboruntersuchung zur potenziellen Sicherheitswirkung einer vorderen Bremsleuchte in Pkw“, in: ZVS Zeitschrift für Verkehrssicherheit, 1/2017, S. 19 ff.

2. Reduction of the severity of accidents by the warning function of a Front Brake Light

The Front Brake Light is expected to have a significant effect not only on the prevention of collisions, by providing drivers with a better understanding of the traffic situation, but also on the reduction in the severity of unavoidable collisions, by improving the victim's ability to mitigate the consequences of the collision (see Appendix B – An opinion on the Biomechanics of Trauma).

3. Road user communication issues related to electric and / or highly automated vehicles

As the proportion of electric and hybrid-powered vehicles increases, it will become more difficult for road users both to hear motor vehicles and also to detect any change in their speed. Both older road users (possibly because of age-related physiological changes) and children (because of their lack of experience in road traffic) may be particularly at risk. It is likely that these groups would find a Front Brake Light to be of particular value.

In addition, as driving becomes more highly automated and the driver becomes less involved in the actual task of driving, it will be necessary to provide new communication signals to replace those (such as facial expressions, hand signals and the like) currently used by drivers to inform other road users of their intentions.[11] Again, a Front Brake Light could make an important contribution.

4. Reduction in stress whilst driving

Enhanced communication between road users can result in greater co-operation between them which, in turn, can reduce their level of stress.[12]

In particular, in dense urban traffic, road users have a variety of signals, manoeuvres and other cues to perceive and interpret at the same time. Although it may seem unwise to add a further signal, such as a Front Brake Light, to an already complex situation, it should be noted that the number of simultaneous signals is less critical for the development of stress than the time needed to interpret the meaning of these signals.

Furthermore, the basic factors required to maintain an individual's competence to make decisions and implement them are selection, optimisation and compensation, to which special attention has to be paid in case of any loss of physical or mental functions.
Thus, if the improved communication resulting from a Front Brake Light makes it possible to interpret the behaviour of another road user more quickly and reliably, then more time is available to the driver, in particular in complex situations, to interpret other, more ambiguous, cues.

Accordingly, it is expected that the overall level of stress of both drivers and other road users (including pedestrians) will be reduced. (see Appendix C – Reducing stress in traffic by the use of a Front Brake Light)

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[11] This discussion will become more and more important as highly automated or autonomous driving will develop.
[12] Courtesy in road traffic is a central value in German Road Traffic law.

III. Technical concept

A Front Brake Light must be regarded as a light-signalling function (L-SF) within the meaning of the authorization[13] , as a version with a lower light intensity would not be fit for purpose.

1. Green as a targeted colour scheme

As part of the conception of a new light-signalling function (LSF) on motor vehicles, there is always the question of the appropriate light colour to be used. This decision has to be taken from both a legal and a factual point of view.

a. Legal aspects

Due to their dedicated assignment to special situations and / or special vehicles, the following colours cannot be used for a Front Brake Light.

- red – No red light which could give rise to confusion shall be emitted from a lamp in a forward direction (ECE R 48 § 5.10)
- blue (generally reserved for emergency vehicles. Its use is normally governed by national legislation),
- yellow (generally reserved to indicate dangerous situations or large or slow-moving vehicles. Its use is normally governed by national legislation),
- amber – permitted only for direction indicator lamp, hazard warning signal and emergency stop signal (ECE R 48 § 5.15).

The choice, therefore, lies between green and white.

Given the already existing high number and range of variation, forward-acting white light signals (dipped beam, high beam, fog lights, etc.), the use of a white Front Brake Light could result in ambiguous information being received, thus nullifying its benefit for traffic safety.

The colour green, however, is currently not used for LSF on motor vehicles.[14]
Against a background of the front end of a vehicle possibly showing several white light signals, it offers the advantage of unambiguousness and fast signal identification.

Although the use of green lights on vehicles is not currently regulated, the colour is already well known in the road environment through its use in traffic signals.
This is another reason why the harmonization of regulations is appropriate.

b. Psychological aspects

The selection of the colour green for a Front Brake Light is also supported by other technical-psychological points of view (see Appendix D – Psychological effect of the colours green and red):

> *"On the basis of the results of the present study, the suitability of the colour green for a Front Brake Light can be established, since green was associated by the test subjects with words of forward movement and the*

[13] https://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2013/R048r9e.pdf
[14] Appendix 5 Convention on Road Traffic. Vienna 8/11/1968

Front Brake Light is designed to arouse the readiness to act accordingly, i.e. to "go" or to "proceed" (cf. arousal, Mehrabian, 1978). In contrast, words of braking/decelerating are associated with red, whereby a red Front Brake Light would signal other road users to stop. This is the case, for example, with conventional brake lights, where the rear brake light is intended to indicate braking so that the vehicle behind also stops and a rear-end collision is avoided. In conjunction with a Front Brake Light, however, this would be counterproductive.

From a psychological point of view, the result of this study is that for a Front Brake Light the colour green should be preferred to other colours such as orange and blue, but especially to the colour red."

2. Technical construction of the Front Brake Light

a. Integration into the existing electronics

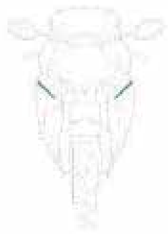
It is assumed that the Front Brake Light is linked directly to the rear brake lights and thus only one more light source must be connected to otherwise identical circuits in the control unit(s).

Decisions still need to be taken on specific details of its operation prior to product implementation. Potential issues to be considered include:

- The detail test with regard to its luminosity; on one hand to ensure visibility at night and in fog, whilst also avoiding glare (possibly by using a version with a 2-level light),
- The release of the Front Brake Light, if the brake pedal is not activated during regenerative braking
- The possibility of different light intensities at different braking strengths.

b. Design

With regard to the design of a Front Brake Light, a number of variants are conceivable, depending on the type of vehicle and its vehicle design.



(Pictures: Lumaco Innovations AG)

Relevant technical details must be clarified in the context of production implementation.

IV. The Front Brake Light within the framework of the objectives of the EU

1. European Parliament report on road safety

In November 2017, the European Parliament published an own-initiative report entitled *On saving lives: boosting car safety in the EU*. [Document A8-0330/2017][15]

Amongst its wide-ranging review, the report stresses that, ”in order to improve road safety, the deceleration of vehicles should be rendered easier for other road users to perceive by means of clear signal lights on vehicles, and expects the compulsory use of an emergency braking indicator in the form of a flashing brake light or flashing hazard lights” [§ 37].

Even if the display of emergency braking is in the foreground, in perspective other light signals in addition to the existing brake lights are also addressed. Furthermore, the general demand in the sense of traffic safety is by no means limited to signals in the background.

It is concluded, therefore, that the concept of a Front Brake Light is also in line with the objectives set out in paragraph 37 of the report, in particular because it also provides the required uniqueness of the signal due to the conceptual colour scheme (green).

2. Requirements for mandatory driver assistance systems

At the same time, the requirements for driver assistance systems were raised in the same report.

“The European Parliament stresses that approximately 92 % of all accidents are due to human error or interaction of human error with vehicles and/or infrastructure, and that it should therefore be compulsory to incorporate only those driver assistance systems which improve road safety significantly as demonstrated by scientific evidence, have a favourable cost-benefit ratio, and have attained market maturity; considers that additionally, the resulting purchase price increases should not be so inordinate that the intended customers for such vehicles cannot afford to buy them, and that driver assistance systems, which are of relevance for road safety, should be checked regularly;” [§ 17]

3. Fulfilling the EU criteria for mandatory driver assistance systems

It can be deduced from the report of the European Parliament (see above) that a system meeting the requirements of being included in the list of compulsory assistance systems complies with the objectives of the EU.

Accordingly, if high-quality and expensive assistance systems are prescribed that pose a particular financial burden for the citizen, then this must also apply to low-cost systems. The only prerequisite is the fulfillment of the criteria for higher-quality

[15] http://www.europarl.europa.eu/sides/getDoc.do?type=REPORT&mode=XML&reference=A8-2017-0330&language=EN

assistance systems. It must therefore first be examined whether the Front Brake Light meets the requirements in the specific case.

a. Scientific evidence

Only rarely are efforts made to investigate scientifically the effect of a new vehicle safety feature on the road users prior to its type approval.
In order to prove scientifically the actual effectiveness of the concept of the Front Brake Light in enhancing traffic safety, a two-stage procedure of scientific investigations was chosen.

The first step was a laboratory study with volunteers using video simulations.

Summary of the laboratory research[16]

> *"Lack of or faulty communication between motorised road users and pedestrians is undoubtedly one of the factors that can explain the still high number of pedestrians injured in road traffic. A vehicle-mounted Front Brake Light communicating the driver's intention to stop would be a very simple way to assist pedestrians in interacting with motorised vehicles. In the course of a laboratory test, video material was used to test the extent to which such a Front Brake Light has an effect on the identification of braking. The results show that braking with the Front Brake Light can be identified much earlier. At the same time, however, it also became clear that, in a scenario in which vehicles are fitted with front braking lights but the lights are not lit, the lack of activation of the light leads to more conservative response on the part of the observers. Accordingly, a positive effect of a Front Brake Light on traffic safety can be assumed."*

The second step was followed by a large-scale field trial on the grounds of the Berlin Tegel Airport.

Summary of the field research[17]

> *"The Front Brake Light makes it easier for pedestrians and other road users to perceive critical traffic situations and can thus increase traffic safety. A longitudinal field study examined the effects of the Front Brake Light on traffic safety in a closed traffic area, the airside part of the Berlin-Tegel Airport (TXL). For this purpose, 102 vehicles were equipped with a Front Brake Light for a period of three months and 516 employees were asked about their experiences with and their attitude towards the Front Brake Light. The results showed that the Front Brake Light rarely led to misunderstandings of the traffic situation. More often it increased the perceived safety of the situation. The attitude towards the Front Brake Light was already very positive in the first survey and significantly improved over the three months of the field test. Overall, the findings suggest that a Front Brake Light as a light-signalling device on motor vehicles can increase road safety by improving communication between drivers and other road users."*

These results were then publicly presented at a press and information event at Berlin-Tegel Airport and discussed with experts in traffic safety work.
In May 2018, the results were published in the German traffic safety journal *Zeitschrift für Verkehrssicherheit* (ZVS)

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[16] Petzoldt, T., Schleinitz, K., Banse, R.: „Laboruntersuchung zur potenziellen Sicherheitswirkung einer vorderen Bremsleuchte in Pkw“, in: ZVS Zeitschrift für Verkehrssicherheit, Heft 1/2017, S. 19 ff.

[17] Banse, R., Keidel, K., Monzel, M., Kirschbaum, B., Schubert, W.: Forschungsbericht „Feldstudie zur Erprobung einer Vorderen Bremsleuchte am Flughafen Tegel“, Bonner Institut für Rechts- und Verkehrspsychologie, Januar 2018.

b. Significant contribution to increasing road safety

The consistently positive results of both studies, both in terms of improving response times and conceptual field assessment, demonstrate that the Front Brake Light could make a real and significant contribution to increasing traffic safety by helping road users analyse potentially critical traffic situations more quickly, avoid them or master them better.

The complementary adoption of communication functions in the context of increasingly automated driving (see above), which has hitherto been performed by the driver, as well as the potential reduction of stress (Appendix C) contribute to an increase in overall road safety.

Last but not least, a potential reduction in collision severity (see above and Appendix B) must also be regarded as a significant increase in traffic safety from a biomechanical standpoint, since the consequences of a collision always form a significant part of the overall consideration.

With regard to the transitional period (vehicles with and vehicles without Front Brake Light) or the introductory phase (when road users must get used to the presence of a Front Brake Light and understand its meaning), it should be noted that

- it has emerged from the laboratory study that road users as a whole are more cautious when vehicles with the Front Brake Light are actually present in traffic but the light is unlit, so that no specific problems are foreseen during the transitional period,

- it has emerged from the field study that the concept of the Front Brake Light is simple and easy to understand.

Thus, it may be assumed that the increase in traffic safety, which can be achieved by a Front Brake Light on motor vehicles, is not insignificant.

c. Positive cost-benefit ratio

The introduction of the Front Brake Light is expected to result in a reduction in the number of traffic collisions coupled with a reduction in the severity of those that do occur (see above).

On the other hand, there are moderate costs for materials (connection to existing control units, software, cables, bulbs, possibly own luminary), design and processing costs, which, according to current estimates, should not exceed € 30 per vehicle for new vehicles in mass production.[18] Thus, no significant effect on the total cost of a motor vehicle is apparent.

However, within the context of traffic safety, financial costs are not the only relevant considerations. Human and emotional aspects are as important, in particular the avoidance of human suffering caused by traffic collisions.

Given the low implementation costs per vehicle on the one hand and the expected significant reduction in both economic (collision) costs and emotional "costs" on the other hand, a positive cost-benefit ratio from the introduction of a Front Brake Light

[18] Consultation with Beratung Mag. Lubomir Marjak, Lumaco Innovations GmbH.

can be assumed - even if, subject to large-scale studies in current traffic, an exact quantification of the cost savings cannot be made.

It should also be borne in mind that the initial discussion does not aim for mandatory introduction, but merely for voluntary approval, so that less stringent requirements should be imposed on the cost-benefit ratio.

d. (Given) Marketability

The required technology for the implementation of a Front Brake Light is available. Its introduction does not depend on further technical innovation.

The only issue requiring clarification relate to vehicle design and other technical details.

e. (No) Financial burden on the citizen

Due to the small amount of material and processing required to install a Front Brake Light as part of mass production (see above), there is no reason why the total cost of the vehicle should increase.

f. (Unproblematic) Integration of the Front Brake Light into the periodic vehicle monitoring

The Front Brake Light alone is analogous to a rear brake light only a light-signalling function (LSF) and, initially, is not classified as a driver assistance system. However, it can be connected such a system.

As a "simple" LSF, it is easy to integrate its device into the procedure of periodic vehicle monitoring. There is, therefore, no apparent justification for a significant addition to the cost of periodical technical inspection.

4. Conclusion

In the light of the above, it should be noted that the Front Brake Light also complies with the high standards set by the European Parliament for driver assistance systems if they are required to be installed.

More importantly, it is essential that such a system, if it meets the requirements for a mandatory requirement, must also be able to be introduced as a "milder remedy" on a voluntary basis. However, this requires basic admissibility within the scope of the regulatory framework.

Thus, the objective of the EU should or must be to create the legal requirements - either within European law or in the context of the UN/ECE regulations - for a corresponding type or type approval procedure of the Front Brake Light within the framework of the self-defined objectives for traffic safety.

V. Legal framework of an introduction

Light-signalling devices – which include the Front Brake Light – are among the components of motor vehicles, the approval for which falls under the international law. Thus, according to the "framework directive" 2007/46/EG, a type approval is required.

Relevant factual regulations are VO (EC) 661/2009 in combination with

- R 48 (UN) ECE for vehicles of categories M, N, and O,
- R 53 (UN) ECE for category L 3 vehicles,
- Regulation (EU) 2015/208 Annex XI and XII for vehicles of categories T, C, R and S.

The 1968 Vienna Convention on Road Traffic, on the other hand, has little direct application for the European Union, but it does, in part, form the basis of type approval regulations (and their amendments), conformity to which is a pre-requisite for worldwide acceptance and the sale of vehicles licensed in the EU.

National legislation, such as the German StVZO, only applies in individual cases and do not justify any pan-European approval options for production vehicles.

1. Legal classification of a Front Brake Light

Clarification is required as to what extent the proposed concept of the Front Brake Light complies with existing vehicle type-approval regulations or what changes would be required in those provisions in the interests of road safety.

a. Design, form and assembly/installation

The design, form and installation of LSF on motor vehicles are defined in detail in regulations R 48, 53, 86 (UN) ECE. The concept of the Front Brake Light, as presented here, is sufficiently flexible to meet these requirements.

b. Green as the colour of an LSF on motor vehicles

Red is generally excluded as a forward-looking LSF.[19] White, which is already approved for forward-looking LSF, would not make sense for a Front Brake Light due to "drowning" in the face of already existing light signals and the associated likelihood of confusion.

The colour green is proposed as the best solution on the grounds of its positive psychological effect as well as its distinctiveness and thus fast detectability (see above under III.1.).

The colours of LSF on motor vehicles is generally governed by the CIE standard panel, to which both the Vienna Convention and the corresponding (UN) ECE R 48 apply. In these, however, green is not yet defined as the colour of an LSF on motor vehicles.

Thus, there is a need to also define green as a colour for LSF on motor vehicles and thus to permit its use.

Insofar as it is stipulated in the framework of the regulations that the light of a LSF, which has the same task and works in the same direction, must have the same colour, this is not a problem here.[20]

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[19] FEE, (UN)ECE R 48, Rdnr. 5.10, 5.10.1. i. V. m. Anhang 4.
[20] Vienna Convention on Road Traffic, Appendix 5.2 Nr. 44

On the contrary, it can be inferred that, even with the same task, LSFs do not have to have the same colour if they act in different directions. Therefore, a simultaneous presence and functioning of a Front Brake Light in green with rear brake lights in red would be permitted.

c. Brake signal in front direction

Brake lights are currently defined as "lights that serve to indicate to other road users behind the vehicle that [...]".[21]

There is, therefore, a need to either extend the concept of the brake light in the regulations or incorporate the concept of the Front Brake Light under a different approach as an additional regulation.

2. Possible legislative implementation

Legislative adaptations of the concept of a Front Brake Light within the framework of the objectives of the EU road safety work therefore require legislative changes.

a. Manageable required changes

What is needed is a manageable framework of essentially two changes:

- Green must be approved as a colour of LSF on motor vehicles.
- Brake signals must also be delivered to the front.

Ideally, these steps would be agreed internationally, at the level of the Vienna Convention. However, due to the large number of negotiating partners, such an approach seems unrealistic in a timeframe appropriate to the EU's objectives for reducing the number of road deaths.

The same problem applies initially to a corresponding change within the framework of the (UN) ECE regulations, even if the possibilities here may be regarded as considerably more promising.

On the other hand, under some national regulations, exceptions may still be granted. For instance, according to Art. 70 of the German Road Traffic Admissions Act (StVZO), exceptions are permitted for trial purposes and research projects, but no general introduction of a new LSF is permitted.

The most sensible and promising way to achieve the gain in safety for road users in the EU through the concept of the Front Brake Light as soon as possible appears to be via the EU's own legislation. Accordingly, it would be desirable – assuming the appropriate political will exists – the above-mentioned changes are implemented as EU-specific extensions within the scope of the respective application provisions of the ECE regulations within the EU area.

b. Required steps

In its report, the EU Parliament has presented objectives for future traffic safety work, to which the EU Commission, as the executive branch, comments and, if necessary, proposes measures to implement the proposals.[22]

[21] Vienna Convention on Road Traffic, Appendix 5.2 Nr. 19
[22] P8_TA-PROV(2017)0423; Entschließung des Europäischen Parlaments vom 14.11.2017 zu dem Thema „Rettung von Menschenleben: Mehr Fahrzeugsicherheit in der EU“ (2017/2085(INI).

The right of initiative for EU regulations usually lies with the EU Commission. The introduction of a Front Brake Light would require an extension of the relevant approval regulations by the European Commission to be initiated and implemented. Further progress would then be in line with the normal course of action under EU regulations and directives.
The exact definition of the text of the relevant provisions to be amended or extended – including any proposed amendments - must be defined in the context of a legal-technical review of the regulations, a mirror image of a homologation procedure.

3. Further questions and perspectives

In connection with the actual introduction of the Front Brake Light in real traffic, further questions are foreseeable and, in view of the ongoing technical development of driver assistance systems, far-reaching perspectives are also possible.[23]

a. Intuitive understanding in normal traffic

Possibly, for safety reasons, it might be necessary to clarify again whether the system of the Front Brake Light is, in fact, intuitively understood even in normal traffic, i.e. not only under the special conditions of a non-public road network.
In doing so, suitable upper and lower limit values of the display must be taken into account and the question be clarified as to how delays in regenerative braking systems should be displayed. Basically, the method used should be analogous to that used for rear brake lights.[24]

b. No liability for the overall situation

Unlike some previous discussions on the use of the rear brake light, instead of gestures, as a means of indicating precedence to other road users,[25] the present conception of the Front Brake Light is solely as an aid to other drivers in dealing with complex traffic situations and, in no way, obviates their responsibilities to drive safely.
According to current design and analogous to existing rear brake lights, the Front Brake Light represent only forward-looking information that the vehicle is slowing but provides no assurance that it will come to a timely halt.
It should be ensured that its function cannot be interpreted differently at the legal level.

c. Further development in connection with emergency braking systems

Both as a function of a possibly undesirable result under Section b above as well as from general considerations in view of the advancing developments in driver assistance systems, the question could arise of an extension of the previous concept of the Front Brake Light to a coupling with driver assistance systems to produce a real picture of the situation.
Such developments could actually analyse whether a braking deceleration is sufficient to clarify a situation (see already existing "emergency brake assistants"). In that case, the Front Brake Light would actually (and only then) signal that at least the signalling vehicle will come to a standstill in time.

[23] Consultations with experts on Road Traffic Safety as mentioned page 2.
[24] Krautscheid, R., Janke, S.: „Gutachten zur Implementierung einer Vorderen Bremsleuchte“, Forschungsbericht Bonner Institut für Rechts- und Verkehrspsychologie 2017, S. 22 ff.
[25] To this discussion: Braun, H., Damm, R., Konitzer, H. in: § 49 a Rdnr. 34 und § 53 Rdnr. 24, StvZO Technischer Kommentar, Kirschbaum Verlag, Bonn.

This consideration is particularly relevant in view of the fact that the EU Commission is planning to introduce automatic emergency braking systems with pedestrian recognition as of the end of 2024, initially for new vehicle types, but successively for all new motor vehicles. The cyclist recognition will follow two years later.[26]
Regardless of the actual accessibility of this timetable, there is a firm political will to anchor pedestrian recognition as a driver assistance system in traffic safety work.

d. Possible further development to the all-round signal

The extent to which a signal effect for a more complex traffic situation with more than two road users can be connected depends primarily on the further development of systems that provide the driver with an overview of the situation.
Against the background of improved communication and perceptibility, both in the context of replacing driver gesture in highly automated driving and in view of increased distractions of pedestrians (smartphones, etc.), a further development of the concept towards an all-round (360°) signal is also conceivable.
Such a signal would also have to be perceived in peripheral vision and would then indicate an intention of both braking and acceleration processes.

VI. Milestones and first presentation in the professional world

Since the beginning of the research and increasingly from the beginning of 2018, the concept of a Front Brake Light has already been presented to experts in traffic safety research in Germany. Concrete results from these discussions have been used as components of this report (for details see Appendix E – Milestones and first presentation in the professional world).

It should be noted that, from the responses of the interviewees in the field test, the concept of the Front Brake Light was consistently understood and generally positively regarded as self-explanatory.

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[26] Krautscheid, R., Janke, S., ebd., S. 28 ff.

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List of Abbreviations

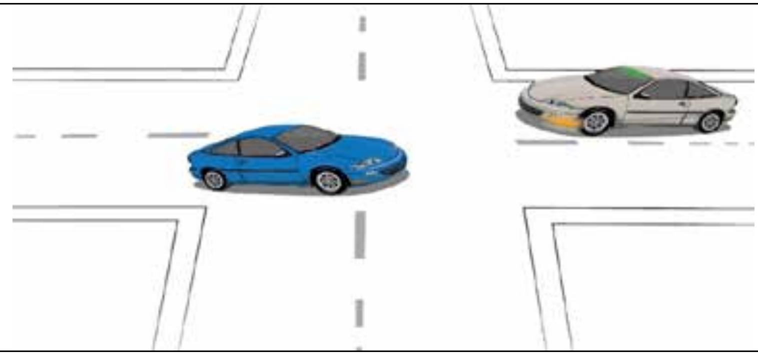
Abbreviation	German	English
a.D.	Außer Dienst	Off duty
ADAC UFO	Allgemeiner Deutscher Automobil Club Unfallforschung	General German Automobile Club Accident Research
AIS	Vereinfachte Verletzungsskala	Abbreviated Injury Scale
BIRVp	Bonner Institut für Rechts- und Verkehrspsychologie	Bonn Institute for Forensic and Traffic Psychology
DEKRA	Deutscher Kraftfahrzeug – Überwachungs-Verein	German motor vehicle – surveillance association
DFV	Deutscher Feuerwehr Verband	German Fire Brigade Association
DHPOL	Deutsche Hochschule der Polizei	German Police College
ECE R	Economic Commission for Europe Regulation	Economic Commission for Europe Regulation
EU	Europäische Union	European Union
e.V.	Eingetragener Verein	Incorporated society/incorporated association
EVU	Europäische Vereinigung für Unfallforschung und Unfallanalyse	European Association for Accident Research and Accident Analysis
EWG/EU/ECE	Europäische Wirtschaftsgemeinschaft Europäische Union/Economic Commission for Europe	European Economic Community / Economic Commission for Europe
FAS	Fahrer-Assistenz-System	Driver Assistance System
FEE	Fahrzeugtechnik EWG/EU/ECE	Vehicle Technology EWG/EU/ECE
FG	Fußgänger	Pedestrian
FSD	Fahrzeugsystemdaten	Vehicle system data
GMTTB	Gesellschaft für Medizinische und Technische Traumabio-mechanik	Society for Medical and Technical Trauma Biomechanics
HWS	Halswirbelsäule	cervical spine
ICS	Injury Cost Scale	Injury Cost Scale
Lkw	Lastkraftwagen	Truck
LMU	Ludwig-Maximilians-Universität (München)	dito
LSF	Lichtsignalfunktion	Light-signalling function
LTE	Lichttechnische Einrichtung	Light technical equipment
MdB	Mitglied des Bundestages	Member of Parliament (Germany)
MdEP	Mitglied des Europäischen Parlament	Member of the European Parliament
PAD	Pleasure Arousal Dominance Scale	dito
Pkw	Personenkraftwagen	Passenger car
SHT	Schädel-Hirn-Trauma	brain injury
StVO	Straßenverkehrsordnung	Road traffic Act
StVZO	Straßenverkehrs-Zulassungs-Ordnung	Road Traffic Admissions Act

Appendix A

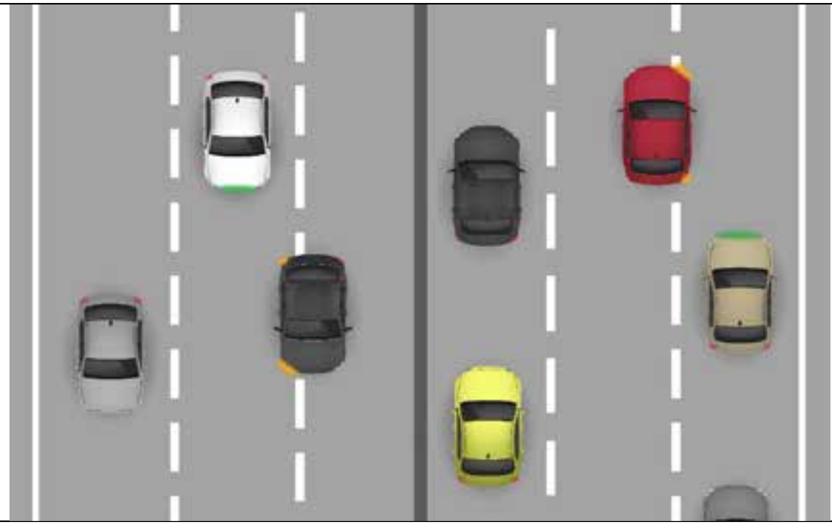
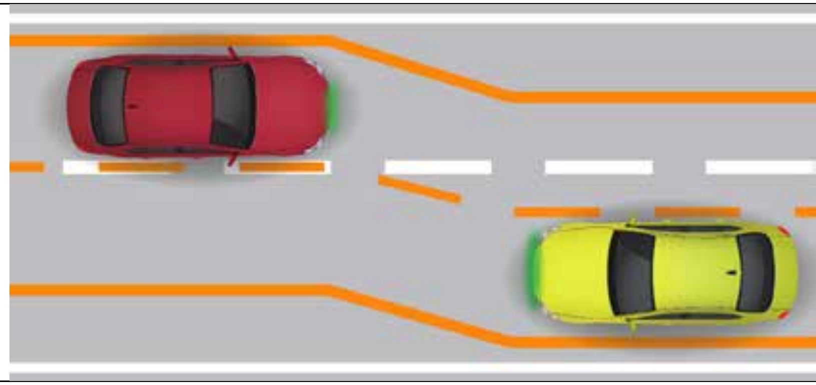
Catalogue of possible applications [1]

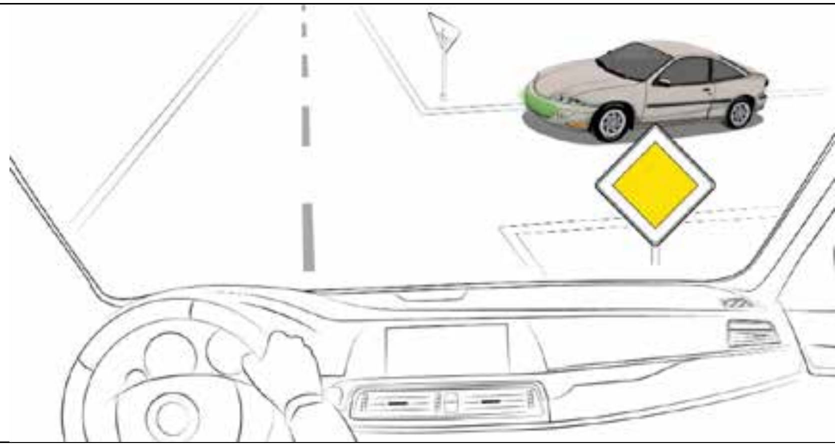
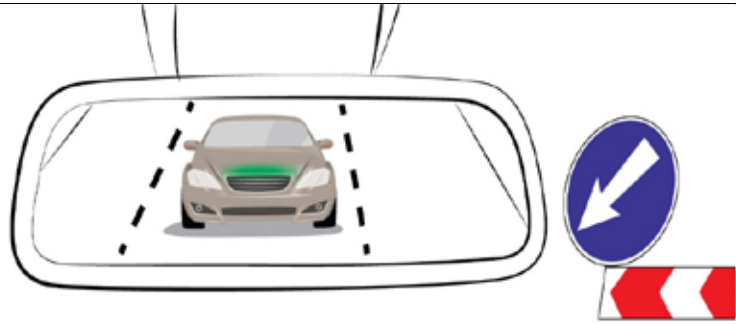
Real-world traffic situations in which a Front Brake Light on a vehicle would assist communication between road users. NB: The illustrations depict driving on the right but the comments are equally applicable to countries where driving is on the left.

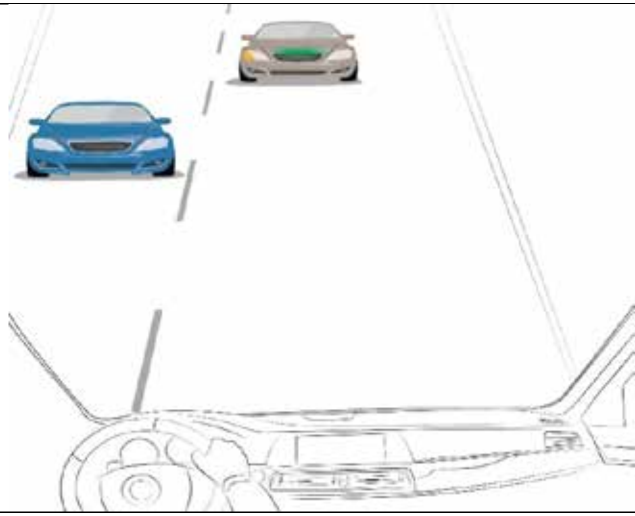
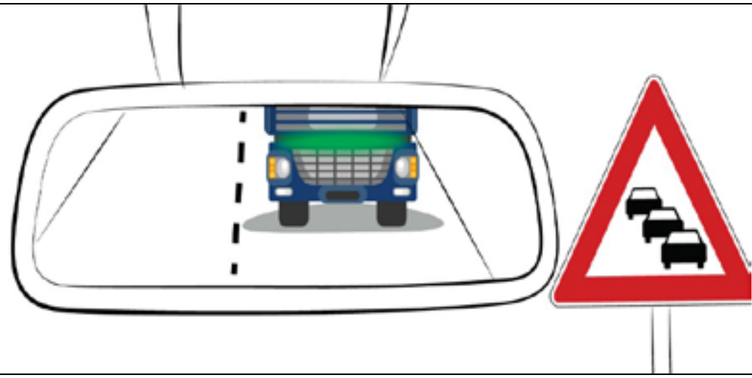
A. Front Brake Light on car, bus, truck

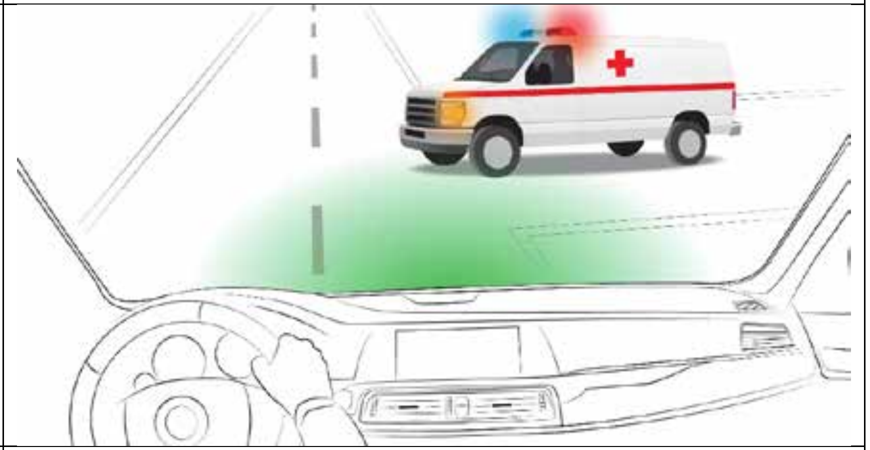
	In relation to	Situation	Advantage / Use:	Advantage / Use for:	image description
		Standard situations			
1	Other vehicles	Turning left from major to minor road	... by oncoming drivers, making it easier for them to decide whether to wait or turn.	Waiting drivers	

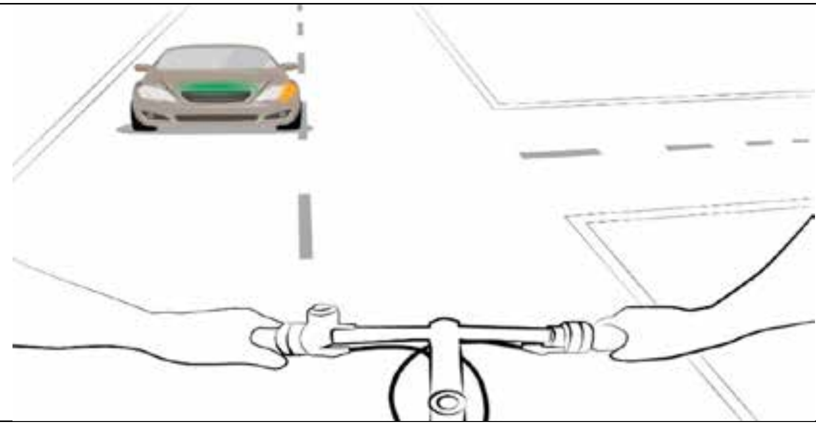
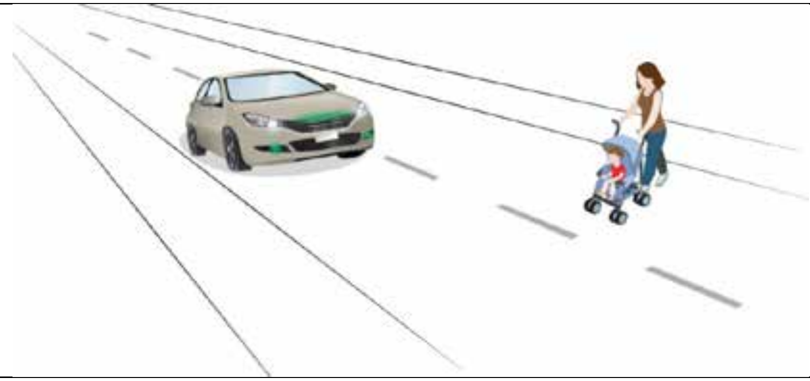
[1] The authors would like to thank Dr. Birgit Kollbach, traffic psychologist and driving instructor at the DEKRA Akademie Berlin, and Dr. Bernhard F. Reiter, Consultant for Road Traffic Safety.

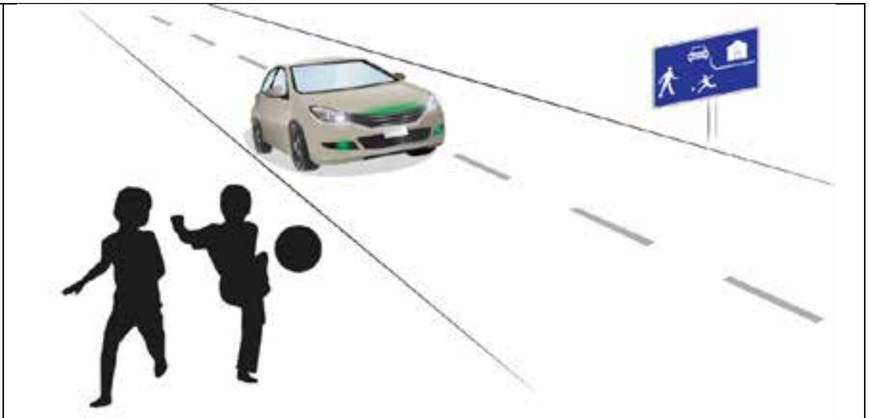
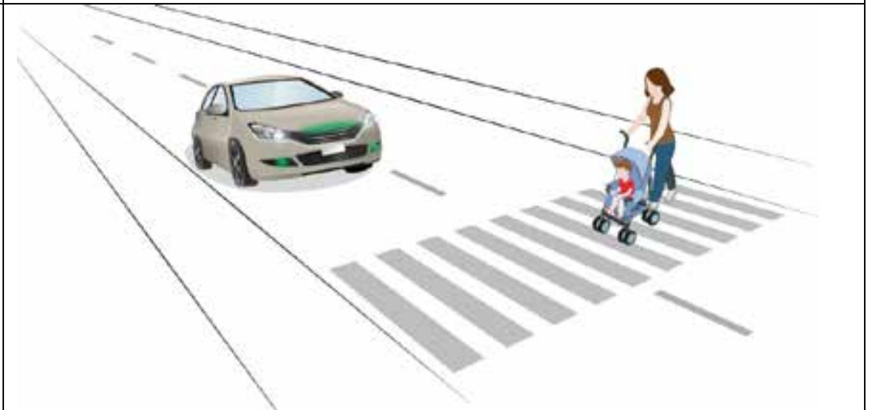
2		Changing lanes, especially in dense traffic	... by a driver who wishes to change lanes in front of the FBL vehicle	Driver wishing to change lanes	
3		Approaching a bottleneck	... by oncoming drivers making it easier for them to decide whether or not to enter the bottleneck.	Drivers with/without right of way	

4		Adjusting speed on the approach to intersections	... by drivers who have the right of way, making it easier for them to decide whether or not it is safe for them to exercise that right	Drivers with right of way	
		Dangerous situations			
5		Heavy or emergency braking on the approach to a hazard	... by the driver of the leading vehicle who can decide if a rear-end shunt is likely and what evasive action, if any, can or should be taken. Especially relevant on motorways or other high-speed roads where quick decisions to either brake heavily or veer sideways onto the verge or hard shoulder are required to ensure survival	Driver at the head of the line of traffic	

6		Overtaking in ambiguous traffic conditions	... by the oncoming driver who can detect the end of the overtaking manoeuvre more quickly	Driver of the non-overtaking vehicle	
7		End of traffic jam or other reasons to brake	The absence of a lit Front Brake Light on the following vehicle warns the driver to consider taking evasive action	Driver of the leading vehicle	

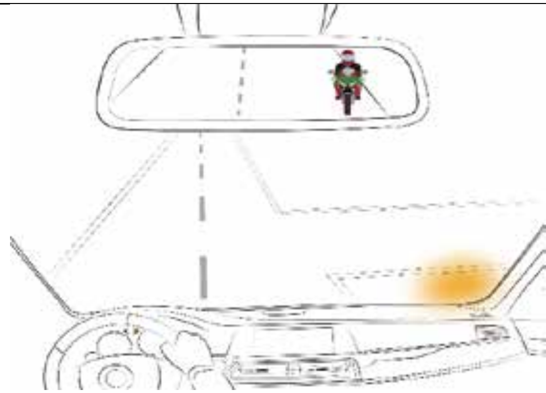
		Driver as traffic obstruction (break-down)	Failure of the Front Brake Light enables following vehicle to get off the road in time	Driver with breakdown	
8	Emergency vehicles with right of way	Crossing an inter-section	... by the driver of the emergency vehicle who can determine more easily if the FBL vehicle is giving way	Driver with right of way	
9	Cyclists	Straight ahead over intersection despite other road user turning right	... by the cyclist who can then de-cide whether to proceed or give way to the turning vehicle	Cyclist with right of way	

10					
11	Pedestrians	Waiting to cross the road (away from designated crossing places)	... by the pedestrian and facilitate judg-ing whether or not to cross the road.	Pedestrian without right of way	

					
12		Designated crossing place where the pedestrian has priority	... by the pedestrian and facilitate judging whether or not the FBL vehicle will accede priority	Pedestrian with right of way	

- As driving becomes more highly automated and the driver becomes less involved in the actual task of driving, it will be necessary to provide new communication signals to replace those (such as facial expressions, hand signals and the like) currently used by drivers to inform other road users of their intentions.
- Also, as the proportion of electric and hybrid-powered vehicles increases, it will become more difficult for road users both to hear motor vehicles and also to detect any change in their speed.
- In both of the above instances, a Front Brake Light could make an important contribution to traffic safety.

B. Front Brake Light on motorbikes, trikes, quad-motorbikes etc.

13	Other vehicles	Turning of cars through track	Turning of cars through track Observer-vehicle wants to turn right, from the right rear comes motorbike with right of way	Road user required to wait	

Appendix B

Dr. med. Wolfram Hell

An opinion on the biomechanics of trauma

The subject of this statement is a discussion about the usefulness of a Front Brake Light on vehicles held on 1st March 2018 at Berlin Tegel Airport

Documents

Field study to test a Front Brake Light at Tegel Airport (University of Bonn January 2018)

A. Question

1. In theory, would it be expected that, in a relevant number of crash victims with traumatic brain injury or cervical spine injuries, these injuries would have been less severe or could have been avoided altogether if the victims had received advanced warning of the impact and could have taken some action to mitigate its effect?

2. If the answer to Q1 is positive, then:

   How many crash victims suffer traumatic brain injury or cervical spine injuries?

   What is the economic cost of these injuries to the nation?

   Is it possible to make some approximation as to how many minor injuries could have been avoided altogether, and how many moderate injuries could have resulted in less serious injuries?

   Is it possible to estimate the resultant cost savings? (In addition, there is always the emotional benefit to those affected from reducing the severity of the injuries.)

3. What effect would the advance warning of an impact have upon vehicle occupants? Can it be hypothesised that the warning and an increased preparedness (e.g. adopting the brace position, stiffening of neck muscles, etc.) can alleviate the resultant injuries such as cervical spine trauma? One could imagine the difference between a body thrown back and forth by the impact, because it is unrestrained, and one that has braced itself and, therefore, is less likely, at least in theory, to be flipped back and forth.

B. Opinion

Question 1:

In principle, at least, it can be assumed that, if the crash victim has prior warning, the severity of the crash will be reduced or the crash could even be avoided completely. Typically, however, the pedestrians who are involved in crashes with cars or trucks are either children (1-12 years) or older citizens (> 65 years, often > 80 years). Such pedestrians are best influenced by active emergency braking systems coupled with pedestrian detection day and night.

The Front Brake Light is most likely to be effective for pedestrians aged 13-64 years.

Title of graph
Distribution of pedestrian crashes, population and risk of crash involvement by age group

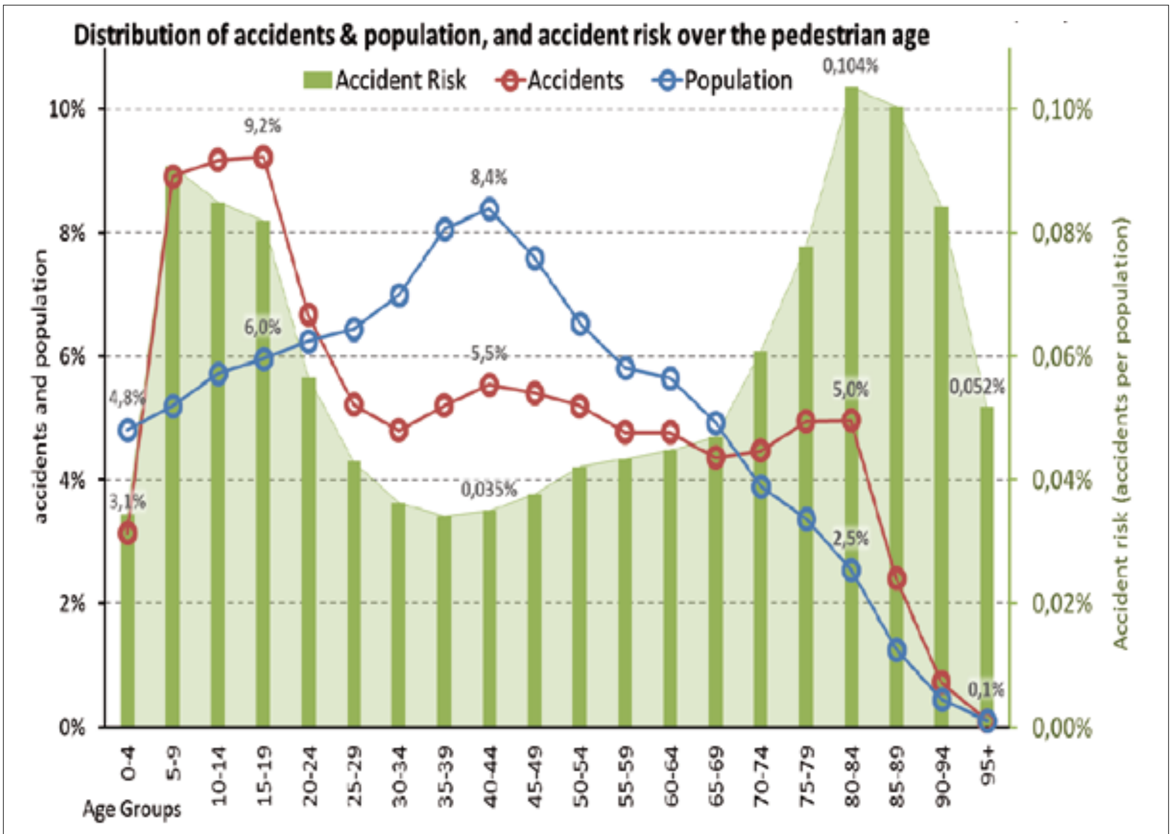


Fig. 1: Pedestrian age, population and risk of crash involvement

An earlier evaluation by my cooperation partner ADAC UFO revealed the following main injury factors: the head, thorax, abdomen, spinal column and pelvis are particularly at risk of life-threatening injuries. Logically, the severity of the injury to the pedestrian is proportional to the impact velocity and the kinematics of the impact.

The lighting conditions can also be crucial, as many pedestrian crashes happen in darkness on unlit roads.

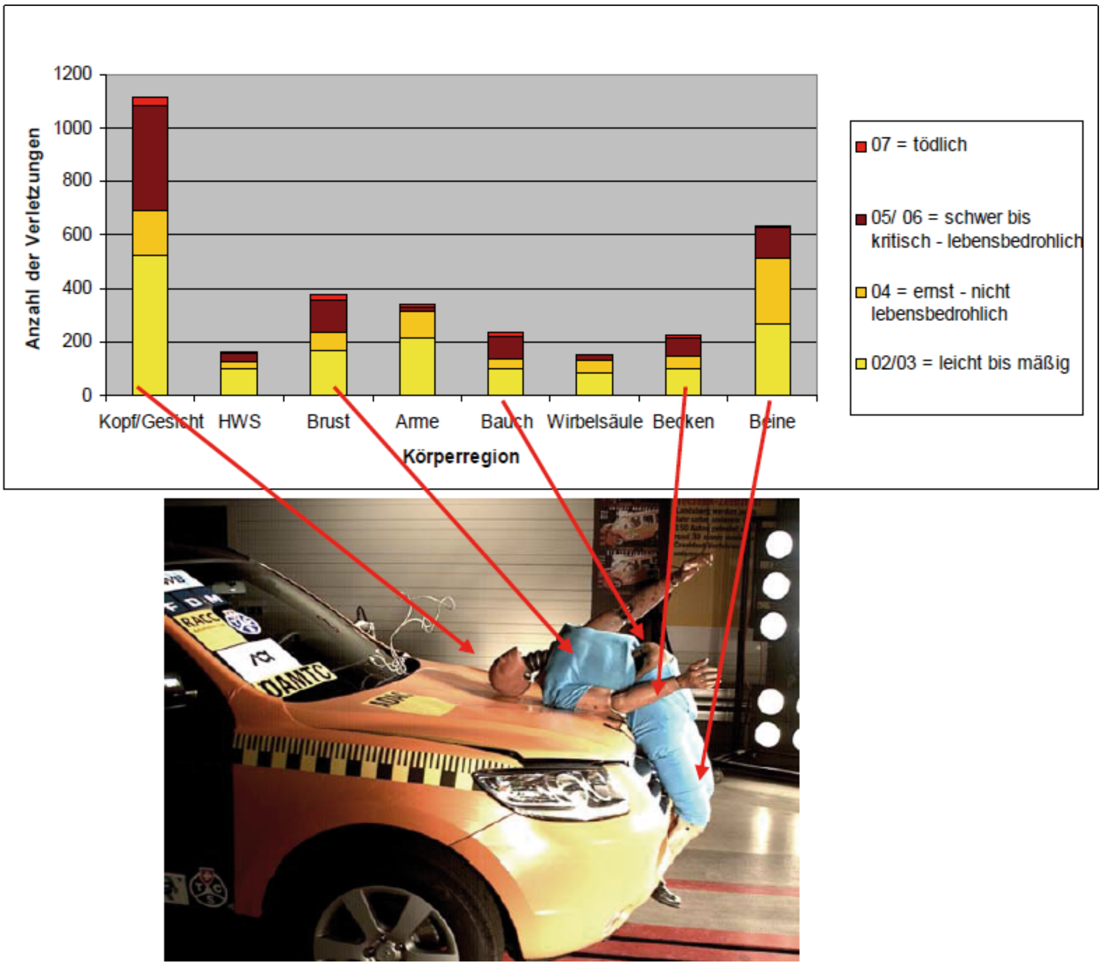


Fig. 2: Patterns of injury to pedestrians in ADAC Accident Research (2013)

Thus, in principle, it can be assumed that the effect of a Front Brake Light, would be positive. The size of the effect would have to be calculated from data obtained from ana-lyses of both real crashes and reconstructed or simulated crashes. However, this positive effect would have to be substantiated theoretically and empirically quantified by accident reconstruction.

In the future, in principle, autonomous self-braking systems will also recognize a green light and thus the braking or non-braking of the oncoming vehicle. In principle, such sys-tems should also reduce bicycle and pedestrian crashes.

Question 2:

In principle, a retrospective study of real pedestrian crashes can shed light on pre-defined questions. There are several databases.

- Pedestrian fatal crashes (major crashes from the database of LMU)
- Pedestrian crashes with serious injuries from the ADAC Accident Research database

The crash data should be differentiated according to whether the impact was with a car or a truck, van or bus.

An approximation of the economic costs of the crash is also possible. A detailed evaluation using the so-called ICS (Injury Cost Scale) is only just beginning.

Depending on the depth of the evaluation, further statements may be possible, for example, a reduction in minor pedestrian crashes.

More likely, it will become possible to classify such crashes as: Preventable, partially avoidable, and unavoidable.

Note:

> European standards have a long lead-in time (up to 20 years). Technical progress, especially in the transition to automated driving, is much faster, which is why opinion-makers and consumer testers are particularly relevant in Sweden, England, Switzerland, the Netherlands, Austria and Germany. In these countries, a public relations offensive should be mounted. Innovations in Sweden are often copied by other countries with a time lag of about 5-10 years.

Question 3:

The car occupants would be forewarned that an uncontrolled or late braking vehicle is approaching them. Results from international research studies suggest that forewarning has a positive effect. For example, unprepared passengers have a higher injury severity than informed and thus muscular-tensed drivers. Even evasive movements can be better planned by the driver or, in the future, by automatic driving systems.

If an out-of-control truck threatens the end of a line of stationary traffic, the threatened driver may also initiate an evasive movement. So-called spinal cord injuries occur in approximately 50-70% of all car crashes involving injured persons. Here, an advance warning, which was tested in volunteer tests on the test sled, also has a positive injury-reducing or avoidance effect.

In Germany, the annual cost of the estimated 200,000 cases of cervical spine injuries resulting from road crashes amounts to around 500 million Euros annually.

A reduction by, for example, 10% would therefore have a significant effect. Likewise, in the case of even more serious injuries, (AIS 2+) a more substantial cost saving could be expected.

For the next decade (2020 – 2030), the EU is particularly targeting the reduction of serious injuries. Modern pre-safe systems (for example, Mercedes Benz) already have all-round monitoring (front, side, rear). By coupling these sensors with a sensor to detect the Front Brake Light, these systems could coordinate their evasive movements more effectively.

Truck / Bus / Van

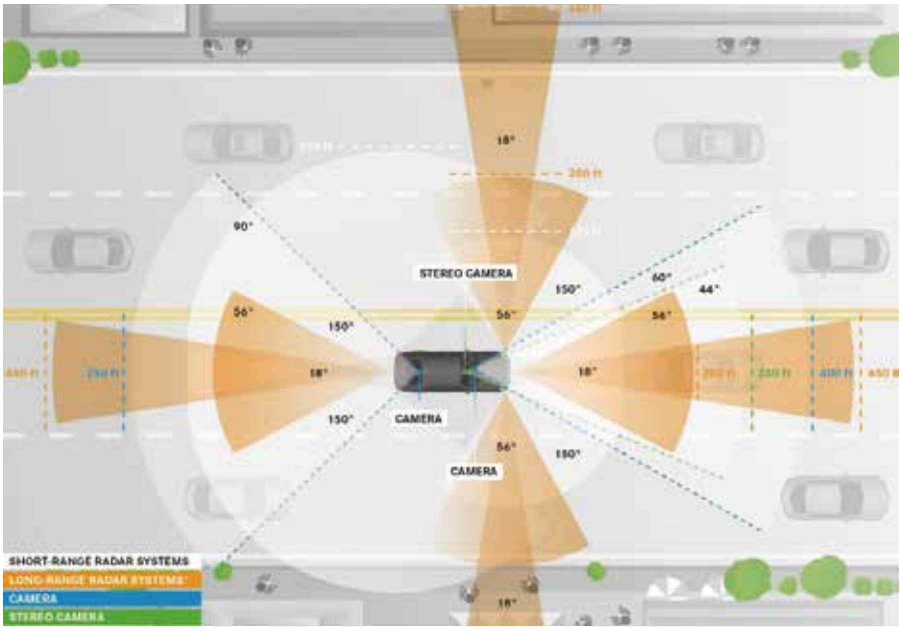


Fig. 3: Mercedes S class sensors (Daimler)

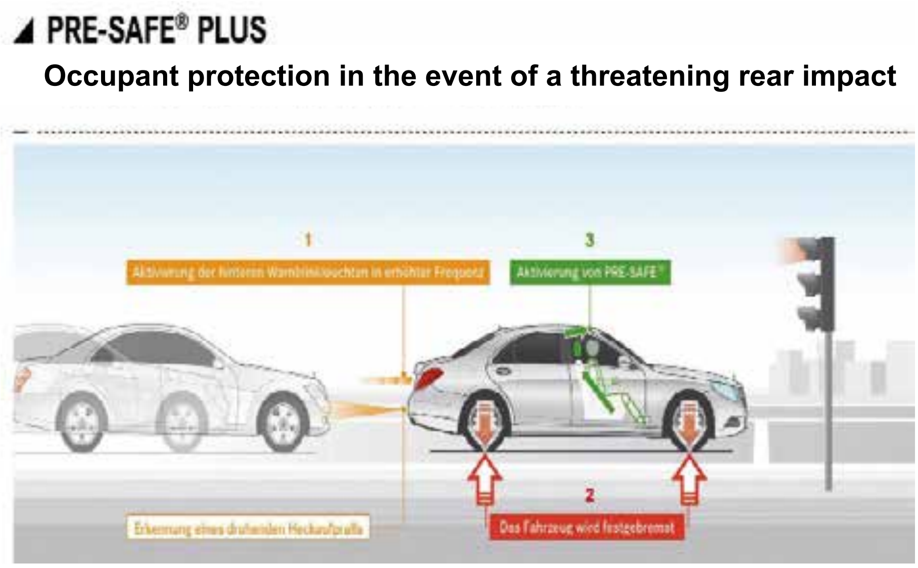
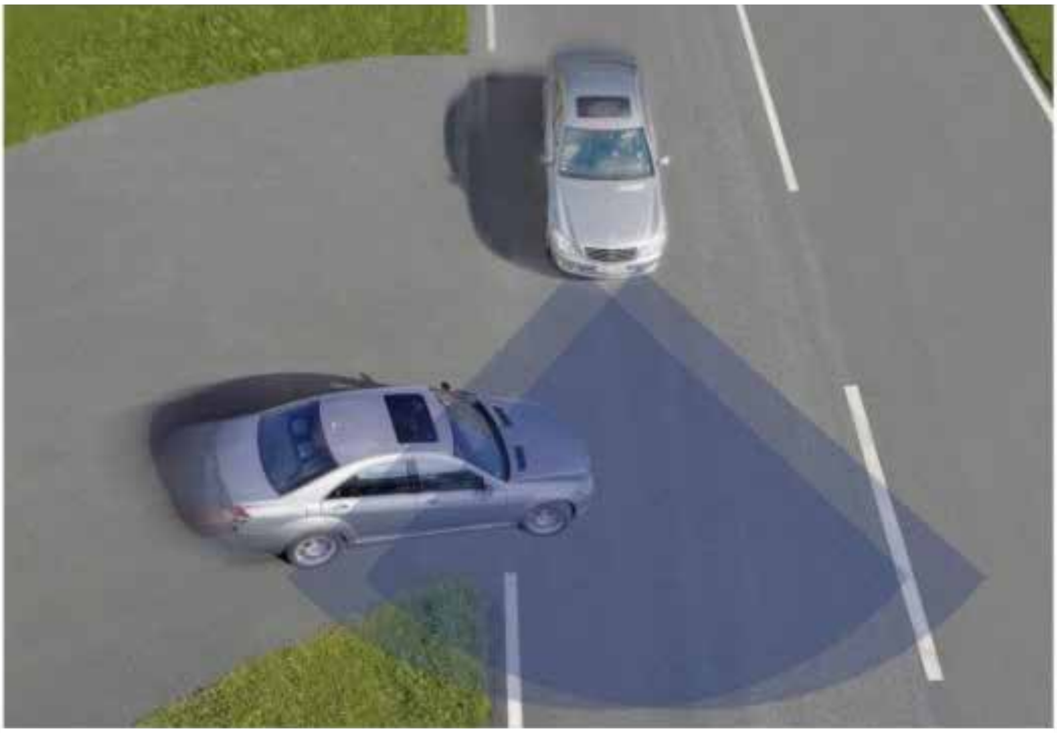
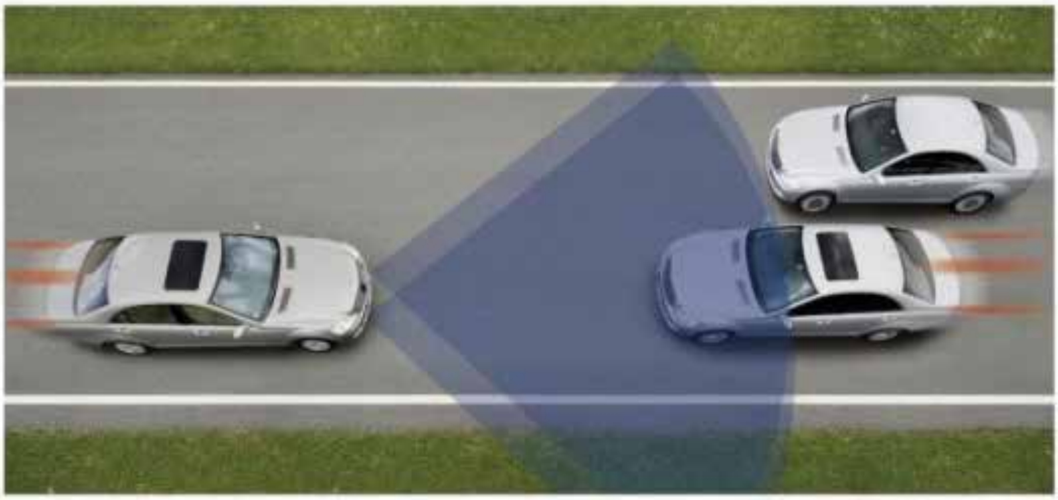


Fig. 4: Mercedes S Class Pre Safe Plus (Daimler)

PRE-SAFE©: Activation of the front belt tensioners due to radar signals



unavoidable crossing accident
Activation of the **PRE-SAFE©** belt tensioners based on the information of the radar at close range



unavoidable collision with oncoming traffic
Activation of the **PRE-SAFE©** belt tensioners based on the information of the radar at close range

Fig. 5: Mercedes S Class Pre Safe (Daimler)

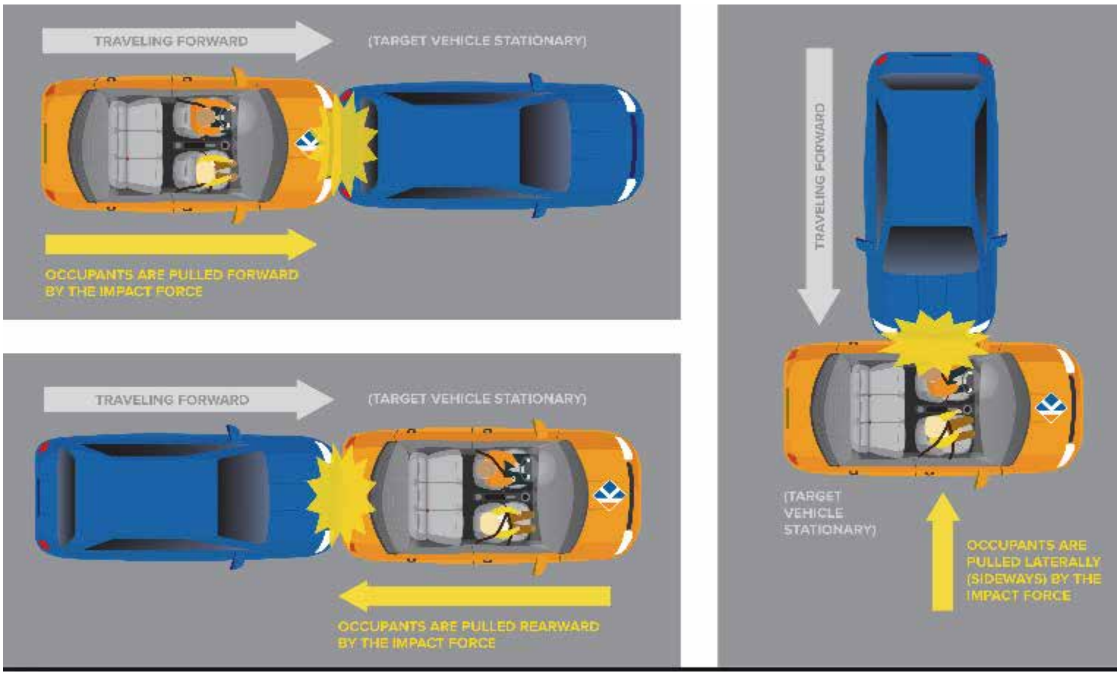


Fig. 6: Injury kinematics car occupant front, rear, side collision (Kodsi Forensic Engineering USA)

Frontal and side collisions in particular have a high risk of injury even for occupants protected by seatbelts and airbags. In the case of rear-end collisions, it mainly results in cervical spurs that are not life-threatening (AIS 1 injury severity) but very common (50-70% of all car collisions) and 10% of so-called long-term cases (resulting in more than 6 weeks occupational disability). Accordingly, the effect of a Front Brake Light and its potential for injury prevention should also be scrutinised in detail on the basis of real road crashes.

	Killed	Total Injured	Seriously injured	slightly injured
1991	11.300	505.535	131.093	374.442
1992	10.631	516.797	130.351	386.446
1993	9.949	505.591	125.854	379.737
1994	9.814	516.415	126.723	389.692
1995	9.454	512.141	122.973	389.168
1996	8.758	493.158	116.456	376.702
1997	8.549	501.094	115.414	385.680
1998	7.792	497.319	108.890	388.429
1999	7.772	521.127	109.720	411.577
2000	7.503	504.074	102.416	401.658
2001	6.977	494.775	95.040	399.735
2002	6.842	476.413	88.382	388.031
2003	6.613	462.170	85.577	376.593
2004	5.842	440.126	80.801	359.325
2005	5.361	433.443	76.952	356.491
2006	5.091	422.337	74.502	347.835
2007	4949	431.419	75.443	355.976
2008	4.477	409.047	70.644	338.403
2009	4.152	397.671	68.567	329.104
2010	3.648	371.170	62.620	308.720
2011	4.009	392.365	68.985	323.380
2012	3.600	384.378	66.279	318.099
2013	3.339	374.142	64.057	310.085
2014	3.377	389.535	67.732	321.803
2015	3.459	393.432	67.706	325.726
2016	3.206	396.666	67.426	329.240

Fig. 7: Traffic injury statistics Germany 1991–2016

The proportion of seriously injured persons (i. e. admitted to intensive care units) has remained constant for about five years, with a cautious annual estimate of approximately 10,000 cases in Germany. A differentiated consideration regarding the effectiveness of a Front Brake Light seems to be indicated here, possibly also with the use of traffic simulation models.

It may be concluded that a full investigation into the potential effectiveness of a Front Brake Light would benefit from analyses of data from both traffic simulation models and real-world crashes.

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DOI: 10.1055/b-0034-20112 (2011)

This statement has been prepared to the best of my knowledge and belief.

Dr. med. Wolfram Hell, Traumabiomechanics

Appendix C

Reducing stress in traffic by the use of a Front Brake Light

Prof. Dr. Konrad Reschke
Institute for Psychological Therapy e.V., Leipzig

Dr. Udo Kranich
Institute for Psychological Therapy e.V., Leipzig

A driver's stress, strain and load are terms that have barely been thoroughly investigated in the context of increasing traffic safety, avoiding traffic accidents and offences, and further reducing traffic-related deaths. Their relevance for traffic safety and the further development of a safe multisystem driver-vehicle-traffic interaction is undisputed. In the following discussion, some of the basics of stress, strain and load are discussed in terms of action theory according to Reschke & Schröder (2010), whereas the discussion of general stress theories (e.g. Lazarus, 1966, Lazarus & Launier, 1978, Heinrichs, Stechele & Domes, 2015) has been omitted.

1. The stress concept – Fundamentals of al stress model based on action theory and related to transportation

In the context of transportation, current stress theory states that drivers are equipped with skills (driving ability, driving skills) and needs that enable them to meet the requirements of (road) traffic (e.g. with regard to attention, length of driving, occupational tasks, traffic density, traffic conditions, time compliance) and thereby regulate their stress levels themselves. The driver can be supported by various resources, both external and internal...

The development of motor vehicle technology is basically a resource development that historically assists the driver and constantly tries to improve traffic safety. The development of a Front Brake Light and all the research carried out on it are also an expression of the effort to increase the safety of multisystem interactions by means of suitable new technical developments.

The relationship between the driver, automotive technology and road traffic is considered to be contradictory in principle as a multi-sensory diversity of requirements for motorists when driving in traffic. It requires ongoing regulatory efforts and further development at all levels. However, not only technical systems have load limits. Even the capacity of the human psychophysical system is limited and its burden cannot be continually increased. Critical limits (e.g. alertness, attention, driving times, alcohol limits or sensory stimulus density) must be observed and should not be exceeded. On the one hand, legal foundations were created for this purpose. On the other hand, technical, environmental and internal regulatory activities complement the automated responses to requirements by matching (congruence) and balancing (consistency).

The term stress, within the multi-systemic and complex context of the driver-vehicle-traffic system, describes a human psychophysical state of regulation which is relevant for an individual, if the personal human-environment relationship can no longer be compensated with behavioural routines and reaction automatisms (Reschke & Schröder, 2010). In the experience of the individual, stress is reflected in the form of need-threat, destabilization, perceptual and information-processing capacities, and stressfulness in coping with demands. Stress thus describes a problem situation that requires a switch from the emotion-controlled behavioural level to cognitively organized and reflected actions.

The psychophysical stress response results from the highly individual interaction of four interacting condition groups (Figure 1). For the individual, above all, their capability structure with basic perceptual and behavioural competencies as well as stress-related coping skills are of importance. These components essentially make up the personality factor, which, with its experience-based and constitutional features, represents a more or less flexible and stable background to coping (driving skills-relevant personality and biopsychosocial competencies, e.g. perception, control and decision-making processes when driving in traffic). Thus, for example, young drivers, who have undergone professional training are less often confronted with skill deficit situations and therefore will act at the limit of their regulatory stability less often than others, such as learner drivers. Those who have skills for solving problematic regulatory situations also have advantages over inexperienced drivers.

At a predominantly instrumental level of behavioural organisation, the stress-relevant discrepancies arise from the relationship between abilities and external requirements. For the analysis and the reduction of stress, strain and load the respective requirement profile and the type of stress in relation to the individual coping possibilities are of importance. It is important to distinguish between stressful long-term requirements and frequently recurring events or short-term stress. These factors are formed by external stressors. The intensity, duration, complexity, predictability and controllability of stimuli from the traffic situation determine the mental requirements components.

Any reduction in the complexity of the safety-related signals to be observed and controlled is a contribution to stress reduction through preventive interventions. The concrete contradictions between the illustrated complexes of conditions put the psychophysical regulatory system of man under pressure. Any attempts to reduce stress by reducing irritation and improving regulation by adding safety-related and control effort-reducing signals can stabilise behaviour and safety in traffic.

Emotional and cognitive assessments identify the onerous situation and provide psycho-energetic power including behaviour as well as the corresponding physiological, endocrine, and immunobiological mechanisms. The acute stress reaction is appropriate; it mobilises individuals and makes them capable of responding to a demanding situation.

Chronic stress reactions, on the other hand, represent a permanent overburdening with the risk of destabilising health and performance. The psycho-physical quality of the condition described here is particularly stressful in its chronic form, as are the negative forms of fatigue under excessive demands and monotony when under-challenged.

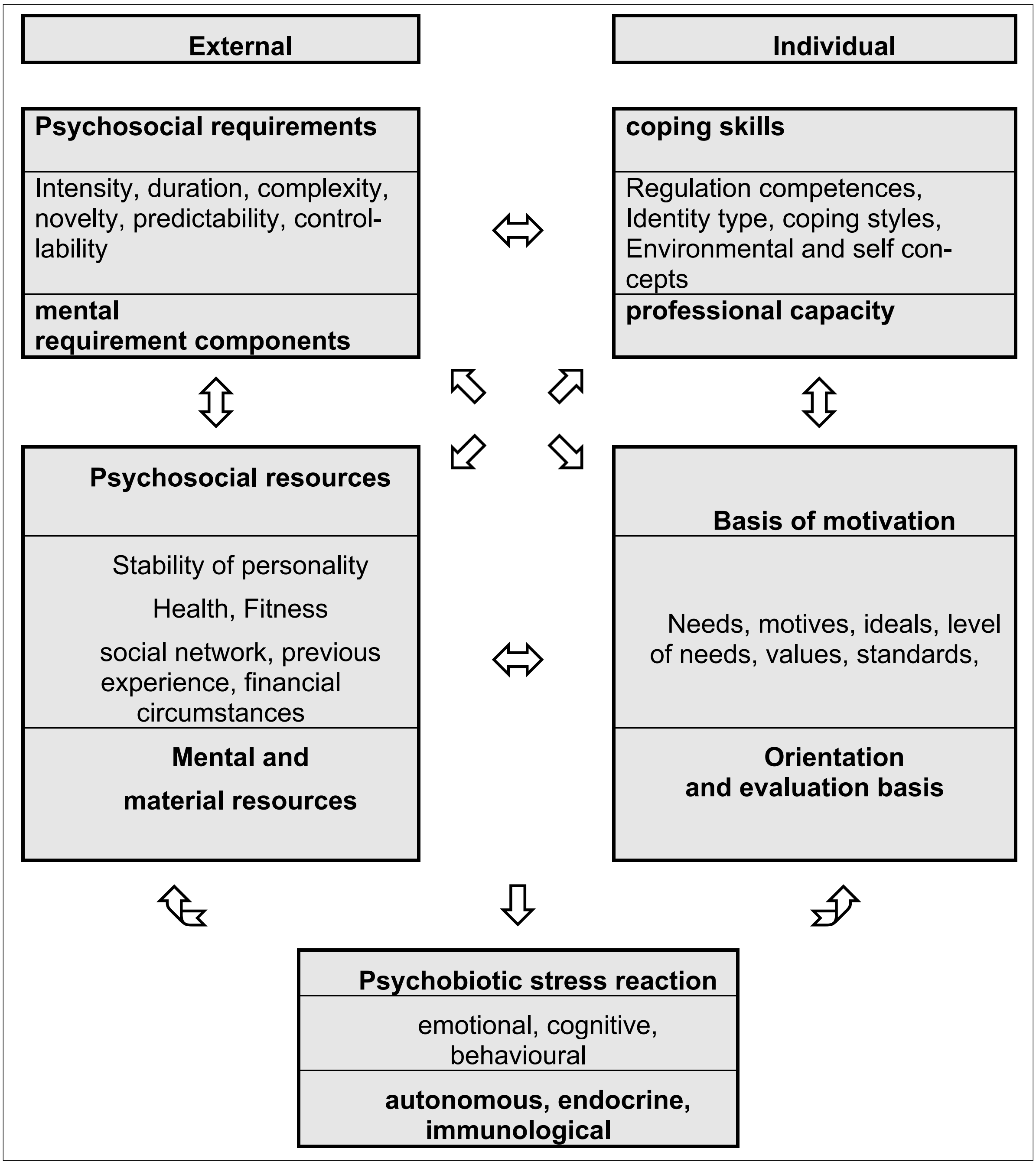

Fig. 1: Condition groups of the psychobiotic stress response according to Reschke & Schröder (2010)

Starting points of stress management and stress reduction

In the multisystemic, complex traffic space, relative and behavioural interventions to manage stress are possible. The activities of stress management on the external requirements and relationships (ratio prevention) are based on the objective load side, in traffic by rules, laws and workplace shaping and action-facilitating measures. This includes all technical equipment of the motor vehicle. They have the general objective to change working and living conditions of the road user positively and according to needs, to influence positively traffic safety and activity regulation.

The following explanations therefore relate in particular to the situation design and technical equipment on the motor vehicle, which must allow by clear signal reduction to reduce stress by security of perception and control. Stress management processes are thus also facilitated by external resources on the vehicle if, for example, these facilitate the perception of and attention to braking from the front, which also increases traffic safety.

2. Stress in traffic

The stress experience of motorists always arises from a combination of personal and environmental variables. Evers (2009) classified these variables in the form of activity-related (environmental variables) and the personal stressors of motorists' lives. In principle, road safety issues affect all road users, but professional drivers and high-mileage drivers (taxi drivers, driving instructors, bus drivers, etc.) have special burdens.

In the meantime, a stress management program entitled "Optimistically mastering the stress of driving" has been developed by Reschke, Kranich & Lessing (2015). In addition to an individual stress analysis of the driver, specific modules for stress management are developed with the participants as well as imparting knowledge on the topic: "Stress in traffic".

3. Stress reduction by the use of motor vehicle technical facilities

The overall system of transportation consists of the subsystems "human" (driver, road users), "vehicle" (means of transport) and "road" (traffic environment), which interact with each other in many different ways (e.g. Klebelsberg, 1982). Factors such as an increasing traffic density, time and deadline pressure increase traffic conflicts. Traffic situations can be perceived by the road user as threatening, especially if they are not sufficiently predictable from the behaviour of other road users. Klebelsberg (1982) defines traffic conflicts as "opposing behavioural tendencies of road users (...) whose direction ultimately leads to an accident, but which are counteracted by one or both road users"
More control over behaviour in road traffic can also be achieved through the use of technical means. These may, for example, help to improve/defuse and / or better identify dangerous situations in traffic. This increases the predictability of potential hazards, reducing the sense of threat, which in turn can reduce stress. In particular, the process of information processing is facilitated because the human brain can handle unique signals more easily than ambiguous ones. In particular, it is not capable of simultaneously processing various signals in complex request situations (multitasking). Information processing includes selection, processing and action and takes place at all hierarchical levels of the driving task and driving behaviour, whilst the specific processes depend on

the difficulty of the task. A driver learns to detect the signals of driving-relevant stimuli and can decide in the course of his driving experience through automation (learning) on the basis of less safety-relevant stimuli.

For example, Rumar (1985) describes processes of information acquisition and processing that are sequential and controlled by cognitive and motivational factors. Within the information processing process, the information is selected and structured and condensed. First, environmental information is sensory-selected and processed cognitively (by memory and perception processes) until finally a decision is made which translates into a response by the driver. The cognitive processing processes are guided by attention, motivation, experience and expectation. At the same time, Rumar (1985) assumes that different filter processes influence information processing.

The physical filtering concerns the external physical environment and means that certain stimuli or objects cannot be detected sensorially because they are masked, for example, by other stimuli or objects (such as sounds). Perceptual filtering may be based on sensory processes and perceptual structuring and means that the attention is directed to a stimulus, i.e. attention are more focused on certain stimuli than others. An additional signal element on the vehicle can potentially attract attention. It can be assumed that control of the level of safety-relevant attention control can also be increased by technical signals which can provide the road user with important additional information for the adequate perception of traffic situations.

4. Stress reduction by using the Front Brake Light

General considerations
Because the Front Brake Light is mounted at the front of the vehicle, this signal is perceived by road users other than those for whom the rear brake lights are visible. The Front Brake Light indicates the current braking behaviour of the driver (or of the autonomously driving motor vehicle) and thus facilitates communication with other road users, particularly the more vulnerable ones such as pedestrians and cyclists. There are numerous traffic situations in which it would be important to obtain information about the driving behaviour of a motor vehicle at an early stage (see chapter 4.2).

The use of the Front Brake Light would give other road users an additional stimulus source. It would be easier for them to tell if a vehicle is really decelerating or not. This gain in information minimises the uncertainty and therefore the potential threat in ambiguous or even dangerous traffic situations, and can, therefore, be regarded as a stress-reducing factor.

This assessment is based on the following considerations according to the stress model of Lazarus (1966). The evaluation of a stressor takes place in several steps: First, the situation is assessed as stress-relevant (primary assessment), e.g. experienced as a threat. This is often associated with negative emotions such as fear, anger and anxiety.

The second step (secondary assessment) is to assess one's own coping skills and opportunities by weighing up which coping options are available, the probability of their success and the extent to which such strategies are mastered. Experiences of more adequate coping with traffic situations, in this case by the presence of additional information about the behaviour of other drivers, can then lead to a change in the assessment of the initial situation and a decision as to whether more information is required. This can lead to a reassessment of the situation. Coping is defined by Lazarus and Folkman (1984) as a cognitive and behavioural effort designed to reduce, master or tolerate internal or external demands. In the present case, it can be assumed that external requirements (uncertainty about the behaviour of drivers in road traffic) can be better detected by the use of the Front Brake Light and then managed more adequately.

However, the following must be kept in mind: A generally effective coping strategy does not exist, as "effectiveness" depends on the content and characteristics of the stress situation, on the characteristics of the individuals concerned or on dispositional coping preferences. However, one form of coping strategy has proved to be effective again and again. It is active problem-solving, but, as a strategy, it can only function effectively if the situation can also be considered sufficiently controllable. The use of the Front Brake Light is likely to increase the likelihood of this being so.

Target group specific benefits (e.g. pedestrians, older road users, drivers with special needs)

In principle, many different groups of road users can benefit from the addition of a Front Brake Light.

For pedestrians, in particular, it is not always clear whether or not a car has really initiated a braking operation. A classic situation is the pedestrian crossing. In most countries, the approaching vehicle is actually obliged to stop so as to enable the pedestrians to cross the road safely. However, pedestrians receives no clearly recognisable optical signal to indicate to them that the driver really has fulfilled this obligation. They can only observe the behaviour of the approaching vehicle and draw conclusions as to whether or not the driver will really comply with the obligation to stop. However, this scenario is associated with considerable uncertainties. It is a subjective assessment. The pedestrian has to rely in part on the fact that the motorist will adhere to the rules regarding the use of pedestrian crossings. In addition, studies have shown that pedestrians are often denied priority at the crossing. By using the Front Brake Light; this uncertainty factor could be significantly minimised. By directing their attention to the specific traffic situation, pedestrians would receive an additional clearly identifiable signal (illumination of the Front Brake Light), indicating that the braking process has been initiated. The use of the Front Brake Light would represent an additional component for reducing stress, particularly for the target groups of elderly pedestrians and children, who are more at risk of injury in road traffic.

The use of the Front Brake Light would also have a stress-reducing effect for drivers of emergency or other vehicles with warning signals. These special signals provide warnings to other road users by means of light and sound signals as specified by the local traffic regulations. Special signals initiated by acoustic and optical devices on vehicles serve to warn against dangers. In cases of emergency, the vehicles of the aid organisations (fire brigade, ambulance service, etc.) only move with blue lights and specified acoustic signals. Once people are in need, the time factor often plays an important role. The faster these vehicles drive, the more effectively the relief measures can be initiated. On their way to help, these drivers must trust that other road users perceive the vehicle with special rights and adjust their behaviour accordingly, for example by giving way to them. This scenario is also associated with considerable uncertainties on the part of the drivers of emergency vehicle. Trips with blue lights and special signals (siren) are among the most dangerous situations in traffic. By using a Front Brake Light, uncertainty factors could be significantly reduced. Drivers of vehicles with special rights directing their attention to the specific traffic situation would receive an additional, clear signal giving them indications that other road users have recognised the emergency vehicle, adjusted their behaviour and initiated the braking process, and so contributed to increasing traffic safety.

5. Summary and conclusions

The term “stress” is defined as a state of psychophysical regulation which becomes relevant for the person when the personal human-environment relationship has reached a quality of contradiction that can no longer be compensated for by behavioural routines and reaction automatisms. In the experience of humans, stress is reflected in the form of need threat and destabilisation. Stress refers to a problem situation that requires the sufferer to switch from the emotion-driven level of behaviour to cognitively organised and reflected actions.

The stressful life of motorists always arises from a combination of personal and environmental variables. In principle, stress in traffic can affect all road users, but special burdens have to be carried by professional drivers and representatives of many professional groups (taxi driver, railroad driver, driving instructor, bus driver, etc.).
Factors such as increasing traffic density, time and deadline pressures can increasingly lead to traffic conflicts. Traffic situations can then be perceived by the road user as threatening, especially if they are not predictable, and behaviour patterns are not always predictable.

The more the road user keeps control in (ambiguous) traffic situations, the less they are perceived as threatening. This in turn can be considered as a stress reducing factor. More control for road users can also be achieved through the use of technical means such as signals. By implementing the Front Brake Light, uncertainty factors could be minimised in traffic situations that are neither clear nor unambiguous. Examples have been given for the target group of pedestrians and the driver for vehicles with special signals.

The present work is a theoretical derivation. Of course, various stress parameters are now also easily measurable. It is for further studies to provide empirical evidence that the use of the Front Brake Light on vehicles can significantly reduce the stress on road users.

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Appendix D

Psychological effects of the colours green and red

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"*The blue, as an opposite movement, slows down the yellow, and finally, with further addition of blue, both opposing motions destroy each other and complete immobility and calmness arise. It is green*."

This quotation by Kandinsky, which is listed in the handbook of the Lüscher colour test (Lüscher, 1949), symbolizes the associations aroused by the colour green: Calm, peaceful and serene (Wexner, 1954). At the same time, however, it also draws attention to the problem which, according to Valdez and Mehrabian (1994), has hindered previous research into the psychological effects of colours. Hardly any empirical approaches have been used to measure the psychological effects of coloured stimuli reliably and validly. Instead, one finds many everyday psychological statements and speculations.

Furthermore, Valdez and Mehrabian (1994), Gorn, Chattopadhyay, Yi and Dahl (1997) as well as Suk and Irtel (2010) showed that the actual hue is of less importance than the brightness and the saturation of the colour. However, if these influences are controlled, the empirical data show a picture contradicting everyday psychology. Valdez and Mehrabian (1994) had volunteers rate different colours on the Pleasure Arousal Dominance Scales (PAD, Mehrabian, 1978) and showed that green was perceived as more exciting than, for example, red or yellow. Wilms and Oberfeld (2014) also showed that the more saturated the green, the greater this effect became. On the pleasure dimension, green was able to achieve higher values than either red or yellow, and values higher than red on the dominance dimension.

On the basis of these results, it could be concluded that, due to its exciting and dominance-inducing effect, green is definitely suitable as a colour for the Front Brake Light, as it indicates a braking process and thus signals to other road users that they can soon start moving. It is not for nothing that green is used as a signal to proceed in traffic lights in most countries of the world. A corresponding intuitive knowledge of a green Front Brake Light could thus be assumed. Nevertheless, it is advisable also to check the effect of the colour green in road traffic on the basis of empirical data.

Chen, Chang, Chang and Lai (2007), for example, showed that motorists accelerated faster at traffic lights equipped with a green countdown device than at traffic lights with red countdown devices. This result also shows that green is more likely to be perceived as a start signal in traffic than red. The results of a study by Elliot, Maier, Moller, Friedmann and Meinhardt (2007) have at least an indirect relation to traffic safety. In an anagram task which measured, *inter alia* the ability to concentrate, subjects made fewer mistakes when exposed to green rather than red light. If green light increases the ability to concentrate, then it could help prevent a false interpretation of the signal of a green Front Brake Light and thus increase traffic safety. Elliot et al. (2007) also associated the colour green with the construct of the 'approach motivation', whereby a green Front Brake Light could facilitate an approach to a critical situation and favour a correct solution.

A. Study on traffic-related associations of the colours green and red

Given the sparse literature on the perceptual and traffic psychological aspects of the colour green, a separate empirical study was conducted to investigate the nature of the problem; namely the association of the colours green and red with traffic-related content. For this purpose, a sequential priming paradigm was used. It was assumed that subjects respond more quickly to "Los" words (“Los” meaning “go”) associated with starting or moving forward after being shown the colour green than after being shown the colour red (hypothesis 1).

Conversely, respondents to "Stop" words associated with braking should react more quickly after being shown the colour red than after being shown the colour green (hypothesis 2). Likewise it should be similar with the error rate. With a presentation of the "Los" words after the colour green, fewer mistakes should be made than with a presentation of the "Los" words after the colour red (hypothesis 3) and vice versa. With a presentation of "Stop" words after the colour red, less mistakes are to be expected than in a presentation after the colour green (hypothesis 4). The presentation of the colours orange and blue should show fewer effects than green in the case of "Los" and red in the case of "Stop" due to lack of associations with "Los" and "Stop" contents (Hypothesis 5). The presentation of orange and blue was recorded as a control condition.

B. Method

Sample. A total of 29 subjects participated in the online study, of which 14 were female and 15 male. They were between 20 and 59 years old (M = 28.93, SD = 12.57). The level of education was at a high level: 14 subjects had gained a high school diploma and 15 a university degree.

Priming paradigm. Four different coloured squares (green, red, blue and orange) were used as the prime stimuli. The size of the squares was determined by screen size, with the height and width of the squares each defined by 40% of the screen height. Influences of saturation and brightness were kept constant by using equal values for all colours (saturation: 100%, brightness: 100%). The target stimuli were "Los" (start, accelerate, go, start) and "Stop" words (pause, slow, delay, hold, Stop), each presented in black (2.50% screen height).

“Participants were instructed to respond to each word displayed as quickly as possible, but to make as few mistakes as possible. Approximately half of the particpants were instructed to respond to "Go" words with the "x" key and to "Stop" words with the "m" key, for the other half of the participants the key assignment was reversed. The participants were also warned that, before each word, a coloured square would be briefly presented which they should ignore.”

The stimuli were presented in a total of twelve blocks, each block comprising 40 trials. Between each block, the subjects had the opportunity to take a break and were then reminded again about the relevant key-word combinations. The 40 trials in each block consisted of a random combination of one of the four prime images and one of the ten target words (drawn without replacement), so that, for each block, there were four trials per combined condition (colour and "Los" or colour and "Stop"). After a pause of 310 ms, the respective prime was presented for every 125 ms before the target appeared. The target was displayed until a reaction occurred. In the case of an incorrect assignment, a red error cross was displayed for 200 ms. There was a pause of 100ms after each trial before the next trial started.

Manipulation check. To rule out colour vision problems or other visual deficiencies, the subjects were presented with the four colour primes and asked to determine the colours of the squares (green, red, blue and orange).

Procedure. The survey period began on 22th February, 2018 and ended on 27th February 2018. The study was conducted online using Inquisit software (https://www.millisecond.com/). After the volunteers had agreed to participate in the study and answered the demographic questions (gender, age, educational status), the priming paradigm was undertaken. Finally, the colour identification task was performed as a manipulation check. The duration of the study was about 15 minutes.

Data analysis. Firstly, the answers in the colour identification task were analysed to exclude any influence of potential visual impairment. Thereafter, the mean response times (ms) and errors (%) in the twelve blocks were used to form baseline-adjusted difference scores from compatible and incompatible trials, which could be used to determine reliabilities. Trials with response times below 250 ms and above 1500 ms were excluded. For the baseline, means of the trials with the colours orange and blue were computed. The hypotheses were tested using a repeated measures ANOVA followed by post hoc t-tests.

C. Results

Reliabilities and colour check. Since no error was made in the colour identification task, it can be assumed that the results of the study were not influenced by colour vision defects. Cronbach's alpha of the individual reaction times was $\alpha RT = .84$, Cronbach's alpha of the error rates $\alpha ER = .59$.

Reaction times. A main effect of the targets became significant ($F(1, 28) = 20.75$, $p < .001$, $\eta^2 = .43$), where the reaction times in the "Los" condition ($M = 608.69$, $SD = 107.12$) were lower than in the "Stop" condition ($M = 633.98$, $SD = 109.71$). For the colour, a main effect could also be found ($F(3, 84) = 3.82$, $p = .013$, $\eta^2 = .12$, $\varepsilon = .84$), with the lowest reaction times for green (M = 612.42, SD = 102.21) and the highest for red (M = 625.37, SD = 110.03). As expected, the times for orange (M = 622.86, SD = 113.20) and blue (M = 624.70, SD = 107.68) were in the middle range. Post hoc t-tests only became significant for the mean difference between green and red (t (28) = -2.94, p = .007, dRM = 0.58). The critical test of hypotheses 1 and 2 is an interaction effect between target words and colours based on opposite effects of the red and green primes on the response time for "Los" and "Stop" words. As expected, this interaction effect was both large and statistically significant (F (3, 84) = 9.97, p <.001, η^2 = .26) With primes of the colour red, the reaction to "Stop" words (M = 621.75, SD = 117.34) was significantly faster and significantly slower to "Los" words (M = 628.99, SD = 106.56). Conversely, after priming the colour green, the reaction was particularly fast to "Los" words (M = 591.30, SD = 109.31) and especially slow to "Stop" words. (M = 633.54, SD = 100.05) (Figure 1).

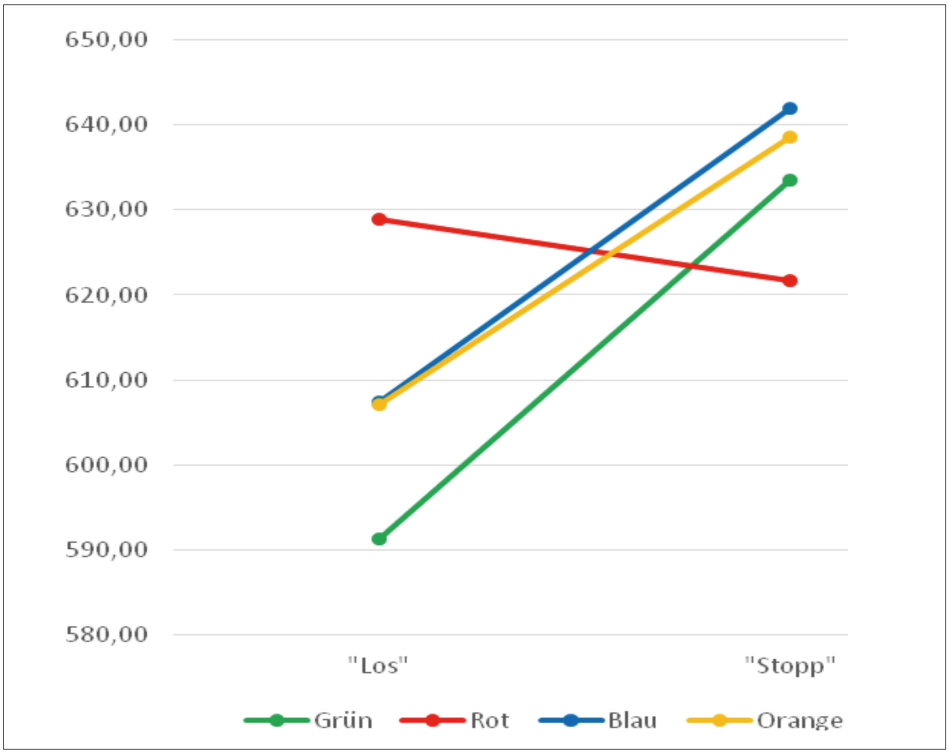

Fig. 1: Mean response times (ms) as a function of colour prime and word target.

In a post-hoc comparison of the individual experimental conditions, the reaction times between the green and red primes differ only in the "Los" condition (t (28) = -5.44, p <.001, dRM = 1.02). In the "Stop" condition (t (28) = 1.46, p = .078, dRM = 0.30) the times are not significantly different.

Error rates. As with the reaction times, a main effect of the targets (F (1, 28) = 26.50, p <.001, η^2 = .49), a main effect of the colour (F (3, 84) = 3.17, p <.028, η^2 = .10) as well as the critical interaction effect between target and colour (F (3, 84) = 10.51, p <.001, η^2 = .27) were found. On average the subjects made fewer errors in the "Los" condition (M = 0.05, SD = 0.03) than in the "Stop" condition (M = 0.10, SD = 0.06). With regard to the colour, the fewest errors were made in the trials with the colour blue (M = 0.07, SD = 0.04) and the greatest number of errors in the trials with the colour green (M = 0.09, SD = 0.05). Trials with the colours orange (M = 0.07, SD = 0.04) and red (M = 0.08, SD = 0.05) were in the middle range. The mean difference between green and red was not significant (t (28) = 1.53, p = .069, dRM = 0.56). As expected, the colours green and red had an opposite effect on the error rate in the "Stop" and "Los" conditions, and the differences between red and green primes were statistically significant in all conditions (in the "Los" condition (t (28) = -3.75, p <.001, dRM = 0.73, in the "Stop" condition (t (28) = 4.25, p <.001, dRM = 0.83), where in the "Los" condition as expected lower error rates for green (green: M = 0.04, SD = 0.03, red: M = 0.07, SD = 0.05) and lower error rates for red in the "Stop" condition (green: M = 0.13, SD = 0.08; M = 0.08, SD = 0.06) were recorded (see Figure 2).

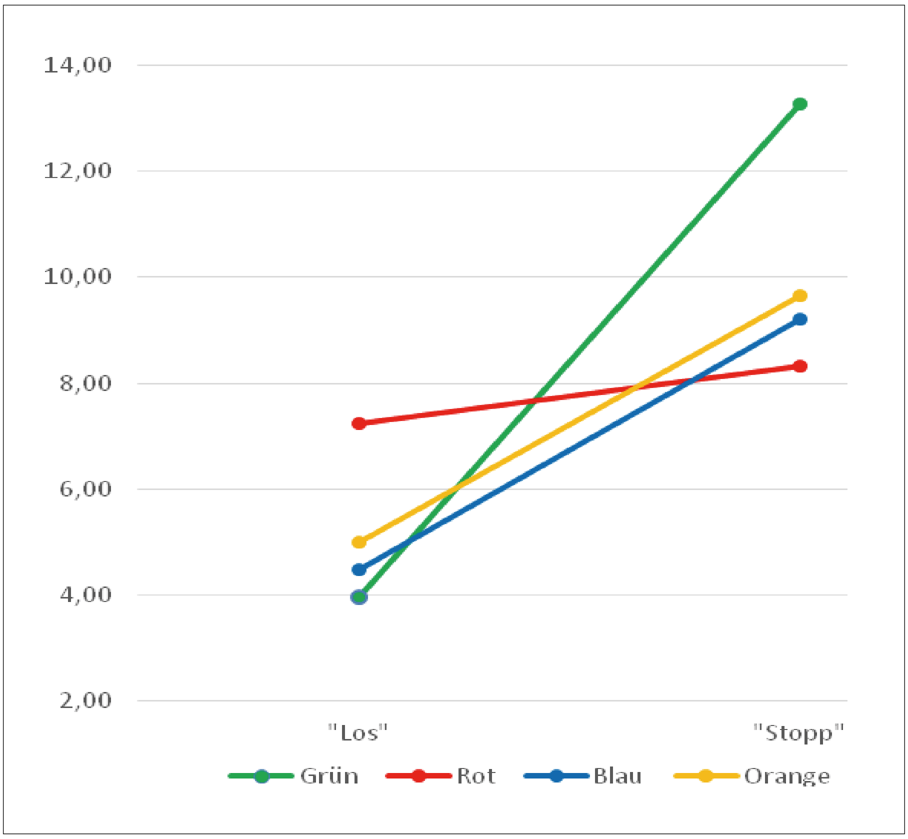

Fig. 2: Mean error rates (%) as a function of colour prime and word target.

D. Discussion

All subjects succeeded in correctly identifying the colours presented in the colour identification task. As a result, no subject needed to be excluded due to colour vision deficiency. The reliabilities of the baseline-adjusted difference scores of the response times were high and the reliabilities of the baseline-adjusted difference scores of the error rates were comparatively low. This could be due to the subjects often reporting unsystematic confusion of the targets "Stop" and "Go". In addition, subjects only made a small number of errors, which may have additionally limited the variance within the determination of the reliability.

Both response time and error rate results provided significant key effects for the target and colour factors. Subjects responded faster to "Los" targets and made fewer errors than on "Stop" targets, which theoretically makes sense because of the stimulatory nature of the "Los" words. The reaction times after the colour green were on average shorter than those after the colour red, thus underlining the stimulatory nature of the colour green. At the same time, most errors were found for the colours green and red, which is contradictive to Elliot et al. (2007). On the other hand, there were no instances of incompatible combinations of orange and blue caused by pre-existing associations.

For "Los" targets, subjects responded faster (confirming hypothesis 1) and made fewer errors (confirming hypothesis 3) if they were previously presented with the colour green than if the colour red had previously been presented (see Chen et al. 2007). This result can be explained in terms of the real-life experiences of the subjects (e.g. in road traffic), where green is understood as a signal for safety and as an invitation to go, whereas red is associated with the perception of danger and a signal to stop (Pravossoudovitch, Cury, Young, & Elliot, 2014). In addition, the response times and error rates for green-prime "Los" words were smaller than those for blue or orange primes, highlighting the importance of colour green as a security signal compared to other colours such as red.

In contrast, respondents did not respond more quickly to "Stop" words if they were previously shown in red than if they had previously been shown the colour green (rejection of hypothesis 2). Possibly, there is only a marginally significant difference between green and red, since the intuitive reactions to the colour red are attenuated and thus slowed down by the slower "Stop" reaction by reflexive processes. Apart from that, the difference in error rates in response to the "Stop" targets became significant: fewer errors occurred after red primes than after green primes (confirming hypothesis 4). These effects could also be due to the strong association of green with security and red and uncertainty (Pravossoudovitch et al., 2014). Again, the meaning of the colour green manifests itself as a security signal against other colours, since the error rates for "Stop" words after green primes turned out to be higher than after blue or orange primes.
A final descriptive look at the colours orange and blue showed that they were quite suitable for measuring the baseline. With regard to the reaction times, orange and blue

showed higher reaction times in the "Stop" condition than in the case of red and in the "Los" condition higher reaction times than in green. With regard to the error rates, higher error rates were found for orange and blue in the "Stop" condition than for red; in the "Los" condition higher error rates were found than for green (confirming hypothesis 5). This reinforces the assumption that orange and blue are associated neither with "Los" nor with "Stop", as might be expected from their use on the road.

Limitations. Based on reaction times and error rates in a sequential priming paradigm, the present study provides strong evidence that the colour red is associated with "Stop" words and the colour green is associated with "Los" words. Only the association of red with "Stop" words on the basis of reaction times became marginally significant, which, however, can be attributed to the sample size. For a larger sample, this effect would probably also have been significant. Another limiting factor is the high level of education in the random sample, although it can be assumed that the associations found also can be found at a lower level of education, as people of all educational levels are on the road and thus able to build up corresponding associations.

E. Conclusion

On the basis of the results of the present study, the suitability of the colour green for a Front Brake Light can be established, since green was associated by the test subjects with words of forward movement and the Front Brake Light is designed to arouse the readiness to act accordingly, i.e. to "go" or to "proceed" (cf. arousal, Mehrabian, 1978). In contrast, words of braking/decelerating are associated with red, whereby a red Front Brake Light would signal other road users to stop. This is the case, for example, with conventional brake lights, where the rear brake light is intended to indicate braking so that the vehicle behind also stops and a rear-end collision is avoided. In conjunction with a Front Brake Light, however, this would be counterproductive. From a psychological point of view, the result of this study is that for a Front Brake Light the colour green should be preferred to other colours such as orange and blue, but especially to the colour red.

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	Publication of the results of the laboratory study "The Potential Safety Effects of a Frontal Brake Light for Motor Vehicles" in IET Intelligent Transport Systems (author as above) http://ietdl.org/t/3GZs6
	Meeting with Dipl.-Ing. Jörg Ahlgrimm, President of the European Association for Accident Research and Accident Analysis (EVU), presenting the idea and supporting advice on how it could be promoted at European level
	Meeting with Dr. med. Wolfram Hell, LMU Munich and President of the GMTTB Society for Medical and Technical Trauma Mechanics e. V., to discuss the benefits of a Front Brake Light in the context of the accident itself
February	Meeting with Dr. Dieter-L. Koch, MEP, for a more detailed definition of the cost / benefit criteria regarding the European Parliament own-initiative report of 14th November 2017 on saving lives: enhancing vehicle safety in the EU (2017/2085 (INI)) including advice on legislative opportunities
	Development and completion of the catalogue of possible application situations of the Front Brake Light in collaboration with Dr. Birgit Kollbach, traffic psychologist and driving instructor at the DEKRA Akademie Berlin, as well as Dr. Bernhard F. Reiter, Consultant for Road Traffic Safety
March	Completion of a brief literature review and empirical study on the psychological effect of the colour green as a targeting signal colour (R. Banse, K. Keidel and M. Monzel, see Appendix D)
	Detailed written opinion on the theoretical consideration of the potential for reducing cervical spinal cord / central nervous system injuries in traffic collisions by a Front Brake Light (W. Hell, see Appendix B)
April	Letter from the Board of BIRVp to EU Commissioner V. Bulc presenting the idea behind the Front Brake Light together with the results of the studies carried out with reference to the own-initiative report of the European Parliament of 14th November 2017 on saving lives: More Vehicle Safety in the EU (2017/2085 (INI)) with a request to consider this issue in the forthco-ming amendment of the General Safety Regulation (EC) No 661/2009
	Meeting with Prof. Kurt Bodewig, former Federal Minister of Transport and President of the German Traffic Watch, to present the idea of a Front Brake Light
May	Publication of the "Field Study for Testing a Front Brake Light”

	Publication of the results of the laboratory study "The Potential Safety Effects of a Frontal Brake Light for Motor Vehicles" in IET Intelligent Transport Systems (author as above) http://ietdl.org/t/3GZs6
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June	Discussion with Dipl.-Ing. Hans Peter David, DEKRA Dresden e. V., amongst others on the further clarification of the possibility of type-approval in the EU context and recommended illuminance levels
	Development of an opinion on the topic "Stress reduction in road traffic" by the introduction of a Front Brake Light (Prof Dr Konrad Reschke, University of Leipzig)
September	Parliamentary working breakfast in Brussels on the topic of the Front Brake Light under the patronage of Dr. Dieter-L. Koch, MEP, with representatives of the EU Parliament and the European Commission as well as from other institutions in traffic safety branch like VOD (Road Accidents Victims Aid Germany) and ETSC (European Transport Safety Council)

The list is detailed enough to make clear which relevant institutions of traffic safety work have already been made familiar with the concept of the Front Brake Light in order to take part in the professional discussion.


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