Traffic accidents and the risks of cycling:
A sociological perspective

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Table of Contents

Abstract

Traffic accidents generate a heavy burden in deaths, bodily harm and monetary costs, and there are growing concerns regarding the unintended consequences of traffic safety policies. Yet, they are marginal in the sociological literature. Drawing on the sociology of knowledge, I explore the construction and spread of truth claims regarding traffic accidents and traffic safety, focusing on accounts of the risks of cycling and specifically the role of bicycle helmets. I use this case to contribute to several sociological debates.

I used a mixed methods approach. I constructed a dataset of 1,902 articles, published 1970-2014, and identified the main themes characterizing different periods using bibliometric and network analysis mapping tools. This was complemented by 19 in-depth interviews; close readings of influential texts; and a qualitative analysis of 665 relevant news stories, published 1970-1995.

In the first chapter I contribute to the sociology of risk by examining if Beck's risk society thesis, criticized for neglecting mundane risks, can be used to account for historical transformations in expert discourse regarding the risks of cycling. Drawing on the mapping of academic debates, I describe the bicycle helmets' journey from the margins to the center of accounts of the risks of cycling, and the growing challenges to their position at the core of national policies. I argue that this process corresponds to the risk society thesis, including the transformation of bicycle helmets from mechanical objects into 'quasi objects'.

In the second chapter I contribute to the sociology of mobilities, in which the development of traffic safety measures, including bicycle helmets, is often attributed to automobility, a car-dominated mobility regime. However, only few studies analyzed how automobility exerted such an influence. Drawing on Actor-Network Theory, I examine how helmet-oriented accounts of the risks of cycling succeeded in expanding their reach in the United States. I demonstrate the constitutive role of non-humans in this process and highlight changes in how participants were represented as well as the different interpretations of the term 'effectiveness'. I describe this expansion as a non-linear, contingent process and argue against the use of automobility as an explanatory factor.

In the third chapter I review sociological studies of traffic accidents and traffic safety, published 1940-2017. Using a systematic search I constructed a dataset of 266 articles that I examined using qualitative text analysis. The results demonstrate that sociological interest in these issues has been marginal and sporadic, but diverse. I discuss the major themes emerging from this literature, including the relations between traffic accidents and suicides, group

differences in risk, human-technology relations, the public marginality of traffic accidents, and their unintended consequences. I then discuss the sociological neglect of traffic accidents and offer venues for further research.

The thesis problematizes the view of traffic accidents and traffic safety as mundane issues, explores the sociological relevance of these issues and suggest heuristic avenues for further research. Potential audiences include sociologists interested in knowledge, mobilities, risk and accidents, traffic safety experts, activists, and policymakers.

Résumé

Les accidents de la circulation génèrent un lourd fardeau en termes de décès, de dommages corporels et de coûts monétaires, et les conséquences involontaires des politiques de sécurité routière suscitent des inquiétudes croissantes. Pourtant, ils sont marginaux dans la littérature sociologique. En m'appuyant sur la sociologie de la connaissance, j'explore la construction et la diffusion des recherches concernant les accidents de la circulation et la sécurité routière, en me concentrant sur les comptes rendus des risques du cyclisme et plus particulièrement sur le rôle des casques. Cette étude de cas contribue à plusieurs débats sociologiques.

J'ai utilisé une approche de méthodes mixtes. J'ai construit une banque de données de 1 902 articles, publiés entre 1970 et 2014, et j'ai identifié les principaux thèmes caractérisant différentes périodes à l'aide d'outils de cartographie bibliométrique et d'analyse des réseaux. Cette démarche a été complétée par 19 entretiens, une analyse détaillée de textes influents et une analyse qualitative de 665 articles pertinents, publiés entre 1970 et 1995.

Dans le premier chapitre, je contribue à la sociologie du risque en examinant si la thèse de Beck sur la société du risque, critiquée pour avoir négligé les risques ordinaires, peut être utilisée pour rendre compte des transformations historiques dans le discours des experts concernant les risques du cyclisme. En m'appuyant sur la cartographie des débats académiques, je décris le parcours des casques, de la marge au centre des comptes rendus sur les risques du cyclisme, et les défis croissants de leur position au cœur des politiques nationales. Je soutiens que ce processus correspond à la thèse de la société du risque, y compris la transformation des casques d'objets mécaniques en "quasi-objets".

Dans le deuxième chapitre, je contribue à la sociologie des mobilités, dans laquelle le développement des mesures de sécurité routière, y compris les casques, est souvent attribué à

l'automobilité, un régime de mobilité dominé par la voiture. Cependant, seules quelques études ont analysé comment l'automobilité a exercé une telle influence. En m'appuyant sur la théorie de l'acteur-réseau, j'examine comment les comptes rendus des risques du cyclisme axés sur le casque ont réussi à étendre leur portée aux États-Unis. Je démontre le rôle constitutif des non-humains dans ce processus et souligne les changements dans la façon dont les participants ont été représentés ainsi que les différentes interprétations du terme "efficacité". Je décris cette expansion comme un processus non linéaire et contingent, et je plaide contre l'utilisation de l'automobilité comme facteur explicatif.

Dans le troisième chapitre, je passe en revue les études sociologiques sur les accidents de la circulation et la sécurité routière publiées entre 1940 et 2017. À l'aide d'une recherche systématique, j'ai construit une banque de données de 266 articles que j'ai examinés en utilisant une analyse textuelle qualitative. Les résultats montrent que l'intérêt sociologique pour ces questions a été marginal et sporadique, mais diversifié. J'aborde les principaux thèmes qui se dégagent de cette littérature, notamment les relations entre les accidents de la circulation et les suicides, les différences de risque entre les groupes, les relations entre l'homme et la technologie, la marginalité publique des accidents de la circulation et leurs conséquences involontaires. Je discute ensuite de la négligence sociologique des accidents de la route et propose des pistes de recherche.

La thèse problématise l’analyse des accidents de la circulation et de la sécurité routière comme des questions ordinaires, explore leur pertinence sociologique et suggère des pistes des recherche plus approfondies. L’audience potentielle comprend les sociologues des connaissances, des mobilités, des risques et des accidents, les experts de la sécurité routière, les activistes et les décideurs politiques.

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Contribution to original knowledge

This is the first study to examine changes in expert accounts of the risks of cycling and to investigate how specific accounts of this peculiar kind of risks spread in the United States.[1] The dissertation demonstrates that the process of re-modernization of risks as defined by Ulrich Beck's risk society thesis can also be applied to mundane risks, specifically to the risks of cycling. The analysis of the bicycle helmets' diffusion in the United States demonstrates that this process cannot be attributed solely to scientific and technological advances or captured by the notion of "automobility". The analysis highlights the role of non-humans in producing and circulating a helmet-oriented account of the risks of cycling.

The dissertation is also the first to systematically review sociological investigations of traffic accidents and traffic safety, demonstrating that the issue is sociologically marginal and fragmented, yet diverse. By highlighting several central themes linking this disparate body of work, the review aims at facilitating sociological debates on the issue. The review, and the database constructed for this purpose, provide a useful starting point for scholars interested in the potential contributions of sociological perspectives to the study of traffic accidents and traffic safety. More broadly, the dissertation contributes to the limited body of sociological work on traffic accidents and traffic safety.

Contribution of the author

The following dissertation was sole authored.

[1] Culver (2018) treats the rise of bicycle helmets in the US as a result of automobility, but didn't examine this historically. I discuss his work in chapter 2.

Introduction

Traffic accidents generate a heavy burden in deaths, bodily harm and monetary costs, and there are growing concerns regarding the unintended consequences of traffic safety policies, in particular with regards to public health. Yet, traffic accidents and traffic safety policies occupy a marginal place in the sociological literature, with a few notable exceptions (e.g. Porterfield 1960; Campbell and Ross 1968; Phillips 1979; Gusfield 1981; Brenner 1987; Beckmann 2004; Wetmore 2004; French and Gumus 2014). This dissertation explores the application of sociological perspectives to traffic accidents and traffic safety, with a focus on the production and spread of expert and lay knowledge regarding the risks of cycling.

Criticized for its neglect of mundane risks, the first chapter examines the relevance of Ulrich Beck's risk society thesis for our understanding of the transformation of public and expert perceptions of the risks of cycling during the last few decades. The second chapter follows the bicycle helmets' rise to prominence in the United States as a countermeasure against cycling risks, and examines whether this process can be attributed to social processes such as automobility (see below for a definition) or to scientific and technological advances. In both chapters I draw on Actor-Network Theory (ANT) to operationalize the research questions. The third chapter consists of an analytical review of how traffic accidents and traffic safety were conceptualized in the sociological literature, including the identification of main themes and the outlining of venues for further research.

In this general introduction, I first discuss the ambiguity of the concept of 'accident', a central theme running through all chapters, and present the case study. I then discuss sociological conceptualizations of knowledge and present central tenets of ANT. Finally, I detail the research questions and present the methods I used to address them.

Accidents in sociology

'Accidents' are a notoriously ambiguous concept (Cooter and Luckin 1997), and have long been marginal as a sociological topic (Green 1997). Green argues that accidents are characterized by

two essential tensions: while they do not involve intent and are therefore, in principle, blameless, blame is often assigned. Moreover, while a single accident is unpredictable, accidents are becoming increasingly predictable at the population level.

Green (1997) and others attribute some of this conceptual ambiguity to the co-existence of different explanations. A first explanation, rooted in 16th century Europe, attributes undesirable, unintentional events causing harm to magic, fate, or divine intervention. A second explanation, linked to the rise of probabilistic thinking, re-conceptualized accidents as a constant random element, impossible to predict at the individual level but predictable at the population level. This logic is at the origin of collective workplace insurance schemes (Ewald 1991). A third explanation is related to the expansion of epidemiology around the mid-20th century and the inclusion of unintended injuries under its scope. From this perspective, accidents were conceptualized as opportunities to learn and as preventable in principle (Douglas and Wildavsky 1982; Green 1997, 1999).

Notably, in spite of periodic attempts to purge the term ‘accident’ from scientific discourse (Loimer and Guarnieri 1996; Davis and Pless 2001), this term remains in regular use among laypersons and experts. For instance, the flagship journal of the traffic safety field is entitled *Accident Analysis and Prevention.* The category of the accident thus remains inherently disputed. The persistence of the earlier explanation in terms of fate or divine intervention may be linked to the inability of more recent explanations to answer what Gusfield calls “Job’s problem”, that is, the tendency of accident victims to ask ‘why me?’(Gusfield 1981:33–34). I chose to use the term ‘accident’ in this dissertation because it was commonly used by the participants in the developments discussed below, both experts and laypersons.

Concerns about cycling injuries have grown in the US and Europe since the late 1960s, giving rise to various policies and safety measures. Bicycle helmets initially played a marginal role in these developments, but by the late 1990s they emerged as the central technology to

address the risks of cycling in several countries, and bicycle helmet laws became common. Today many view bicycle helmets as a matter of common sense, and experts often promote helmet use and helmet laws (Peden et al. 2004; Hagel and Yanchar 2013). Yet other experts question the effectiveness of these measures, arguing that they can discourage cycling, encourage risky behavior, and cause a public health loss (OECD/ITF 2013). Policies vary: some countries and jurisdictions have recently passed helmet laws (Japan, 2008; France, 2017) or increased the scope of existing laws (Spain, 2014) while others relaxed helmet laws (Israel, 2011) or repealed them (Mexico City, 2010; Bosnia Herzegovina, 2017).

The sociology of knowledge and Actor-Network Theory

It is often argued that expert knowledge is in crisis and that expert authority is challenged, yet, paradoxically, reliance on expert knowledge is growing (Beck 1992; Collins and Evans 2008; Eyal 2019). Drawing on Actor-Network Theory, I examine the practical work going into the production of expert claims. I aim to understand how claims emerge and gain influence, rather than adjudicating between truth claims. The logic of this approach was shaped by the analysis of controversies (historical or contemporary) as deployed by the sociology of scientific knowledge.

Sociologists of scientific knowledge have long criticized the view of scientific change as a linear process (Kuhn [1962] 1969) and of science as a distinct, autonomous domain, operating detachedly from other spheres of human activity. Scholars argued that scientific findings are inherently open to interpretation and emphasized the influence of extra-scientific factors in reaching agreement, both at the macro level (e.g. the influence of political ideologies) (Barnes 1977; Shapin and Schaffer 1985) and the micro level (e.g. the influence of shared norms on laboratory practices) (Collins 1985). Several theoretical frameworks carried this logic further: instead of trying to identify how society influences scientific work, they rejected the distinction between science and society and shifted to studying how labels such as ‘scientific’, ‘social’, ‘technical’ and so on are produced in practice (Pickering 1992).

Actor-Network Theory (ANT) developed this approach into a general method for analyzing sociotechnical knowledge and practices. A detailed discussion of ANT's approach and terminology goes beyond current scope (see Latour 1993, 2005). For current purposes, suffice to highlight a few tenets. Claims are produced by sociotechnical actor-networks, which extend across artificial boundaries such as social-technical or micro-macro. This leads ANT to reject the exclusive resort to 'social factors' as the primary explanatory factors, for example Capitalism or, as elaborated below, Automobility.

The scope and composition of actor-networks can be wide and include non-obvious participants. The products of these networks, as well as their human and non-human components, are hybrid entities, in the sense that their articulation requires the performance of a network cutting across the artificial boundaries described above. Per Latour (1993) modern thinking is marked by the ability to ignore this hybridity and instead treat entities as belonging to a specific sphere. For example, claims are purified of subjective uncertainties and are re-presented as objective facts. However, the hybridity of claims becomes evident during controversies or during formative periods. Moreover, Latour (2003) also believes that this hybridity is increasingly evident, in line with the above-mentioned crisis of expertise.

ANT famously highlights the role of non-humans in actor-networks. It does not privilege any type of participant but examines their observable influence on the network's development. This gives rise to accounts highlighting the role of participants such as germs, materials, machines, and standards, alongside more traditional actors. Participants are treated as opportunistic and self-interested, but their interests are determined via their relationships in the network, in a reciprocal process. The network's development generates a re-alignment of interests. Agency is thus distributed through the network and does not 'belong' to a single node (Callon 1986; Akrich et al. 2002).

Following Latour, I approach risks similarly to other claims, as accounts produced by specific sociotechnical networks, and seek to examine their development and spread. This conceptualization allows to operationalize the risk society thesis (chapter 1) and to examine different explanations for the spread of helmets in the US (chapter 2).

ANT highlights the role of usually neglected participants in the development of claims, and more specifically their role in representing and circulating claims. ANT studies dealing with traffic safety often emphasized the role of representations of road users, both implicit and explicit, in shaping policies and perceptions (Beckmann 2004; Wetmore 2004). In addition, studies stressed the non-obvious influence of specific scientific methods (Leonardi 2010; Vardi 2014). For example, Vardi argued that the quantification of traffic accidents facilitated their re-conceptualization as pseudo-natural events.

Accordingly, an additional goal of this dissertation is to follow changes in representations of the risks of cycling and of their different components. Standardization processes, in particular, offer a useful venue to examine such changes, as standards provide a site — a 'trading zone' — for different parties to meet and negotiate the specific ordering of reality to be embedded in the standards (Busch 2011). However, the influence of standards, once created, is not unitary and uniform, as it depends upon their associations with other network components (e.g. Timmermans and Epstein 2010).

Traffic accidents and the sociology of risk

The ambiguity of traffic accidents makes them an interesting subject for a sociology of risk. Accidents both challenge and justify risk technologies, designed to transform accidents into calculable risks (Green 2003). Accidents do play a major role in prominent sociological theories, but these usually focus on novel, large-scale catastrophic accidents (Perrow 1984; Beck 1992; Tierney 2007). For example, Perrow conceptualized accidents as normal events in complex

systems, and argued that as some high-risk accidents such as nuclear malfunctions cannot be accepted, the conditions enabling them should be changed. His analysis, however, paid little attention to mundane accidents.

The risks of cycling are a highly controversial issue, and the helmet question, in particular, has given rise to heated debates (e.g. Curnow 2005; Olivier et al. 2014). The sociocultural theory of risk (Douglas 1994; Douglas and Wildavsky 1982) suggests that this controversy is linked to changes in the power relations between social groups, raising new types of demands on the public agenda. Governmentality scholars treat risk as a governmental technology, shaping individual needs and wants, and examine the relations between risky technologies and macro-scale institutions (Dean 1999; Zinn 2008b). They argue, for instance, that attempts to control all accidents are linked to the privatization of risk and the focus on taking personal protective measures against potential accidents (O'Malley 2008). To put it differently, both governmentality and the sociocultural theory emphasize the social influences on the selection of risks and how they are perceived.

Beck's 'risk society thesis' rejects the objective-subjective distinction itself as an artificial construct. Moreover, it argues that observers increasingly recognize this artificiality. For Beck, the recognition of the non-technical dimensions of risks is part of a fundamental transformation of industrial society, aka 'first modernity', into risk society, aka 'second modernity'. First modernity applied scientific rationality to the reduction of risks, as part of an attempt to increase control over nature and society. However, in second modernity science also generated "modernization risks", which are catastrophic, invisible, and cut across classes and borders (e.g. radioactivity). Such risks require expert mediation for public understanding, but their rise is accompanied by a growing erosion in expert authority, expressed among other ways in the abovementioned growing recognition of the non-technical dimensions of risks (Beck 1992; Beck and Lau 2005). This leads individuals to internalize the responsibility for managing risks

but also encourages critical reflections regarding the need for broader systemic changes (Mythen 2004).

The risk society thesis has been criticized for its focus on a universal subject, defined by society's exposure to global risks, while neglecting the influence of local circumstances, including mundane risks, which can be more substantial from an individual's perspective (Tulloch and Lupton 2003; Green 2009). Traffic accidents in particular are less likely to fit into the rubric of modernization risks (Green 2003): they are individual rather than general, considered to be voluntary, do not seem to require expert mediation, can be compensated for by insurance (Zinn 2008a:24), and are often seen as a normal, inevitable component of modern life (Böhm et al. 2006). However, this critique treats mundane risks as static, and does not consider the possibility that their dynamics may also correspond to Beck's thesis, i.e. their transformation into a second modernity risk.

Accordingly, I draw on Latour (2003) to operationalize the risk society thesis. I examine changes in expert debates regarding the risks of cycling, as expressed in academic publications. I draw on scientometric mapping tools to produce visual representations of academic debates over several periods. These maps, complemented by interviews and close readings of influential texts, allow me to examine changes in representations of the risks of cycling, and whether these changes correspond to the process of re-modernization.

More specifically, I investigate whether the objects populating early accounts of the risks of cycling are replaced by quasi-objects, characterized by uncertainty and disputes. This is examined with regards to bicycle helmets but also with regards to other participants, e.g. the image of the typical cyclist or the typical accident. I also analyze whether these changes generate constructive criticism and calls for major changes in sociotechnical arrangements, or lead to apathy and despair with current arrangements.

Traffic accidents and the mobilities literature

Sociological interest in mobilities has grown over the last two decades (Faulconbridge and Hui 2016; Sheller 2017). The role of traffic accidents and traffic safety in this literature is often understood via the lens of the automobility concept. Urry (2004) suggests that the 'system' of automobility spreads around the globe like a virus, re-shaping societies it comes in contact with in its image. The car shapes economic and material environments as well notions of citizenship and the "good life", and engenders new identities such as the car-driver (Dant 2004; Featherstone, Thrift, and Urry 2005; see also Gorz 1973; Freund and Martin 1993).

Urry's formulation is controversial (e.g. Böhm et al. 2006; Manderscheid 2014), but in all variants I found traffic safety was conceptualized as subordinated to automobility, i.e. defined in ways that would support this concept. The mechanisms involved include for example the individualization of accidents, assigning responsibility to individual road users, often described as 'bad apples', and the normalization of accidents, presenting them as an unavoidable price of progress. Both these mechanisms divert attention from the structural causes of traffic accidents.

The concept of automobility is instructive as an analytical framework, as also suggested by Urry (2004), but its contribution as an explanatory factor is ambiguous. As previously discussed, ANT is critical of using such broad concepts as explanatory factors, arguing that resort to these concepts neglects much of the work invested in producing claims in practice. Accordingly, drawing on ANT the second chapter examines the rise of the bicycle helmets in the US. While, as just mentioned, this process has been attributed to the influence of automobility (e.g. Furness 2010; Culver 2018) as well as to scientific and technical progress (Centers for Disease Control and Prevention 1995), I re-assemble the network producing helmet-oriented accounts of the risks of cycling in the US without privileging any a priori mechanism or generic explanatory notions.

Debates about the risks of cycling usually involve several prominent national models, for example those developed in the Netherlands or Denmark. The US experience is particularly interesting with regards to the history of bicycle helmets, partly due to its observable influence

on other countries: US-based studies provide an important model to study helmet effectiveness and US helmet safety advocacy campaigns were adopted in other countries. I focus on the formative period of helmet-oriented accounts of the risks of cycling in the US, beginning in 1970, when bicycle helmets were a rarity, and 1995, when helmet laws became common and work on a federal bicycle helmet standard was underway. I follow this network using scientific publications, the mass media, interviews and publications by some of the parties involved.

My analysis highlights the role of non-humans in the network's spread. For example, I argue that the deployment of a new surveillance system in US hospitals transformed disparate cases of bicycle accidents into a national problem; that cycling manuals played an important role in naturalising the use of helmets among club cyclists in the US; and that the prominence of a certain study, conducted in Seattle and published in 1989, is the result of its links with other participants in the network. I also discuss different ways of measuring the effectiveness of bicycle helmets and the composition of the account associated with each type of measurement, including the number and stability of the participants involved.

A review of the sociological literature on traffic accidents and traffic safety

The marginality of traffic accidents has always struck me as peculiar. Throughout my research, I encountered repeated examples of similar critiques, stressing the abovementioned consequences and scope of traffic accidents and the fact that these issues are amenable to sociological investigations. Scholars frequently used the social patterning of accidents (by gender, class, race, age, etc.) as an example for the non-random nature of these events and of the influence of social factors (Ross 1940; Francis 1960; Stinchcombe 1975; Brooks 1982; Rothe 1994; Ross 1984). I was interested in whether and how this issue was studied sociologically over the years in the margins of the field.

In the third chapter, I present the results of a comprehensive analytical review of sociological investigations of traffic accidents and traffic safety, 1940-2017. I examine the

development of this body of work, separated into two partly overlapping sections: studies focused on the social or sociotechnical conditions causing traffic accidents, and studies focused on the formation of policies and perceptions regarding traffic accidents and traffic safety measures.

The review is aimed at identifying potential sociological contributions and perspectives on these issues, thus helping to identify possible research questions and grounding them in previous literature. I also use this review to further explore the conceptualization of traffic accidents in terms of Beck's risk society thesis.

Methods

My investigation is based on a mixed methods approach. For the first chapter, I searched academic databases (in particular, the Web of Science) to construct a dataset of 1,902 articles published between 1970 and 2014. I analyzed this dataset using scientometric mapping tools, namely the CorText software platform (https://www.cortext.net/) specifically designed for the analysis of heterogenous networks. This allowed me to visualize historical shifts in the identify of central authors and themes prevalent in this body of work and the relations between them. This was complemented by 9 half-structured, in-depth interviews with researchers and safety advocates as well as close readings of central texts. Key publications included scientific articles and documents by governmental agencies, for example guidelines and factsheets. I also made use of several reviews of the field.

The second chapter makes use of previously collected materials, additional interviews and 665 relevant publications in the mass media, published between 1970 and 1995, identified using the Lexis-Nexis platform. The third chapter relies on the results of a comprehensive search in academic databases (Web of Science, Scopus and JSTOR), giving rise to a dataset of 266 relevant sociological articles.

The audiences for the dissertation include sociologists interested in mundane risks and accidents, and specifically those interested in traffic accidents and traffic safety, as well as experts from other disciplines interested in the potential contributions of sociological perspectives to the subject matter. Additional audiences include policymakers and activists interested in the bicycle helmet controversy.

The first and second chapters were published as single-authored, peer-reviewed articles in the journals *Health, Risk & Society* (Blank-Gomel 2017) and *Mobilities* (Blank-Gomel 2019).

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Chapter 1. Cycling Injuries and the Re-Modernisation of Mundane Risks: From Injury Prevention to a Population Health and Environmental Problem

Abstract

Commentators drawing on the concept of Risk Society, have argued that the proliferation of large-scale risks generates critical reflection on the modernistic logic and drives current societal changes. Critics have argued that this thesis neglects the centrality of mundane risks in shaping contemporary identities. However, such critics have not considered the dynamics of mundane risks and the possibility that these dynamics follow the predictions made by Risk Society theorists. In this article, I examine this issue using the recent history of cycling risk, focusing on expert knowledge in the Global North between 1970 and 2014. I draw on Actor-Network Theory to operationalise Risk Society, conceptualising accounts of cycling risk as the products of a dynamic network. I examine this network using scientometric analyses of scientific papers, analyses of influential texts and in-depth interviews with experts and activists. I argue that the dynamics of this network follow the predictions of Risk Society: bicycle helmets emerged as a technological fix for a specific risk, but are now described as the source of new risks to health and safety, due to their potential interactions with human psychologies and social behaviours, for example their potential to discourage cycling. This encourages reflexivity on the conditions producing such risks, namely, the modernistic logic. Thus, mundane risks are both re-modernised and remain central to shaping identities and concerns. More specifically, the interaction between mundane risks and holistic conceptualisations of health is shown to contribute to the shift from first to second modernity.

Introduction

In this article, I examine whether the transformation of mundane risks follows the predictions of Risk Society theorists, particularly the argument that risks are undergoing re-modernisation, that is, their externalities, ambiguities and complexities are becoming visible and

the uncertainty around them grows (U. Beck, Bonss, & Lau, 2003). A positive answer would support the use of the Risk Society framework, albeit with modifications to account for mundane risks. Scholars have suggested using Actor-Network Theory (ANT) to operationalise Risk Society (Latour, 2003; G. Beck & Kropp, 2011). I draw on Actor-Network Theory to examine the dynamics of a specific mundane risk, cycling risk, conceptualising it as the product of a dynamic, heterogenous network. I then examine whether changes in this network correspond to the re-modernisation thesis.

Risk Society and Cycling

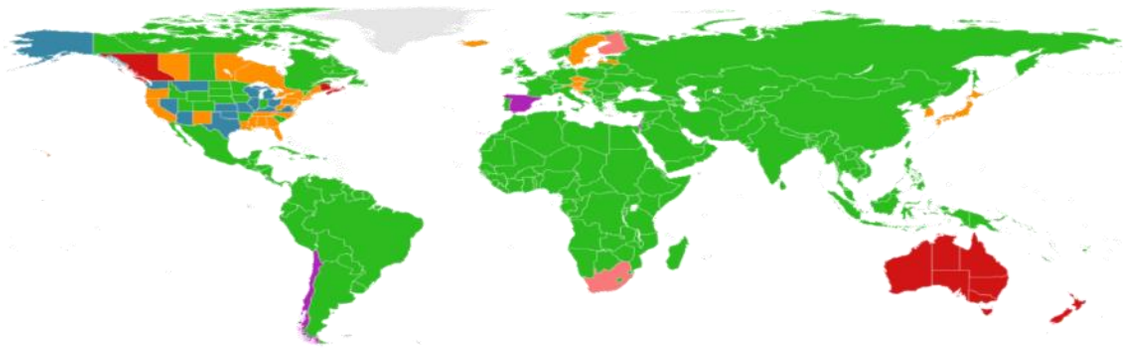
A central critique of Beck's Risk Society has revolved around the theory's disregard of mundane risks. Beck argued that individuals are collectively individualised by exposure to increasingly global risks, causing them to share anxieties and critically reflect on the conditions producing such risks, that is, on the modernistic logic and modernistic social and political institutions (U. Beck, 1992, 2009). Cultural theorists have demonstrated that individuals are not necessarily more anxious and that much of their concerns are about mundane, rather than global, risks (Tulloch & Lupton, 2003; see also Woolgar & Neyland, 2013). This challenges Beck's thesis, particularly the break between first and second modernity. Yet, this critique treats mundane risks as static and does not consider the potential of Risk Society theory to explain their dynamics.

The risks and health benefits of cycling: background. Concerns about cycling injuries were voiced in the late 19th and early 20th centuries (Bijker, 1995) but became marginal with the rise of the car. The issue re-emerged with a renewed interest in cycling in Europe and North America during the 1970s (Epperson, 2014), and was approached as a problem of injury prevention: the goal was to prevent or mitigate the injuries to cyclists (Waller, 1971b; Craft, Shaw, & Cartlidge, 1973; Guichon & Myles, 1975). Initially, bicycle helmets did not play a major role in mitigating cycling risk. Devices resembling contemporary helmets have been available on the market since

the early 1970s, but their uptake has been slow and limited until the spread of helmet laws during the early 1990s.

As figure 1 demonstrates, by 2010 helmet laws have spread across the English-speaking world and made inroads into Europe and the Middle East. Bicycle helmets and helmet laws were promoted by the World Health Organization (Peden et al., 2004, p. 136) and for many they were matter of common sense. Counter-intuitively, this spread did not correspond with the mandating of helmets in high-profile cycling competitions. For example, the *Union Cycliste Internationale*, the world governing body for the sports of cycling, which organises among other things the Tour De France, only made helmets mandatory in 2003 (Lippi & Mattiuzzi, 2004).

Figure 1: Helmet laws around the globe, 2010 (Source: Helmetfreedom.org)



Mandatory state-wide Mandatory but no fines apply Partial rules apply Children only

Some local laws apply No legal restrictions

Since the early 2000s, cycling has been increasingly championed as a healthy, energy efficient, non-polluting, cheap alternative to motorised transport (Mapes, 2009; Buehler & Pucher, 2012). Bicycle use in Europe and North America has risen, supported by the spread of hundreds of bike-share programmes (Fishman, Washington, Haworth, & Watson, 2015). However, injury prevention experts are alarmed, arguing that cycling is riskier than other modes of transport and that its promotion must include the promotion of helmet laws (Hagel & Yanchar, 2013). However, others have attacked helmet laws on both libertarian and utilitarian grounds, suggesting that helmet laws or helmet promotion discourage cycling, leading to a decline in physical fitness and increased air pollution. A 2013 OECD report warned that those who continue to cycle after helmet laws are passed may be at a higher risk because drivers are less

likely to expect them (a reverse 'safety in numbers' effect), and that helmet laws may cause risk compensation, a phenomenon in which individuals change their behaviour to compensate for added safety (OECD/ITF, 2013). These arguments are bitterly disputed (e.g. Olivier et al. 2014). In practice, policies vary: some countries and jurisdictions have recently passed helmet laws (for example Japan 2008; France, 2017) while others relaxed helmet laws (for example Israel, 2011) or repealed them (for example Mexico City, 2010; Bosnia Herzegovina, 2017).

Risk Society, re-modernisation and mundane risks. Beck suggested that those living in high income countries in the global north are in the midst of a major societal transformation. The dominant logic of industrial society, or 'first modernity', relied on the use of scientific methods by experts to de-politicise questions about how societies should be governed. The transformation of disparate dangers into quantifiable risks was central to the attempts to predict and govern the future.

In second modernity, or 'risk society', risks are undergoing re-modernisation. The modernistic attempts to address risks using technological fixes have become the source of 'modernisation risks', which transgress political and class boundaries. Exposure to them is collective and involuntary, so one cannot choose whether to take such risks. Modernisation risks have large-scale consequences, yet their effects are often invisible and the lay public requires expert mediation to grasp them. At the same time, the proliferation of risks undermines expert authority, making it difficult to assign responsibility for risks and undermining the authority of governments relying on expert knowledge (U. Beck, 1992). Table 1 summarises central differences between first and second modernity risks.

Table 1: Risks in first and second modernity

	First Modernity	**Second (late) Modernity**
What are risks?	Calculable probabilities of encountering particular dangers and the magnitude of associated harms	Risks are transformed into uncertainties due to the entanglement of political and technical dimensions of risks
Who defines risks?	Experts utilize scientific rationality to define and manage risks	Risks require expert mediation to be understood, but the crisis of expert authority generates calls for more public involvement

The role of experts	Guardians of the public good	Expert are necessary to deal with risks, but they may be biased and are not able to understand and control risks
Are risks voluntary?	Exposure to risks depends on individual decisions	Exposure to risks is collective and cannot be avoided
The outcomes of risk managements	Reducing the risks	The creation of new uncertainties and of reflexivity, that is, fast-paced critical reflection

Table 1 demonstrates that the meaning of 'risk' and its relations to 'uncertainty' changes between first and second modernity. In first modernity, risks are attempts to manage uncertainty through quantification. Paradoxically, in Risk Society risks are transformed into uncertainties. Attempts to mitigate uncertainty continue, but the belief that issues can be fully represented through quantification is undermined or abandoned. Modernisation risks do not represent closed matrices with clear borders and a limited number of stable participants. Rather, uncertainties and ambiguities become an inseparable part of modernisation risks and their definition itself becomes a stake. In this situation of organised irresponsibility, individuals are left alone to deal with increasingly global risks. This generates widespread anxiety but also facilitates reflexivity, that is, fast-paced critical reflection, on the conditions producing such risks (U. Beck, 1992; U. Beck et al., 2003).

A central critique of the Risk Society focusses on its treatment of mundane risks. Risk Society scholars have focussed on large-scale risks. However, researchers have found that individuals have not necessarily become more concerned about such risks and seem to remain focussed on local, mundane, rather than novel, global risks (Mythen, 2004; Tulloch & Lupton, 2003; Green, 2009; see also Woolgar & Neyland, 2013). Such findings tend to undermine Beck's assumption about the ways in which the move from first and second modernity has undermined individuals' experiences of risk. In his later work, Beck changed his position, arguing that the move from first to second modernity was ongoing and the two logics coexisted in diverse configurations (U. Beck & Lau, 2005). Critics of Beck's analyses have tended to treat mundane risks as static and as inherently tied to a first modernity logic. However, I will argue that such

conceptualisations are contingent and that mundane risks can in the process of re-modernisation transform into uncertainties in the same way as global risks.

Analysing the re-modernisation of risks using insights from Actor-Network Theory. Scholars have argued that Actor-Network Theory can be used to test Risk Society (Latour, 2003; G. Beck & Kropp, 2011). Actor-Network Theory is one of several relationist approaches developed within the sociology of knowledge since the late 1970s. These approaches broke with social constructivism by focusing on how knowledge is produced in practice, stressing the role of non-humans (Pickering, 1992), for example tools, materials, germs and methods. Actor-Network Theory conceptualises knowledge claims as produced by, or performed through, the coordination of a sociotechnical network between humans and non-humans (Latour, 2005).

Actor-Network Theory does not conform to Beck's narrative of societal transformation, but both approaches treat modernistic dichotomies such as nature/society or objective/subjective as artificial constructs. The allocation of claims and objects to one side of such dichotomies is an achievement, rather than inherent; claims and objects are *hybrids*, the result of continuous coordination between entities across such dichotomies (Latour, 1987, 2005).

The artificiality of the object/subject distinction is central to Beck's rejection of the classical distinction made in the sociology of risk between dangers as objective harms and risks as the subjective constructs through which such phenomena are selected, generating two different realms of investigation (Douglas & Wildavsky, 1982). For Beck, risks are both objective and subjective. This complexity is present in every stage of their production; from perception and recording to aggregation, statistical analysis and communication, alternative interpretations are and always have been possible. Re-modernisation is bringing this ambiguity, or the hybrid nature of risks, into light. The objects produced in first modernity are replaced by 'quasi objects', whose effects are inherently disputed. Disputes can revolve around the reliability of media outlets, specific experts, forms of expertise and methods, and so on. This approach has

been criticised as vague and difficult to translate it into a feasible research program (Mythen, 2004; Green, 2009).

Following Latour, risks can be conceptualised as the products of sociotechnical networks organised around efforts to understand and control hazards. This is a pragmatic approach; it does not commit to an ideal typical definition of risk but focusses on the processes through which risks gain or lose influence, that is, the expansion (or disintegration) of the network. A risk is only as influential as people or things are influenced by it, or, to put differently, when they become part of the network performing it. At the same time, the enrollment of new participants can change the network's product, as this product is defined by the relationships between the participants.

This approach assumes that risk selection and framing are influenced by social divisions and positioning, and therefore resonate with cultural theory approaches to risk (Douglas & Wildavsky, 1982). However, unlike cultural theory it stresses the role of non-humans in shaping risks, assuming that they can influence the debate in unforeseen ways diverging from the intentions involved in their creation (Latour, 2003; see also Cambrosio, Limoges, & Hoffman, 1992).

This approach is neutral with regards to the view of risk as an aspect of reflexive modernisation, as suggested by Risk Society scholars. Yet, it facilitates an examination of whether the dynamics of a particular case correspond with the re-modernisation thesis. In first modernity, risks are constructed through the purification of different entities of their hybridity and their linkage in networks producing generalisable claims. We would expect to see the knowledge claim as the product of a closed matrix, with a limited number of well-bounded participants acting within well-defined borders. The transformation of risks into uncertainties is the opposite process.

To identify re-modernisation, we should demonstrate, first, that this transformation stems from modernistic attempts to mitigate risks (U. Beck, 1992). Latour suggests several indicators

for assessing whether re-modernisation has or is occurring. Here I focus on three indicators applicable to a specific risk: risks are re-presented with their uncertainties and unwanted consequences; boundary-making work is becoming more visible and therefore de-naturalised; and the rise of quasi-objects leads to changes in how subjects perceive themselves. Importantly, these changes must demonstrate a constructive critical reflection on the conditions producing risks, rather than showing how this reflection leads to desperation and apathy alone (Latour, 2003).

Traffic accidents as modernisation risks. Risk Society has little to say about traffic accidents, which supposedly follow a voluntary activity, occur on an individual basis and can be compensated for. Hence, they do not fit the rubric of modernisation risks and are sometimes used as an example for a first modernity risk (Mythen, 2004, p. 22; Zinn, 2008, p. 24). However, I would argue that each of these categorisations of road traffic accidents can be challenged.

Driving, for the most part, is not voluntary. Trips are usually work-related and current socio-spatial arrangements assume the use of a car (Urry, 2004). Moreover, pedestrians and cyclists are also exposed to traffic accidents, and with less protection compared to car occupants (WHO, 2015); thus, that exposure is collective and unavoidable. While the harms of each accident are individual, but their aggregated harms are substantial. The World Health Organization estimated their annual death toll at 1.25 million, ranked as the eighth global cause of death (WHO, 2015).

The allocation of responsibility for traffic accidents is contingent. Norton has shown that early public reactions to traffic-related deaths have assigned responsibility to drivers, the manufacturers, and the new technology as a whole (Norton, 2008). With some exceptions (Nader, 1972), this approach was marginalised over the following decades by a new orthodoxy assigning responsibility to individual road users (Wetmore, 2004; Eastman, 1984). Recent years have seen the rise of an alternative approach, which assigns a larger portion of responsibility to the state, transportation planners, and the roads. Yet, the allocation of responsibility in this

framework remains disputed (McAndrews, 2013).

Thus, traffic accidents can be seen as a modernisation risk: exposure is mostly collective and involuntary, responsibility is debated, and the harm is both widespread and significant.

To summarise, in this article I aim to examine whether the dynamics of an exemplary first modernity mundane risk over the last 40 years can be interpreted within and support the re-modernisation thesis, and to highlight the complex relations between risk and an increasingly holistic view of health.

Methods

In this article, I aimed to examine whether mundane risk undergo re-modernisation. Given the centrality of experts in producing risks in both first and second modernity, I assumed that re-modernisation would be evident in expert discourse over the issue and constructed a corpus of scientific articles that examine the risks and health impacts of cycling. This analysis is focussed on how the risk is conceptualised within the scientific community in the global north, and cannot replace analyses of developments in specific countries.

I constructed the dataset by searching for ‘bicycle’ + ‘risk’ or ‘bicycle’ + ‘health’ as topics in the ISI Core Web of Science, retrieving 1,902 articles on December 23, 2014. These keywords were chosen due to their prominence in reviews of the debate (Goldacre & Spiegelhalter, 2013; Bateman-House, 2014) and were verified using interviews with participants in the debate. I used the ISI website because it hosts a greater variety of journals than other search engines, for example PubMed. I analysed this corpus using the *CorText* platform, which can be used to generate 'maps', graphical representations of the relations between different entities across the dataset. These maps can be divided into periods, enabling the identification of changes in the role of participants through changes in their relational positioning over time (Rule, Cointet, & Bearman, 2015).

The maps I use in this article provide a visual representation of the relationships between the

most highly cited authors and the most common terms. Cited authors refer to the authors most commonly cited in the papers' bibliographies. I used CorText to extract terms from the papers' abstracts and titles. The platform's algorithm does this mechanically by searching for the most common strings. This approach allowed me to identify non-human actors without a pre-conceived bias (for example, deciding that 'helmet' should be a key term). This corresponds with my assumption that non-humans can influence the debates in different and unexpected ways.

I manually removed non-relevant strings such as 'the aim of…' and grouped together essentially similar entities, for example 'Fred Rivara' and 'F. P. Rivara'. The platform automatically establishes links between entities through their co-occurrence in a publication. When several entities appeared together frequently they formed clusters corresponding to specific topics or subdomains. The proximity of two nodes represents the overall set of relationships of that node and the other nodes to which it is linked within the dataset. Larger nodes indicate that entities appeared together more frequently, and colours are assigned mechanically. The periodisation was set to 8-year periods, a compromise between granularity and parsimony: longer periods would make it difficult to identify the dynamics, while shorter periods would allow to identify more nuances but at the cost of creating more maps. I examined shorter periods (4 years) and did not identify significant differences (maps available upon request).

Drawing on the maps, I identified key nodes in the debate's historical development using two overlapping criteria: size, indicating the prevalence of these nodes, and position, which can be either central or serve as a link between otherwise separate clusters. I then identified influential texts by examining which publications underlined the appearance of key nodes in the maps.

I treated influential texts as narratives regarding cycling risk, representative of the debates occurring within specific clusters on the maps. I also conducted 9 in-depth interviews with prominent five advocate-researchers and four activists, including pro-helmet and anti-helmet advocates. I used these interviews to verity the maps' validity and to acquire multiple narratives

regarding the development of the field. Interviews averaged about 1.5 hours.

However, the analysis of corpora of scientific papers was subject to the biases inherent in the instruments used to acquire and analyse the data (Marres, 2015). For example, key journals may not be indexed in the ISI platform, and CorText only identifies first authors when using ISI corpora. Such biases threatened to distort the maps. I mitigated such biases using scholarly reviews to identify potential participants missing from my analysis. This proved to be more relevant to the earliest period of the investigation.

Limitations

The data I use in this article have several limitations. My focus on publications by experts and on expert discourse means that I neglect other influences, for example changes in rules regarding helmet use in competitive cycling. However, such changes actually appeared in expert debates and are evident in the interview data. My focus on helmets means that I may have missed other sources of cycling risk, such as cycle design. However, this focus developed from my review of the literature and was the dominant theme in it. I derived the data for this study from expert debates over cycling risk in the global north, and my focus on English-written texts may downplay other potential influences. Finally, Brown argues that Actor-Network analyses of risk are limited to social relations, failing to grasp the emergent novelty and uncertainties following the interactions between humans, technology and nature (Brown, 2013; see also Harman, 2009). I addressed this issue by using a method sensitised to the influence of non-humans.

Findings

1970-1997: Constructing an injury prevention-oriented account of cycling risk

In this section I examine the ways scientific reports between 1970 and the early 2000s constructed the risks of cycling in the Global North.

In the first part of this period, cycling risk does not appear to be a major focus of scientific research and I could only identify 6 papers published between 1970 and 1989 (less than

0.5% of the sample). I consider these papers as well as sources commonly used in later publications to describe historical milestones in the debate's development.

During the 1970s, expert discourse on cycling risk was produced mainly in the US, Canada and the UK. It touched on various issues, including different kinds of cyclists, accidents, injuries and potential remedies. Experts sometimes suggested helmets, but this was low on their agenda compared to bicycle design or the content of bicycle marketing, e.g. commercials. In addition, there was no consensus about what a 'helmet' was. This is evident in the efforts by the helmet industry in the US, most notably Bell Sports (later Bell Helmets), to use advertisements to create a distinction between 'helmets' and 'hairnets' made of crisscrossing strips of leather (for historical examples, see Bagnall, 1990).[2] Yet, the experts failed to transform disparate anecdotal evidence and series of consecutive injuries into generalisable claims (Waller, 1971a; Craft, Shaw, & Cartlidge, 1972; Craft et al., 1973; Guichon & Myles, 1975). Even a large-scale hospital survey was questioned: as the denominator- the number of cyclists – was unknown, interpretation of accident figures was impossible (Flora Jr, 1978).

However, over time the expert discourse on cycling risk was shaped by research in the US and Australia, that highlighted the head and brain injuries associated with cycling accidents and advocated a technological fix to mitigate the risk: the bicycle helmet. This was sometimes justified as addressing the most serious injuries. In addition, experts noted that the social acceptability of helmets was rising, especially among members of bicycle clubs, usually men (Kaplan, 1975). Long-time club cyclists stressed that the spread of helmets among club cyclists was not due to scientific evidence but due to anecdotal evidence in the form of personal stories swapped between cyclists in large-scale shared rides, bringing together different clubs. By the early 1980s, helmets became an integral part of the club cycling culture in the US, and were often compulsory for cyclists who wanted to participate in club activities (Swart, Interview;

[2] A 'hairnet'-style helmet consists of an interlace of leather strips. Models often including padding. Variants of hairnets have been used for several decades (Bagnall 1990; Swart 2017b).

Clarke, interview; Forester, Interview). The prominence of bicycle helmets among club cyclists supported the growth of the US helmet market and justified the efforts to develop a helmet standard. More broadly, it supported the identification of helmets as a part of the gear usually used by an adult cyclist.

In the 1980s researchers focussed on the continuing resistance to helmet use among children (Weiss, 1986). Using interviews and surveys, they found that children experienced helmets as hot, heavy, and unfashionable and that parents often did not see the merit of using a helmet or preferred to avoid conflict with the child; even doctors showed little willingness to support the new measure (Weiss & Duncan, 1986; Ciastko, 1987; Weiss, 1987). Some researchers called for legislation, but this raised concerns about a possible libertarian backlash. Those promoting cycle safety in the form of cycle helmets needed scientific evidence to justify helmets and helmet laws, but this was difficult to achieve. While researchers could test helmets in labs, they found it difficult to test their effectiveness in real world conditions. Researchers could not conduct randomised controlled trials because of ethical issues, and the rarity of bicycle accidents and helmet use, coupled with the lack of clarity over what constituted a helmet, meant that gathering enough data for statistical representation in a cohort study required immense resources (Rivara, interview). As a result, researchers tended to use informed judgement to advocate helmet use based on the consensus view that helmet use mitigated the cycling risk (for example, Wasserman, Waller, Monty, Emery, & Robinson, 1988).

In 1989 a team of researchers in Seattle in the USA published a paper in the highly influential *New England Journal of Medicine* (R. S. Thompson, Rivara, & Thompson, 1989). As I will show this article and subsequent publication by this research team had a major impact on the research community from 1989 until 1997.

The impact of the Seattle team can be partially attributed to production of ‘solid data’ that demonstrated the benefits of cycle helmets. The team could research the benefits of helmets as the US helmet industry had largely accepted a voluntary standard, published by the American

National Standards Institute (ANSI, a private non-profit organization) in 1984, which focussed on preventing a catastrophic accident. This enabled the Seattle team to identify a general 'bicycle helmet'. Furthermore, Seattle provided a natural experiment. In the mid-1980s the use of helmets was negligible, but the Seattle team led a helmet promotion campaign which led to a 10% rise in helmet use among the youth (DiGuiseppi, Rivara, Koepsell, & Polissar, 1989), enabling them to examine data on helmet use and injuries.

The Seattle team addressed the rarity of cyclists' injuries by using a novel research design; a retrospective case-control design. For 1 year, the researchers interviewed cyclists admitted into five Seattle hospitals, comparing head injuries (case group) to other injuries (the control group). They assessed the benefits of wearing helmets by measuring the association between the use of helmets and the incidence of head and non-head injuries, taking the form on an odds ratio. The results were 0.25 and 0.16 for head and brain injuries, respectively. The researchers than used these ratios as relative risks, a common practice in epidemiological studies when diseases are rare (Rivara, interview). After controlling for covariates, the researchers interpreted these ratios as suggesting that helmets are associated (respectively) with an 85% and 88% reduction in the risk of a head and brain injury for helmet users. To put differently, the researchers compared the effectiveness of helmets in reducing the likelihood of head injuries to its effectiveness in reducing the likelihood of other injuries, given that a cyclist experienced a crash (R. S. Thompson et al., 1989). The research and the publications based on it is focussed on the mechanical effectiveness of the standard helmet, that is, its performance as an object, independent of human subjectivity.

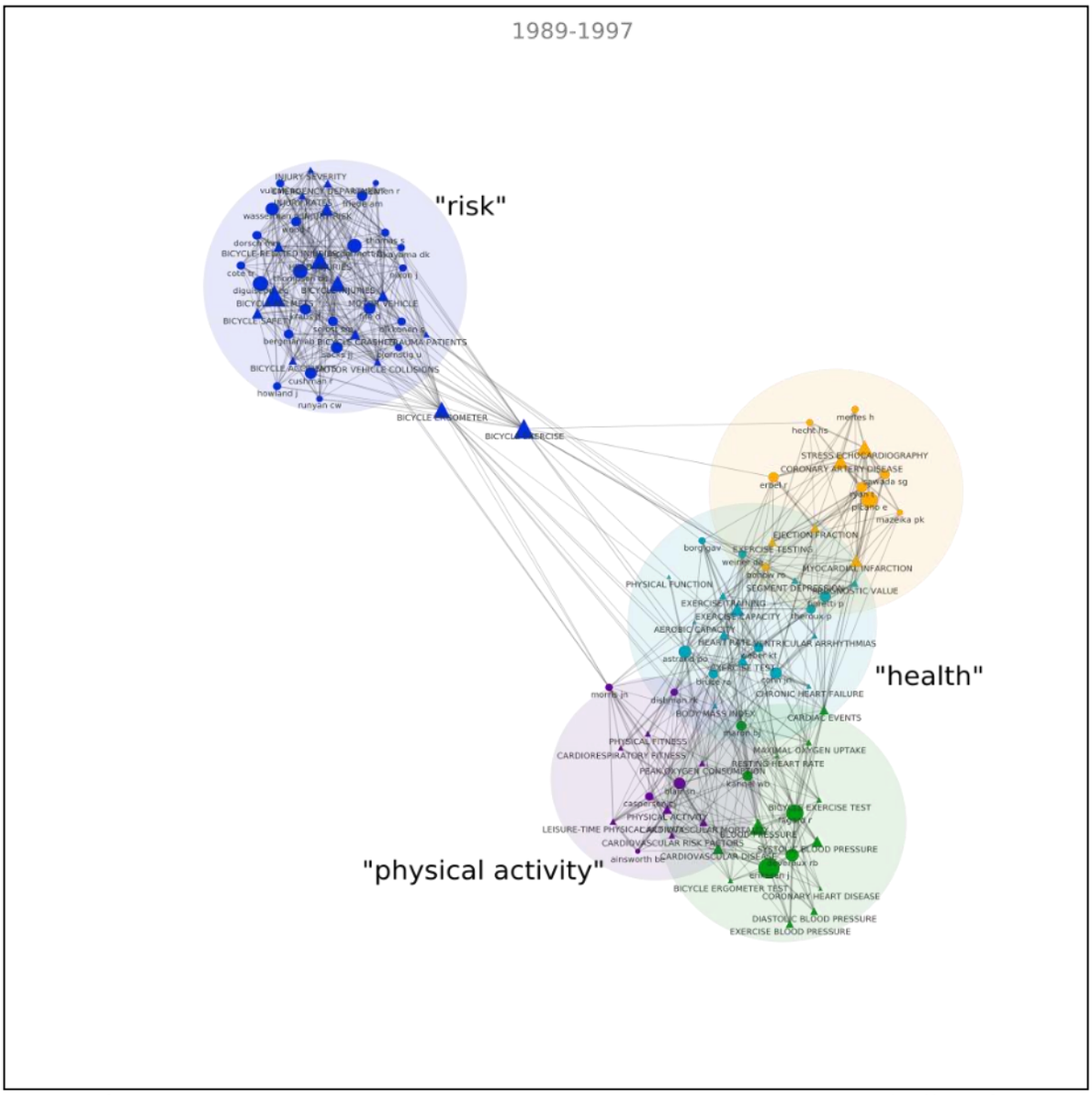
While the retrospective case-control design was considered inferior to the 'gold standard' of medical research, randomised control trials, or to cohort studies, researchers argued that this design provided robust data that demonstrated the effectiveness of helmets (Rivara, interview).

The findings from the Seattle team were rapidly accepted by researchers, politicians and activists. This included the team's headline figures for the relative reduction of the probability of

head or brain injury associated with wearing a cycling helmet of 85% and 88%, respectively. The findings were attractive because they could transform cycling accidents from random, individual events with varying causes and outcomes into categorised events, accidents with or without cycle helmets with predictable outcomes. The impact of the Seattle team's publications between 1989 and 1997 can be demonstrated by a graphical presentation of publications over this period.

Figure 2 provides a 'map' of the publications categorised according to the main theme. The cluster in the upper left corner (blue in the on-line version of this article) represents publications that focus on injury prevention. It is dominated by researchers (circles) associated with the Seattle team (*Thompson dc* and *diguiseppi cg*). It includes other researchers who published before the Seattle team's initial 1989 article, identifying the characteristics of bicycle accidents *(Kraus, Fife, Selbst, Friede*) and evaluating the effectiveness of helmets (*Wasserman, Mcdermott*). The main terms populating this cluster (triangles) indicate its core topic of interests: 'bicycle injuries', 'head injuries', 'injury risk and 'bicycle helmets'. On the lower right corner of Figure 2, there are four health clusters, which are not connected to the risk cluster. These represent expert debates about the relations between cycling and heart conditions (light blue and light orange), cycling and blood pressure (green), and the benefits of cycling as part of a physical activity regime (purple).

Figure 2: relationships between the top 50 most cited authors and terms, 1989-1997



Apart from publications by the Seattle team, the risk cluster includes ‘Sacks jj’, referring to a widely cited cost-benefit analysis of helmet use carried out by the US Centers for Disease Control and Prevention (Sacks et al, 1991). The ‘Cote tr’ node refers to an evaluation of a ‘natural experiment’. In October 1990, Howard County in the US state of Maryland became the first jurisdiction in the US to pass law making helmet wearing mandatory for cyclists. A research team from the nearby Johns Hopkins University used Howard County as a natural experiment by comparing how it affected head injuries when compared to two nearby counties, one with a helmet promotion programme but no law and another where no helmet promotion was carried out. Their results showed that laws are effective in increasing helmet use (Cote et al., 1992).

Importantly, this study did not examine changes in head injuries but only the ability of helmet laws to increase helmet use.

The appearance of the injury-prevention account of the risks of cycling cannot fully explain how this risk spread beyond the research community. Importantly, at this period numerous US states were at the process of repealing motorcycle helmet laws due to libertarian challenges (Homer and French 2009), suggesting an atmosphere unsupportive of bicycle helmet legislation. In an interview, helmet expert Randy Swart observed that a Washington-based advocacy organisation, Safe Kids, used its hundreds of local chapters across the US to promote helmet legislation at the municipal and state level (in the US, traffic safety is under the authority of the states). Former Safe Kids director Alan Korn explained that the organisation developed a narrative matrix combining statistical evidence, mainly from the Seattle study, with personal accounts from those involved in accidents to highlight the harms of head injuries and the benefits of helmets (Korn, interview). Safe Kids has taken on various issues over the years, but helmet use remained high on its agenda. The initial campaign was not funded by the helmet industry, but by a subsidiary of pharmaceutical giant Johnson & Johnson. In later years, however, Safe Kids has worked with Bell Helmets, a major US cycling helmet manufacturer, on this campaign. Indeed, Safe Kids has accepted Bell Helmet funding for its ongoing helmet campaigns (Korn, interview; Mickalide, interview).

Publications by the Seattle team provided the initial stimulus for policy developments that made the wearing of cycle helmets mandatory (Mickalide, interview). This in turn created the opportunity for further research, as it created natural experiments which research teams such as the one at Johns Hopkins University or at the Centres of Disease Control and Prevention could exploit (Cote et al., 1992; Schieber & Sacks, 2001). However, because of the rarity of cycling-related head injuries and under-reporting of such injuries, the findings of these research teams examined helmet use rates rather than changes in injury rates, thus remaking assumptions about the effectiveness of helmets in reducing head injuries (Schieber, interview). In the US, this

movement was resisted as an infringement on individual liberty (Korn, interview). Some academic sources refer to the influence of the libertarian critique on the bicycle helmet debate explicitly (for example, Scheidt, Wilson, & Stern, 1992), but this critique did not gain enough influence to appear on the graphical maps. This suggests that the issue was largely separate from the scientific debate over the effectiveness of bicycle helmets and helmet laws.

1997-2006: Consolidation of separate discourses on the risks and health implications of cycling

The pattern and categorisation of publications in the 1990s and into the new Millennium was the same as the early period. As Figure 3 indicates, publications fell into two main groups, a risk and a health group, with minimal overlap between the clusters.

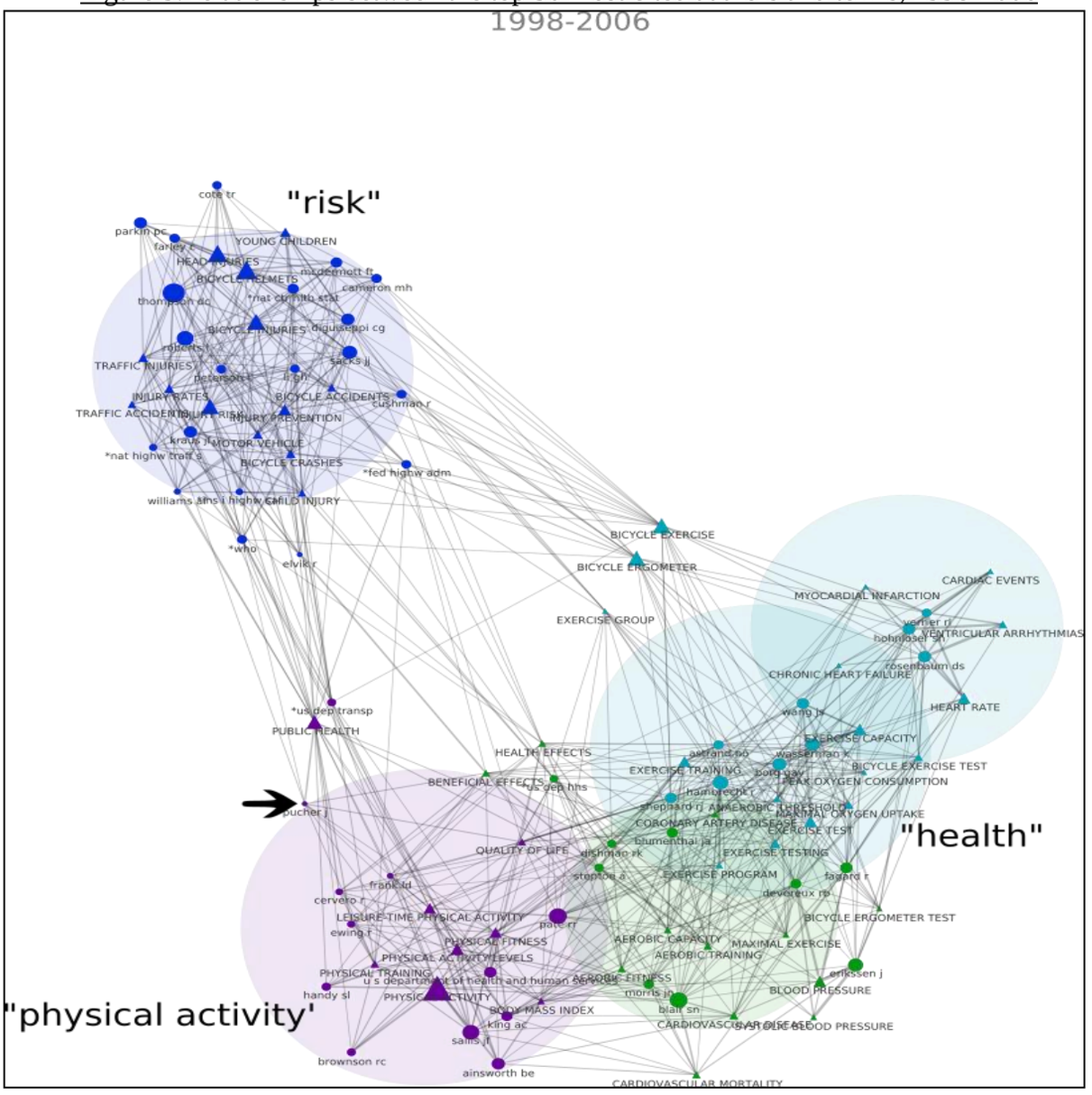
The ‘risk’ cluster maintained its composition. The Seattle team still retained a prominent position, partly due to a 1996 publication reporting on a larger-scale replication of their earlier research, which also found helmets to be effective, albeit to a smaller degree (they estimated the relative reduction of the risk of injury attributable to wearing helmets as between 65% and 74% reduction depending on the type of injury) (D. C. Thompson, Rivara, & Thompson, 1996). In 1999 the Seattle team published a Cochrane review (D. C. Thompson, Rivara, & Thompson, 1999) (the Cochrane Collaboration is a UK charity that since the 1990s has become an influential a global independent network of researchers, professionals, patients, carers, and people interested in health that synthesises evidence on health interventions in the form of systematic reviews). Most of the evidence they reviewed came from their own work (In 2009 they published a follow-up Cochrane review but did not include any new studies in their analysis, D. C. Thompson, Rivara, & Thompson, 2009). The findings of the Seattle team were confirmed by other publications. For example, Attewell, Glase, & McFadden (2001) published a systematic review commissioned by the Australian government that used more inclusive criteria than the Seattle team’s review and this also found helmets were effective in reducing head injuries. These reviews form the basis for the WHO 2004 recommendations for helmet laws (Peden et al., 2004). In addition, during 2005 Safe Kids went international, continuing its quest for helmet laws but on

a wider scale.

The Seattle team played a key role in creating the risk narrative in which cycling was linked to head injury that could be mitigated through helmet wearing. While this was the dominant narrative there were other alternative constructions of risk in which helmets did not play such a benign role. According to these constructions, helmets provided a false sense of security increasing the probability of accidents and injury (risk compensation), or discouraged cycling reducing its health benefits (health in cycling effect), or made the remaining cyclists more vulnerable (reducing the safety in numbers effect). In the United Kingdom a British Medical Association report (British Medical Association, 1992) emphasized concerns regarding the discouragement of cycling and did endorse mandatory helmet laws. The report's author suggested that the BMA report played a role in preventing a helmet law in the UK (Hillman, interview).

While critical commentary on helmets was muted in the 'risk' cluster, it is possible in this period to see new risks, which would later become salient to the helmet issue, emerge within the 'health' cluster. In the 'health' cluster in Figure 3 (lower left side; purple in the online version), there was an expansion of the 'physical activity' node, reflecting the growing concerns about the obesity epidemic. The most prominent cited author (circle) in the cluster was psychologist James Sallis, who gained prominence by advocating a shift from motivating individual-level physical activity to changing individuals' environments in ways that would encourage such activity (*Sallis js*, for example Sallis, Frank, Saelens, & Kraft, 2004). This approach is shared by other participants, many of them urban planners (*Handy sl, Ewing r, Frank ld, Pucher j*). The publications underlying their appearance in the cluster include studies of walk/bike to school programmes and studies of the relations between the built environment and health (for example Ewing et al, 2003; Frank et al., 2006). The most prominent proponent of cycling was Pucher (marked by a black arrow; see Pucher & Dijkstra, 2003), thus explaining his proximity to the 'risk' cluster.

Figure 3: relationships between the top 50 most cited authors and terms, 1998-2006

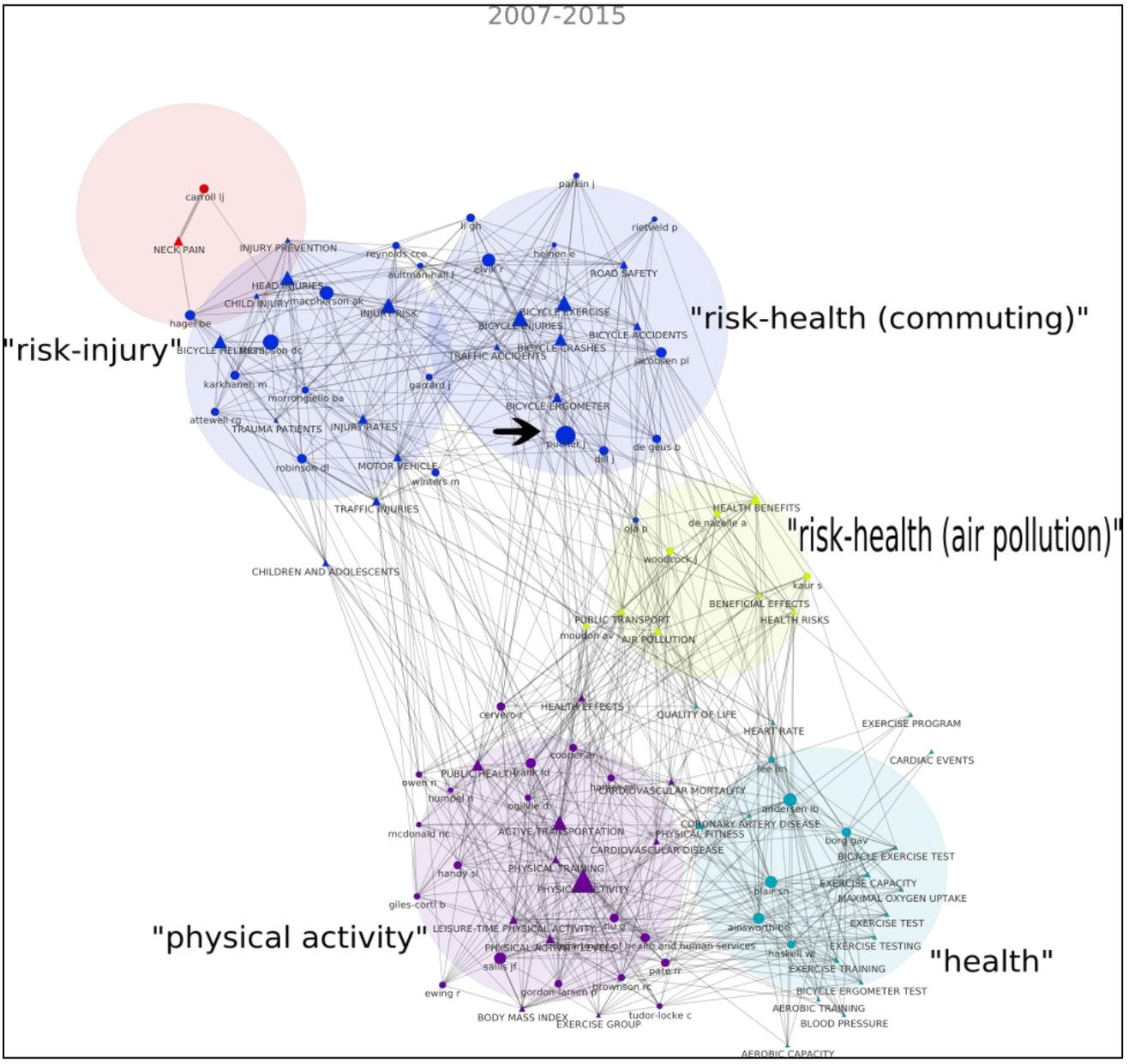


2004-2014: The dismantling of a first modernity risk

In the period from 2007 to 2014 there was a breakdown of the first modernity account of the cycling risk and the rise of a second modernity account of this risk. New entities invaded what was previously a closed matrix with a fixed number of participants, and quasi-objects, whose effects are disputed, replaced objects, whose effects are independent of human subjectivity. This can be seen in the increasing links in publications between the ‘risk’ and ‘health’ clusters indicating the development of new entities linking what was previously two separate discourses and creating a new in-between space (see Figure 4). This space is populated by entities who receive 'risky descriptions' (Latour, 2003), that is described in uncertain terms

which include externalities and ambiguities. The upper right cluster (blue) is dominated by concerns about bicycle injuries and crashes, but these are considered not only for their immediate, objective harms but also for their role as potential deterrents to cycling, particularly commuting. Note the dominant position of Pucher in this cluster.

Figure 4: relationships between the top 50 most cited authors and terms, 2007-2015



Below this blue cluster is an area marked in yellow which is based on studies of risk-health trade-offs with an emphasis on air pollution (Oja, de Nazelle, Woodcok; for example, de Nazelle et al., 2011). The influence of air pollution is uncertain. For example, one review points out that a shift from car to bicycle means that overall pollution will be reduced, but it was

unclear whether the increase in the number of those exposed to air pollution through cycling increased the overall level of harm experienced even though the actual level of pollution would fall (Oja et al., 2011). In other words, the impact of air pollution was mediated by the way people will behave and on their physical reactions.

The interest amongst researchers on health-risk trade-offs was stimulated by growing concerns about the health consequences of declining levels of physical activity in the global north. The influence of these concerns was evident in the emergence of an 'active transportation' node in the central 'physical activity' cluster (purple) in Figure 4. Researchers use this term to denote the need to incorporate physical activity into non-leisure everyday activities. More broadly, several of the studies underlying this cluster were published as part of an effort to promote the use of Health Impact Assessment (Dannenberg, interview). According to the US Centers of Disease Control and Prevention's website, this is a method designed to bring 'potential public health impacts and considerations to the decision-making process for plans, projects, and policies that fall outside the traditional public health arenas, such as transportation and land use' (CDC, 2015). While the scopes of Health Impact Assessments vary, their influence in this case demonstrates a shift toward a holistic view of the cycling risk which includes the risks of non-cycling.

Most studies in the in-between space did not refer to helmets. They took the accident rate as a given, accepting that it would rise linearly with a rise in cycling but argued that the health gains still outweigh the life years lost. However, some researchers advocated an alternative scenario, based on 'safety in numbers' in which that the accident rate would not rise in a linear manner or decline following a tipping points (for example, de Nazelle et al., 2011; OECD/ITF, 2013).

The composition and behaviour of the potential cyclist population, or 'the missing cyclists', became an important issue in the debates over the risks of cycling. However, this issue also received 'risky description', that is, an open description in which entities are unstable and

their behaviour is uncertain. One reason for this is that there is little data available, as travel surveys have usually focussed on car trips. Methods to measure 'the missing cyclists' included the difference between recorded cycle ownership and cycle use (British Medical Association, 1992), raising questions about the reliability of ownership as a proxy, and international comparisons (Pucher & Dijkstra, 2003), raising questions about the influence of local cultures (for example, Newbold, 2012). Relatedly, the magnitude of the health gains from the promotion of cycling was dependent on the size and the internal composition of 'the missing cyclists'. Some commentators argued that the dose-response curve representing the relations between exercise and health was non-linear with most health gains being made when the population shifted from no activity to a low physical activity profile (Woodcock, Franco, Orsini, & Roberts, 2011). Thus, the effect of promoting cycling would be lower than predicted if only or mainly already active individuals shifted to cycling.

The publications in Figure 4 not only addressed risk and fitness when considering the 'missing cyclists', but also the impact of age and gender. For example, Garrard and her colleagues (on the border of the new in-between space in figure 4) argued that women were more risk-averse, leading them to choose cycling only if they can ride on segregated cycle-paths (Garrard, Rose, & Lo, 2008). More recently, Garrard added that women were less likely to see the protection provided by helmets as sufficient (Garrard, Handy, & Dill, 2012). Thus, representing the missing cyclists becomes complicated and context-specific, making it difficult to draw generalisations.

The risks of helmets

I now return to the bicycle helmet, and consider how its representation was changing. A comparison of Figure 4 to previous Figures shows that the debate over the health benefits of cycling marginalised the issue of head injuries. Furthermore, the composition of the 'risk' cluster was changing to includes publications of studies by commentators who opposed helmet laws, most notably Robinson and Morrongielo (Robinson, 2005; Morrongiello, Lasenby, & Walpole,

2007). Their presence indicates that a growing number of studies within this cluster that were critical of the various Seattle studies, indicating that helmets were no longer indisputably a way of mitigating risk.

Robinson, an Australian statistician, appears in the 'risk' cluster in figure 4 based on several publications between the years 2005-2007 (for example Robinson, 2006) dealing with the 'safety in numbers' effect (Jacobsen, 2003). Robinson argued that helmet laws in Australia reduced cycling, but that the reduction in cycling was accompanied by a smaller-than-expected reduction in fatalities and serious head injuries, that is, a reverse safety in numbers effect: helmet laws deterred cycling and inflated the risk for the remaining cyclists (Robinson, 2005). Note that this publication and others like it accepted the mechanical effectiveness of helmets but challenged the effectiveness of helmet laws. This can be seen as a process of re-modernising cycling risk with the fragmentation of a single risk (that of head injury mitigated by helmet wearing) into a number of complex interacting risks (the attempt to mitigate head injuries through helmet laws creates new risks by making the cycling environment more dangerous).

The risk compensation associated with helmet use, that is individuals cycle more dangerously because of a sense of security, was discussed by researchers in the early 1990s and again in the early 2000s (Adams & Hillman, 2001), but did not at that time become a prominent theme in the risk discourse. The rise of 'risk compensation' in the helmet debate is evident in the prominence of the publications by the Canadian psychologist Barbara Morrongielo, who focussed on this issue, in the 'injury prevention' (blue, upper right) cluster in Figure 4. Morrongielo and her colleagues used new methods to assess the impact of risk compensation (Morrongiello et al., 2007) indicating that helmets could create risks by encouraging dangerous behaviour.

In addition, researchers started questioning the mechanical effectiveness of helmets, the amount of protection they provided in an accident. These concerns were articulated in the early 2000s (Curnow, 2003) but acquired more force when Rune Elvik, an established authority in the

field of traffic safety, criticised the procedures used in the Seattle team's Cochrane review and in the Australian review. Using different inclusion criteria and newer studies, he estimated the mechanical effectiveness of helmet-wearing at a 22% reduction in head and brain injuries. To account for the difference, Elvik opened up some of the issues closed by the Seattle team, including the idea of a single helmet by arguing that different types of helmets, even if all conform to the same standard, might have significantly different impacts (Elvik, 2011).

Thus, the pattern of research and publication in Figure 4 indicated that the pattern of discourse relating to risk of cycling has shifted. In the earlier periods (Figures 2 -3) there was a consensus that cycling brought health benefits, and that the main risk was accidents resulting in head injuries. However, these could be mitigated by wearing helmets, and the state could and should promote even enforce helmet wearing. This consensus has fragmented and the established researchers and commentators who still see risk in these terms have been challenged by new researchers and commentators who have a more fluid and complex construction of risk in which helmet wearing is as much a source as a mitigator of risk.

Discussion

In this article I have examined the dynamics of a mundane risk, that of cycling, as represented within expert debates. I have shown how the initial construction of cycling risk, with its focus on injury prevention, corresponded to a first modernity logic. It focussed on severe head injuries and on a technological fix, wearing cycle helmets, and did not explore the broader setting and context (and risks) of cycling. I have argued that this initial construction of risks was associated with a few authoritative research groups, most notable the Seattle team. However, as the community of researchers and commentators expanded this account was undermined as researchers, through their publications, gave voice to new sources of risks and uncertainties. The development of these alternative perspectives and constructions reflected the development of alternative approaches that provided critical, yet constructive, reflections on the conditions that produced the

accounts of cycling risks and how such risks related to aggregate population health. The transformation of mundane risks, particularly as part of a focus of a population-level approach to health was an important, albeit less visible, engine of change in the shift from first to second modernity. More specifically, the product of the network performing the cycling risk transformed from a focus on mechanical effectiveness, accompanied by a separate political debate between libertarianism and social planning, into a socio-technical issue characterised by uncertainties and disputes.

The effect of the changing nature of the risk debate was that a well-bounded object, the cycle helmet, was transformed into a quasi-object, whose boundaries – and accordingly, whose effects – are disputed. While researchers and commentators had expressed reservations about the effectiveness of helmets as early as the early1990s (for example, British Medical Association, 1992), their influence on the expert debate was initially limited but over time has increased, as a comparison between Figures 2 and 4 demonstrates. Over time some researchers and commentators undermined the assertion that wearing helmets would mitigate risk by increasing safety and reducing injury and improve public health. Risk compensation and 'safety in numbers' undermined this simple relationship, while any reduction in the prevalence of cycling resulting from the enforcement of helmets would reduce public health.

The disruption of the debate about cycling risk by the insertion of new types of risk, goes beyond their impact on the helmet=safety equation. This can be seen in the emergence of a new socio-technical space between the 'risk' and 'health' clusters in Figure 4, made possible by the growing use of health impact assessments, based on an explicit comparison and assessment of the risks and health benefits of cycling. New entities, such as 'female cyclists', 'old cyclists' or 'air pollution' receive 'risky descriptions': there is no expert consensus on their composition or effects. Yet they are treated as real and have had an impact on policy decisions: for example, the debate about missing cyclists, the hypothetical individuals who don't cycle but would if it was safe and convenient, has influenced policies designed to encourage them to cycle, such as cycle-

paths for more safety and bike-share systems for easier access (Pucher, Dill, & Handy, 2010). Such debates are not necessarily informed by the identities or concerns of actual or potential cyclists, but their population-level representations, usually defined through the relationship between cycling and other activities. The decision to cycle is seen less as an individual decision and more as the result of an individual's sociotechnical positioning; more whether a lane is available rather than a personal desire. Thus, the transformation of the helmet into a quasi-object gave was linked to the rise of a new kind of subjectivity, a new way of thinking about how humans make decisions and why. This shift in focus from cyclists to the positioning of cycling as a sociotechnical activity can be seen in Goodman, Green and Woodcock's analysis (2014).

The development of the risk discourse indicates the changing role of risk expertise. The initial construction of cycling risk focussed in a 'self-evident' relationship between accidents, head injuries and cycle helmets that could be made evident through a matrix of statistical and anecdotal evidence. As the discourse developed the picture became more complex and less evident relying on issues that were difficult to measure or visualise such as the potential population increase in cardiovascular diseases or the magnitude of human tendency to compensate for perceived added safety. However, the increasing complexity and contestation of the debate has not prevented the moves towards practical policy initiatives to address some of the new risks, for example moves to increase cyclist sense of security through changes in infrastructure such as cycle-lanes.

The shift from a restricted individualistic approach to risk based on the supposition that the key issues was whether or not cyclists wore helmets to a broader population approach, in which the disincentive and false sense of security effects of helmets were factored in, acknowledges the potential negative effect of helmet legislation (Mishori & Levy, 2009; De Jong, 2012) but does not necessarily work against such legislation. New evidence can alter the balance of the debate, for example Rivara has evaluated the evidence that minor head injuries can cause long term cognitive difficulties (Rivara, 2011). Evidence, how it is used and who used

it, is just part of the process of claim and counter claim that underpins new modernity.

Conclusion

In this article, I have shown that the Risk Society framework can be usefully applied to study mundane risks as well as global risks. Moreover, paying attention to mundane risks can prove fruitful for analysing emerging kinds of concerns, identities and modes of participation, especially with regards to the relations between risk and health. In the current case, I have shown that the re-conceptualisation of the cycling risk as a problem of population health and an environmental issue, gradually replaced the conceptualisation based on injury prevention. Thus, the focus on mundane risks provides one gateway into the construction of what Beck calls 'subpolitics', that is, new arenas of political participation, in which new modes of action and thought are used and which may grow to challenge modernistic institutions. Importantly, while mundane issues tend to receive little public and sociological attention, their influence is far-reaching. For example, changes in transportation have secondary and tertiary effects on familial relationships, fuel consumption, and international relations (Urry, 2004). Accordingly, the role of mundane risks in shaping our lives needs to be explored further.

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Appendix I: Interviews

Andy Clarke, former president of the League of American Bicyclists

Andrew Dannenberg, former member of the injury prevention team at Johns Hopkins University

John Forester, a leading figure of the vehicular cycling movement

Mayer Hillman, Policy Studies Institute

Alan Korn, former general counsel and policy director at Safe Kids

Angela Mickalide, former research director at Safe Kids

Frederick P. Rivara, Harborview Medical Center

Richard Schieber, US Centers for Disease and Control Prevention

Randy Swart, head of the Bicycle Helmet Safety Institute

Chapter 2. Re-assembling Automobility: Bicycle helmets and the risks of cycling in the US, 1970-1995

Abstract

Traffic safety conceptions are often analysed as subordinated to automobility, but how this occurs remains vague. I examine the emergence and spread of accounts of the risks of cycling in the US and their domination by head injuries and bicycle helmets, a framing often attributed to automobility. I trace the sociotechnical network producing these accounts using academic and governmental publications, the mass media, and interviews. I demonstrate that the emergence and spread of traffic safety conceptions are non-linear and contingent, highlight the constitutive role of non-humans in these processes, and argue against the use of automobility to explain such developments.

Keywords: automobility, risks, accidents, bicycle helmets, actor-network

Introduction

- *What is key is not the 'car' as such but the system of […] fluid interconnections.*
John Urry, The 'System' of Automobility, 2004, p. 26

Traffic safety is often considered a technological or psychological problem. Recent years have seen a growing recognition of the complexity of traffic safety and its interactions with issues such as public health, socio-economic disparities and familial relations (Parusel and McLaren 2010). Yet the emergence and spread of traffic safety conceptions remains neglected and under-studied, with some notable exceptions (e.g. Bijker 1995; Norton 2008). These processes are usually attributed to automobility, a car-centric regime, and specifically its ability or tendency to individualize accidents, assigning responsibility for them to 'bad apples' among drivers. This framing aids automobility's re-production, threatened if blame was assigned to alternative culprits such as speed-centred advertising or the axiomatic acceptance of cars on city

streets (Böhm et al. 2006). However, the mechanisms through which automobility operates remain vague (Manderscheid 2014).

I examine the emergence and spread of accounts of the risks of cycling in the US and their gradual domination by bicycle helmets. Drawing on Actor-Network Theory (ANT), I conceptualize "risks" as a shorthand for different sociotechnical networks attempting to bring dangers under control and transform them into calculable and preventable entities (Latour 2003, 2005). I examine the development of the network producing accounts of the risks of cycling, focusing on the position of bicycle helmets and their relations with other participants, most notably bicycle-rider hybrid(s) (Cook and Edensor 2017).

I challenge two explanations of changes in traffic safety conceptions. Like other safety measures, the rise of the bicycle helmets is often explained in terms of automobility's attempt to individualize accidents: the focus on the presence or absence of a helmet obscures potential culprits such as drivers or poor traffic planning (Furness 2010; Culver 2018). Alternatively, technological or scientific developments are explained using a model of a linear process of progress through discovery and improvement. This narrative has also been applied to bicycle helmets (Centers for Disease Control and Prevention 1995). However, such linear imagery is created retrospectively. When the process unfolds it is non-linear and contingent; both the problems and the technologies designed to address them are fluid (Bijker 1995; Akrich et al. 2002). ANT avoids the preconceptions imposed by either narrative.

The scope and magnitude of the sociotechnical relations involving mundane artefacts is frequently overlooked (Latour 1992). For many, bicycle helmets are obviously useful albeit somewhat uncomfortable objects. Yet, they are frequently and often passionately debated. Some authoritative bodies promote bicycle helmets and bicycle helmet laws (Centers for Disease Control and Prevention 1995), while others are concerned about unintended consequences, mainly that these measures may discourage cycling and indirectly increase the burden of

cardiovascular diseases (OECD/ITF 2013). Some governments enact new bicycle helmet laws (France, 2017) while others repeal them (Bosnia and Herzegovina, 2017).

Latour (2003) has argued that the non-technicality of risks is increasingly evident to contemporary thought. Elsewhere, I have demonstrated this process for the risks of cycling (Blank-Gomel 2017). Here I focus on the formative period of these risks. Their controversial status emphasizes that their rise should not be interpreted as either necessary or mistaken, as the question whether their harms outweigh their benefits remain open. Rather, this development should be examined empirically.

The US experience has been instrumental in shaping popular and expert views on bicycle helmets and bicycle helmet laws worldwide. US-based studies have set a model for the measurement of helmet effectiveness and provide the main justification for the WHO's support for helmets and helmet laws in its 2004 report on traffic accidents (Peden et al. 2004). US Helmet advocacy campaigns were transferred to other countries, and the US helmet industry promotes helmet use worldwide. Thus, even though these measures did not originate in the US, it provides an appropriate site to study the emergence of helmet-oriented accounts of the risks of cycling.

I focus on the years 1970-1995. In 1970, US experts were beginning to consider the emerging problem of bicycle-related dangers, and bicycle helmets were rare. By 1995, 11 states and 50 local governments had helmet laws, helmet promotion and education became common and was recommended by the CDC, and the Consumer Product Safety Commission began to prepare a federal standard for safety bicycle helmets, albeit after being coerced by the US Congress. Accordingly, I treat this as the formative period of helmet-oriented accounts of the risks of cycling, during which they gained influence and stability.

Several scholars have commented on the peculiar prominence of bicycle helmets in the US. Furness suggests helmets serve as a synecdoche for bicycle safety in the country, and Culver’s analysis of the safety agenda of 25 metropolitan cities leads him to conclude that the US

has a ‘fixation’ with bicycle helmets (Furness 2010; Culver 2018). This is more remarkable when considering that from an international perspective, US helmet use rates are moderate. Jewett and her colleagues (2016) estimate that 30% and 40% of adult and child cyclists, respectively, use helmets regularly. This is higher than Germany or the Netherlands and lower than some Canadian provinces or Australia (Uibel et al. 2012). Yet, these rates remain indicative of a sea change compared to almost negligible rates of helmet use in late 1980s. Notably, helmet use rates among children are estimated to be about 40% in both states with and without helmet laws, demonstrating that the spread of helmet-oriented accounts of the risks of cycling in the US goes beyond helmet laws.

Mobility, Safety, Automobility

The relations between mobility and safety are characterized by an inherent tension. Contemporary perceptions of mobility link it to freedom and autonomy, while safety requires constraining one’s mobility. Yet, unconstrained mobility endangers the mobile subject and others. Analyses of attempts to resolve this tension raise questions regarding whose mobility is constrained, how is this determined (Packer 2008), and how are human-technology relations influenced in the process (Beckmann 2004; Wetmore 2004; Emanuel 2012).

It is often argued that conceptions of traffic safety support automobility. Per Urry, automobility describes a historically contingent self-expanding 'system' composed of several intertwined components, including the car's centrality in the capitalistic mode of production, its cultural associations, its dominance as a form of personal mobility, and its implications for the organization of work and family life. Automobility is also an analytical framework focused on the relations between identity formation, ethical conceptions regarding autonomy and mobility, and human-machine interactions (Urry 2004).

Some have suggested correctives to this definition (Böhm et al. 2006; Manderscheid 2014), but in all definitions I found traffic safety occupied a similar role: a device to support

automobility. Some explain safety perceptions as the result of automobility, and Culver attributes the prominence of bicycle helmets in the US to ‘unfettered automobility’ (Culver 2018, 12; Parusel and McLaren 2010). Yet automobility’s mode of operation remains vague (Manderscheid 2014). Notably, some approaches to traffic safety may challenge automobility if examined through this perspective, most notably the Vision Zero schemes applied in Sweden and Norway, although the degree of this challenge is debated (e.g. McAndrews 2013).

Several mechanisms have been put forward to explain how traffic safety becomes biased towards automobility. This includes individualization- traffic accidents are attributed to individual road users rather than a systemic flaw (Lutz and Lutz Fernandez 2010), and normalization- they are treated as inevitable, a matter of fate, luck, or an act of god (Vardi 2014). Often, safety concerns are used to curb the mobility of vulnerable road users while protecting and enhancing the mobility of drivers (Norton 2008). The operation of these mechanisms is attributed to the automobile industry (Lutz and Lutz Fernandez 2010) or, more diffusely, to automobility (Packer 2008).

There are numerous examples for the operation of such mechanisms, but there is also evidence that the construction of safety conceptions is more complex. Studies have highlighted the role of images of road users, defined via their demands, needs and capabilities, as well as the role of statistical methods, in shaping expert discourse (Beckmann 2004; Wetmore 2004; Vardi 2014). Moreover, the automobility framework can be misleading if it is applied as a ready-made set of assumptions regarding the identity and interests of participants. I draw on Actor-Network Theory (ANT) to examine the spread of traffic safety conceptions with no presuppositions.

ANT offers a rich terminology and philosophy (Latour 2005; Harman 2009). For current purposes I emphasize one of its central tenets, the rejection of the analytical distinction between ‘science’ and ‘society’. For ANT, labels such as ‘scientific’ or ‘cultural’ (etcetera) are artificial, ongoing achievements produced by sociotechnical networks operating across such boundaries in practice. This leads ANT to reject the exclusive resort to social factors as the primary

explanatory variables (Latour 2005). Accordingly, “automobility” can denote that which needs to be explained but is insufficient as an explanatory factor.

ANT follows claims by tracing the actor-networks involved in their production. These networks are populated by humans and non-humans, whose role - framed as ‘identity’, ‘function’ or ‘interest’ - is determined through their relationships. Agency is distributed between participants, rather than being the property of a participant. Networks spread when new participants are enrolled in them and when their products become enrolled in other networks. Such links can transform the network’s product and, in a reciprocal process, the participants’ identities (Latour 2005).

Analytically, the participants in actor-networks are hybrids, entities whose articulation requires crossing the boundaries between seemingly separate spheres. Mobility scholars often examine the sociotechnical configurations giving rise to road users, mainly variants of driver-car hybrids (Dant 2004) but also bicycle-rider hybrids (Pesses 2010; Cook and Edensor 2017). For ANT, all participants are hybrids in principle, but their hybridity becomes visible only during controversies or formative periods, when their composition is challenged or constructed. The purification of a hybrid, that is, the dispelling of uncertainty and its assignment into a distinct sphere, facilitates its ability to create new links.

The network metaphor offers a middle way between loose interactions and rigid institutions or social worlds. It remains agnostic regarding the stability of the relations discovered. I will describe the influence of the network producing accounts of cycling using a rhetoric of control, attributed to the network or to participants, as part of the helmets’ attempt to entrench their position. This is a rhetorical strategy rather than an attempt to identify a governmental strategy.

Both ANT and the mobilities literature reject treating actors as static and emphasize the dynamism, fluidity, hybridity and complexity of phenomena. Often, ANT is used to examine the phenomenology of road users (Manderscheid 2014) or to demonstrate their variation. In contrast,

there are relatively few historical analyses using ANT or examining the role of non-humans with regards to changes in traffic safety conceptions (although see Wetmore 2004; Vardi 2014). I suggest that following the creation and purification of hybrids populating accounts of traffic safety (or mobility) provides a partial answer to Sheller's call for historical methods in the mobilities field (Sheller 2017). Tracing accounts identified with automobility offers a way to re-assemble automobility, or more accurately to re-assemble specific instances identified with automobility, without preconceptions.

Materials and method

I examined the transformations in accounts of the risks of cycling by following their digital traces in the mass media, scientific papers and publications by participants, complemented by 9 semi-structed in-depth interviews.

The mass media was operationalized by searching the Lexis-Nexis database, on 28/8/2016, for combinations of bicycle/cycling/bicycle-related and accident*/crash*/injur*. I included items referring to US locations and appearing between January 1, 1970 and December 31, 1995. This generated 665 results. I used this data to follow the spread of accounts of the risks of cycling outside academia, for example through helmet legislation campaigns or summer preparedness efforts, as well as resistance to this spread, for example arguments regarding fashion.

Influential scientific articles were defined as articles commonly referred to in scholarly reviews, commentaries on the helmet debates and the mass media, or articles identified as influential by interviewees. Publications by participants include reports by the Consumer Product Safety Commission, Safe Kids, the Snell Foundation, and newsletters published by the Bicycle Helmet Safety Institute (BHSI), 1983-2000. I used these sources to examine the sociotechnical organization suggested in accounts of the risks of cycling circulating in the US, including who

were the participants involved, how were they represented, and what relations were they embedded in.

Interviewees were selected based on the literature review and their appearance in the media. Interviews were carried out using the phone, Skype, or e-mail. Interviewees were asked about key junctures in the network's development and about the position of organizations they represented or were associated with.

The rise of helmets and helmet laws in the United States

Emergence of the bicycle accident

Concerns about bicycle accidents were voiced in the US at the turn of the 20th century (Bijker 1995; Norton 2008), but were marginalized with the rise of the car. Public health experts began to re-raise such concerns in the late 1960s, worried about the consequences of a growing public interest in cycling (Waller 1971b).

Green argues that in this interval the meaning of the term ‘accidents’ among public health experts transformed, shifting from unfortunate yet unpredictable events - ‘lay misfortunes with a medical outcome’ – to risks, calculable and predictable events constituting ‘a proper category of disease’ (Green 1999). The aspiration to control accidents and transform them into calculable risks is evident in the early academic studies of bicycle accidents. However, the lack of sufficient data to conduct statistical analyses obstructed the use of epidemiological methods, forcing the experts to use anecdotal evidence and research designs considered weak, for example non-random series of a small number of cases (Waller 1971a, 1971b).

By the mid-1970s, bicycle accidents emerged as a national problem. The main impetus was the deployment of a product-based classification of injuries and fatalities by the newly established Consumer Product Safety Commission (CPSC). The CPSC collected data about products involved in injuries and fatalities using the National Electronic Injury Surveillance System, known as NEISS, a sample of emergency rooms in hospitals designed to be nationally

representative. The CPSC than calculated a ‘product hazard index’, designed to identify harmful products. In 1973, 1974, and 1976 this index was led by bicycles (Consumer Product Safety Commission 1976b).

Through NEISS, bicycle accidents were translated from scattered events into a threatening statistical regularity. The CPSC’s results appeared on the front page of the New York Times, and both newspaper stories and scientific articles began to describe new cases as part of a broader national problem. Several organizations including the CPSC, the CDC, and the Insurance Institute for Highway Safety, an agent of the auto insurance industry, began to invest funds and skilled work in the study of bicycle accidents, producing data and offering policy measures. Bicycle accidents thus served as a focal point for various parties seeking to transform them into preventable risks.

Notably, the CPSC’s product hazard index was severely criticized. One critique, raised among others by a research team hired by the bicycle industry, argued that it ignores exposure: the bicycle’s ranking reflects higher use rather than the bicycle being inherently dangerous (Flora Jr 1975). The CPSC later created a new formula, in which bicycles ranked high but did not lead the list.

NEISS data was too general to allow identifying mechanisms of injury. A review of the academic literature demonstrates the variability in the types of injuries considered by experts, for example lacerations, fractures and genital injuries. Head injuries were not singled out but studied alongside other more common injuries. These accounts of the risks of cycling identified different culprits, including the cyclists’ behaviours, advertising campaigns, and bicycle design, especially high-rise bicycles. Potential solutions included changes in bicycle design, using reflectors (declared mandatory by the CPSC in 1976), cycling education, car modification, and traffic separation, either by creating bike lanes (parallel to car lanes) or bike paths (not necessarily parallel to car lanes).

The calls for government regulation of cycling attracted the attention of cyclists' organizations. Beckmann (2004) observed that road users usually enter expert discourse as victims, as was the case in accounts produced by the CPSC or by academics. The cyclists' organizations offered an alternative image, emphasizing the cyclist's responsibility for safety.

The main spokesperson for US cyclists in the 1970s and 1980s was the League of American Wheelmen, a federation of bicycle clubs (henceforth: the league) which organized large-scale shared rides (Epperson 2010). Studies of club cyclists found them to be mainly white, middle-upper class, young adult males (Burgess and Burden 1978). Members were not professional cyclists but people who found cycling to be fun, thrilling, and providing a sense of independence. Their involvement in cycling ranged from hobbyists and enthusiasts to self-proclaimed aficionados.

The league's position on safety was influenced by the spread of the 'vehicular cycling' approach among club cyclists. Broadly, vehicular cycling suggests that cyclists and drivers should have the same rights and responsibilities. Cyclists are expected to mitigate risks by developing cycling skills, including the use of appropriate gear. Those lacking such skills, including children and untrained cyclists, should avoid the roads (Forester 1993; Furness 2010; Epperson 2014).

The league campaigned against what it perceived as paternalistic policies. In the early 1970s John Forester, usually recognized as the face of vehicular cycling in the US, gained fame by successfully leading club cyclists in California against attempts to enact laws prohibiting cyclists from using traffic lanes wherever bike lanes or sidepaths existed. Forester and his colleagues then used the league to attack traffic separation measures, which gained ground in several European countries in the time and were also suggested by US activists.

The argument against traffic separation demonstrates the sociotechnical organization guiding the vehicular cyclists' account of the risks of cycling. It suggested that bicycles and cars must interact, because a nation-wide bike lane system is not feasible. Creating separated paths

alongside some roads (for example in urban centres) would lead drivers to expect cyclists to ride only on these paths and encourage them to harass cyclists seen as trespassing. Moreover, separated paths would create new risks due to the speed differentials between serious cyclists (read: vehicular cyclists) and other cyclists (Wachtel and Lewiston 1994). The vehicular cyclists' approach, focused on cycling education, prevailed through the 1970s and 1980s.

The vehicular cyclists' position problematizes the image of 'the cyclist', particularly its relations to automobility. While some present cycling as an alternative to car-dominated automobility, cyclists are not necessarily antagonistic to automobility (Pesses 2010). Vehicular cycling adopts the ethical imperative of automobility, linking autonomy and mobility (Urry 2004), but adapts it to cyclists. Ironically, the vehicular cyclists used safety considerations to curb the mobility of other cyclists while enhancing their own mobility, replicating a mechanism often used by drivers against cyclists. This provides a vivid example for the need to consider different kinds of 'cyclists' (e.g. Horton 2007) and even the potential antagonism between them.

The influence of vehicular cycling is remarkable given the low numbers of self-identified 'vehicular cyclists', estimated by Forester to be in the low hundreds at best (Forester, 18/11/2015, interview). Former league president Andy Clarke explains that the vehicular cyclists were politically active both nationally in the league and locally in municipal cycling committees (Clarke, 12/7/2015, interview; see also Furness 2010, 72–73). Forester and other vehicular cyclists also became involved with cycling training, writing cycling manuals, developing courses, and often acting as instructors. Later manuals and training programs were heavily influenced by these materials, exposing many US cyclists to the principles of vehicular cycling. This approach was also adopted in the American Association of State Highway and Transportation Officials' Guide for the Development of Bicycle Facilities, a commonly used resource for transportation engineers (Epperson 2014). Thus, when vehicular cyclists were not in planning committees, their position, represented as the position of 'cyclists' in general, could be mediated via the local engineer.

Bicycle helmets played a marginal role in the accounts produced in academia (e.g. Williams 1976) and by government agencies. For example, a 1976 CPSC pamphlet, titled 'Bicycles: buy right, drive right', does not mention helmets at all (Consumer Product Safety Commission 1976a). Helmets were also marginal among club cyclists in the early 1970s. Their popularity grew as the decade progressed, albeit only as part of the gear a responsible cyclist was expected to use. The meaning of the term 'bicycle helmets' was also undergoing changes in this period.

The emergence of bicycle helmets

In 1970, bicycle helmets were rare, unregulated and vaguely defined. Both the material composition of helmets and the tasks they were designed to perform varied. The term 'bicycle helmet' included artefacts resembling contemporary helmets, composed of a shell, a layer of protective material (liner) and a strap system, but also artefacts composed of several interlaced leather straps, sometimes referred to as 'hairnets'. Below, I examine the helmets' spread and the stabilization of the current US-style conception of helmets, focused on preventing a single catastrophic injury.

Bicycle helmets initially spread in the US through their associations with club cyclists. By the early 1980s, helmet use became common and sometimes mandated in club events. Helmet experts and veteran club cyclists attribute the helmets' popularity to improved designs and to the circulation of stories about how helmets prevented serious injuries or about the long-term effects of head injuries among club cyclists. Large shared rides involving different clubs provided sites for the circulation of such stories (Swart, 26/6/2015, interview; Clarke, 12/7/2015, interview; Forester, 18/11/2015, interview).

Other developments supported the spread of helmets. As mentioned, helmets were represented as part of the standard gear used by a cyclist in training programs and manuals inspired by vehicular cycling. Helmet advertising campaigns in cyclists' magazines likely also

helped. Notably, these campaigns sometimes focused on distinguishing ‘primitive hairnets’ from ‘modern helmets’, aiming to label the former as non-helmets (Bagnall 1990). Another factor was the growing popularity of helmets among professional cyclists, although this should not be over-emphasized; the US Cycling Federation, which governs competitive cycling in the US, only mandated helmets in 1986.

The helmets’ spread was accompanied by a stabilization of their sociotechnical role. The origins of current US-style helmets can be traced to a voluntary standard published in 1971 by the Snell Memorial Foundation, a private organization developing and selling motorcycle helmet standards. Modelled on a light motorcycle helmet, this standard simulated a scenario in which the mechanism of injury is vertical impact leading to catastrophic head and brain injuries. It materialized into heavy helmets rarely used or produced (WABA 1983; Barcott 2013, 65). Some manufacturers used a similar testing logic without necessarily prescribing to the standard. Importantly, alternative scenarios of accidents are also possible, including the risk from rotational acceleration, a scenario in which the cyclist falls on the sidewalk and the helmet drags on the curb, leading the head to decelerate at a slower rate than the brain and straining the axons.

In the early 1970s, members of the Washington Area Bicyclist Association (WABA), a cycling advocacy organization, became frustrated with the lack of information on helmets. They created a helmet committee and began to collect and distribute such information. The latest incarnation of this committee, the Bicycle Helmet Safety Institute, remains a highly regarded source of helmet information. The committee also attempted to produce information, for example by conducting comfort tests, but it lacked the resources to study helmets systematically in the lab. WABA turned to Snell’s chair, Dr. George Snively, who agreed to provide WABA with guidance and access to Snell's test results (Swart, 26/6/2015, interview).

Snell’s testing replicated the logic of the 1971 standard, focused on vertical impact. The method used to simulate a catastrophic accident was known as ‘the drop’: the helmet is placed on a headform, raised and dropped vertically on an anvil. When the impact reaches the shell, the

protective material begins to crush; the energy is transformed into heat and the impact on the head and brain is reduced. In this design, a helmet can only be used once, as the crushed protective material becomes ineffective. Seeking to address the realities of helmet use, for example being left at the trunk of car on a hot day, helmets were heated, chilled, drowned, and then dropped. Ed Becker, Snell's executive director, explains that it is difficult to develop a reliable, repeatable test for the rotational scenario. He argues that these concerns should be balanced with concerns regarding catastrophic impact (Becker, personal correspondence, 30/5/2015).

The focus on a catastrophic accident interacted with the helmets' material composition. By the late 1970s, manufacturers were usually using expanded polystyrene (EPS) foam as the protective material. EPS is well-suited to address a catastrophic crash, because its density is associated with its crushability: denser foam begins to crush at higher levels of impact. This enabled manufacturers to produce denser and therefore smaller helmets, more attractive to consumers, while passing the drop test. This also meant that addressing the risk of an accident in a lower speed, which might cause a concussion, would require using looser foam, inflating the helmet's size and reducing its attraction (Swart 2017).

In 1979 the American National Standards Institute (ANSI), a voluntary standards organization, convened a subcommittee on bicycle helmet standards. Members included representatives of the industry, the CPSC, Snell, WABA, and other cyclists' organizations. WABA and Snell promoted a standard replicating the logic of the 1971 Snell standard (with some modifications). In 1983 WABA's newsletter reported dejectedly that the committee made little progress due to the industry's resistance to regulation (Swart, November 1983).

At the same year, WABA published the results of their collaboration with Snell in *Bicycling*, a popular cycling magazine. The article attracted national media attention due to the failure of a popular American brand, Skid-Lid, to meet the standard. Skid-Lid's president argued the test was 'grossly oversimplified' with regards to how a helmet needs to function (Sinclair

1983), and petitioned the ANSI committee against it (Swart 1983). This petition was rejected, and the ANSI standard was published in 1984. It was followed by the publication of a new Snell standard in 1985, using a similar logic but a higher drop.

The ANSI standard quickly demonstrated its coercive power. By 1986, Skid-Lid went out of business. Helmet experts viewed this as a signal for the industry to focus on meeting the ANSI standard (Greer 1986). In 1987, Swart excitedly reported from the annual helmet exhibition in New York: 'Virtually all of the new helmets are designed to conform to the ANSI or Snell helmet standards, which we found very encouraging […including] manufacturers who had never before produced helmets which would pass any standard' (Swart 1987).

By late 1980s helmets became an integral part of the accounts of the risks of cycling circulating among club cyclists and their sociotechnical composition was stabilized, focused on a single catastrophic accident. Yet they remained marginal, almost negligible, among the largest section of US cyclists: children.

The quest for proving the effectiveness of bicycle helmets

In 1985, according to one study, only 2% of child cyclists on the US wore a helmet on a regular basis (Weiss 1986). Experts have been suggesting helmet use for children for more than a decade, but with little success. In the mid-1980s researchers surveyed children and parents, identifying four barriers to helmet use: comfort, price, fashion, and low awareness of benefits (Weiss 1986; Wasserman et al. 1988).

The helmet industry continuously sought to undermine the first three barriers. Swart's reports from annual helmet exhibitions document the efforts to produce lighter, better ventilated helmets, including helmets designed for children. The price barrier was largely overcome with the creation of a dual market: cheap yet ANSI-approved helmets, often sold in department stores, and upscale, more expansive helmets sold in bike shops, usually meeting the most recent Snell standard. The industry also sought to improve the helmets' fashionability, for example by using

brighter colours or linking the helmets to cycling champions. Yet, surveys of US children, and later reports of attempts to impose helmet use, demonstrate that many children and youth viewed helmets as unnecessary and, to put simply, uncool.

Some helmet advocates focused on raising parental awareness to the helmets' benefits. If parents viewed helmets as necessary, they would force children to wear them or to give up riding – two beneficial outcomes from the point of view of injury prevention. Helmet advocates lobbied family physicians and paediatricians to educate US parents and children on helmets, with some success. However, parents proved unwilling to join the network. Many parents- more than half in one survey- simply did not consider purchasing a helmet; others viewed them as costly or accepted their children's resistance as justified (DiGuiseppi, Rivara, and Koepsell 1990).

Another strategy to raise awareness was demonstrating the effectiveness of helmets. This route faced familiar obstacles: the rarity of helmet use, coupled with helmet variability, and a lack of data on exposure (overall cycling levels). Cohort studies required gathering vast amounts of data to allow calculation, and randomized controlled trials were ethically impossible. Researchers thus advocated helmet use, but did not present their effectiveness as a scientific fact. Consider the concluding remarks of a 1988 article in the *American Journal of Public Health*: 'The findings […] suggest that helmets may be effective in preventing head injuries […] consistent with the findings of Dorsch, laboratory evidence, experience in other sports, and common sense. However, for methodological reasons, this interpretation should be made with caution' (Wasserman et al. 1988, 1221).

In 1989, the *New England Journal of Medicine* published an article ending in a very different tone: 'we conclude that safety helmets reduce the risk of head injury by 85 percent and of brain injury by 88 percent […] bicycle helmets are effective in preventing head injuries in bicycle riders […] they are not being used enough. The time has come for a major campaign to increase their use' (Thompson, Rivara, and Thompson 1989).

The 1989 study originated with the frustration of Dr. Fred Rivara, a paediatrician and epidemiologist working in Seattle, with treating child cyclists with severe head injuries (Rivara, 25/2/2015, interview). Rivara, who has long been involved in injury prevention campaigns, recruited several colleagues (henceforth the Seattle team) and set out to prove helmet effectiveness. To do so, the team transformed its environment –Seattle –to generate the conditions necessary to conduct statistical calculations.

In 1986, the Seattle team launched a 3-year helmet promotion campaign, which included PBS announcements, distributing discount coupons and pamphlets by doctors and in community events, giving safety lectures in schools and providing discounts for children entering McDonalds branches with a helmet. By 1989, helmet use rates among children increased from 5.5% to 15.7% (DiGuiseppi et al. 1989).

The Seattle team tamed the variability of helmet designs by relying on the ANSI standard. Observers sent by the team to measure helmet use were directed to ignore 'hairnets', easily distinguishable from shell-covered helmets, and to treat all hard-shell helmets as comparable, assuming they meet the ANSI standard (Rivara, 25/2/2015, interview). Helmets were thus made comparable for the purposes of statistical calculation.

Even after the campaign, the number of reported bicycle crashes involving helmets remained small. The Seattle team overcame this by using a case-control research design, sometimes used as a proxy for cohort studies or randomized controlled trials. To measure the effectiveness of helmets, the team examined helmet use rates in cyclists suffering head injuries (case) and in cyclists suffering other injuries (control). The risk of bareheaded cycling was posed in the form of an odds ratio: $\frac{\frac{\text{Helmet users (case)}}{\text{Head injuries (case)}}}{\frac{\text{helmet users (control)}}{\text{other injuries (control)}}} = \text{Risk}$. To put differently, the Seattle team examined how likely were helmeted cyclists to suffer a head injury, compared to their likelihood to suffer other injuries. After controlling for confounders, the Seattle team found that the risk of a

helmeted cyclist to have a serious head or brain injury was reduced by 85% and 88% (respectively) compared to the risk of having another injury.

The 1989 study is often presented as a key event in the linear narrative describing the rise of the helmets as scientific progress. It proved the effectiveness of helmets and paved the way to helmet laws (Centers for Disease Control and Prevention 1995). As discussed, such narratives are commonly used to describe scientific and technological change, but the reality is often messier, and in practice the direction of such changes is fluid and contingent (Bijker 1995; Akrich et al. 2002). Similarly, when the 1989 study was first published its results were not unanimously accepted. Notably, the Seattle team expressed scepticism regarding the feasibility of helmet legislation (Rivara, DiGuiseppi, and Koepsell 1990). In 1991, the British Medical Association (BMA) rejected the 1989 study's conclusions, effectively ending a helmet legislation campaign in the UK.

Some arguments appearing in the BMA's report on cycling safety resemble those used in contemporary debates. The author, Dr. Mayer Hillman, argued that helmet laws are likely to discourage cycling and reduce public health, estimating a 20 to 1 ratio for the life years lost against those gained. Note that this critique does not challenge the effect found in the 1989 Seattle study, but broadens the account by introducing the vaguely defined figure of the potential cyclist, characterized by an unwillingness to cycle with a helmet. This highlights the multiplicity of the term 'effectiveness', similarly to other scientific terms, (e.g. Collins 1985), by contrasting the 'public health effectiveness' of helmets- their population-level influence – to their 'mechanical effectiveness' during an accident.

Hillman also suggested that helmets may cause 'risk compensation'. The history of this concept is beyond current scope (see Wilde 2001); the variant promoted in this period, mainly by Dr. John Adams, suggested that people do not desire a risk-free life: when risk is artificially reduced, people compensate and increase the risk involved in their behaviour. This critique

problematizes the relationship between the cyclist and the helmet.

These critiques and others were debated by academics (Adams and Hillman 2001) but remained marginal in the US. Their example emphasizes why the influence of the 1989 Seattle study in the US cannot be attributed to its objective success in proving a fact. Instead, understanding the study's pivotal role requires identifying its associations.

Helmet legislation and beyond

Helmet advocates in the US in the late 1980s believed that legislation was politically impossible. This belief was grounded in the recent backlash against motorcycle helmet laws in the US. In 1967 the federal government conditioned funding for highway construction and safety programs on the legislation of motorcycle helmet laws. 47 states passed such laws by 1975. This condition was relaxed since 1976, and by 1989 less than 25 states still had universal helmet laws (Homer and French 2009).

This atmosphere did not seem promising for bicycle helmet laws. Yet, by 1995 11 states and about 50 counties or cities passed such laws, almost invariably targeting children and youth (Swart 2018). Helmet laws do not equal helmet use; yet, their spread greatly extended the circulation of accounts of helmet-oriented accounts of the risks of cycling, drawing new participants into the network.

The helmets' cause was championed by Safe Kids, a safety advocacy organization based in Washington DC. In 1989 Safe Kids launched its first national campaign, focused on helmet promotion. The campaign was funded by a subsidiary of pharmaceutical giant Johnson & Johnson, which produced band-aids and other injury-related products. Safe Kids' co-founder and media relations expert, Herta Feely, explains helmets were chosen because of their orphan status, as a marketing strategy: as no organization has claimed ownership on this problem, newcomer Safe Kids could distinguish itself by doing so (Feely, 1/5/2015, interview). Safe Kids launched a

multi-faceted campaign, including a national media campaign, collaborations with the helmet industry to improve the helmets' status, and activities carried out by local chapters, aka Safe Kids Coalitions, including legislative efforts.

The question of a US bicycle helmet law was first put to the test in 1990. The venue was Howard County, Maryland. Students in a local high-school began a campaign for a helmet law following the deaths of two young cyclists, and the case reached the national media. Soon, advocates for public health, safety, and cyclists' rights were on their way to testify in front of the Howard County council, hoping to generate or prevent 'a tide' of helmet laws across the US (Beyers 1990). Professor Andrew Dannenberg, then with the Center for Injury Prevention in the nearby Johns Hopkins University, also testified. For the centre, the case provided an opportunity for a US precedent which could be evaluated and, if successful, copied elsewhere in the country (Dannenberg, 15/5/2015, interview). The council passed the helmet law in October 1990, limiting it to youth under 16 and using the ANSI standard as the minimum requirement. One councilperson, foreshadowing later developments, argued against the law due the lack of a federal standard and the need to rely on voluntary standards (Beyers 1991).

Over the next 5 years, dozens of helmet campaigns were carried out in the US. The media reports demonstrate that the accounts of the risks of cycling presented in these campaigns were remarkably similar. Campaigns were often led by the local Safe Kids coalition, consisting of representatives of parent-teacher associations, the police, and the medical community. Coalitions carried out activities such as the distribution of helmet coupons, safety lectures, bike safety rodeos and, often, helmet legislation campaigns.

According to former Safe Kids director Alan Korn, who was responsible for maintaining contact between the national headquarters and the local coalitions, by 1995 Safe Kids had considerable experience in helmet campaigns. Safe Kids formalized this experience in a standard helmet campaign kit, distributed among the coalitions. The kit's contents shed light on the dynamics of a typical campaign. It included a template for the law as well as ammunition for

public debate, including personal testimonies of victims and statistical evidence, mainly from the Seattle study. An actual helmet was added to help visualize the protection guaranteed. Safe Kids headquarters also provided tactical advice, for example to overcome libertarian resistance by focusing on children and youth and by bartering on the age limit (Korn, 2/12/2015, interview). When police officers expressed concerns about enforcement, the coalitions could re-frame the role of the law, assigning it a declarative function aimed at empowering parents against children. In addition, new laws were used by activists as precedents supporting the next law.

Safe Kids took on other issues since 1990, but helmets and helmet laws remained high on its agenda. Former Safe Kids directors explain that this was partly because Bell Helmets stepped in to fund the promotion of helmets and helmet laws (Mickalide, 23/7/2015, interview; Korn, 2/12/2015, interview), as it continues to do (Safe Kids 2019). By 1996 there were about 200 Safe Kids coalitions acting in the municipal, county or state level (Medeiros 1997).

The tactics applied by Safe Kids sometimes worked and sometimes failed. Moreover, helmet laws do not equal helmet use. Media reports suggest that helmets became the object of familial disputes, and that enforcement sometimes depended on specific individuals, for example a highly motivated cop or teacher. One indicator for this variability is the variability in the definition of 'children' in US helmet laws; the upper limit ranges from 12 to 17.

Yet, when considering the influence of such campaigns, a focus on the numbers of laws passed or cyclists fined is overly narrow. Even when laws failed, the coalitions' activities probably swayed some minds; this is supported by the above-mentioned rise in helmet use rates. To put differently, the network producing helmet-oriented accounts of the risks of cycling increased its reach, drawing in activists, politicians, cops, parents, educators, giving rise to educational programs and local publicity campaigns, and reaching children and youth. Some new recruits were convinced to join; others were coerced, including children forced to wear helmets, cops compelled to enforce laws, politicians coerced into supporting them, or parents exposed to criticism if their children failed to wear helmets. As mentioned, in 2012 regular helmet use was

estimated at about 40% for children in states both with and without helmet laws, suggesting that legislation captures only part of the spread of the network producing helmet-oriented accounts of the risks of cycling.

Campaigns usually relied on the Seattle study, circulating its results as undisputed facts. Activists working both for and against helmet laws in this period recalled that arguments regarding the discouragement of cycling or risk compensation were rare and had little influence. This is also mirrored in their rarity in news reports. In practice, the 'effectiveness' and the 'mechanical effectiveness' of bicycle helmets became synonymous.

Safe Kids and other organizations also attempted, with some success, to control the popular visual image of the cyclist and to ensure it was helmeted. Members wrote angry letters to newspapers and cycling organizations, chastising them for publishing images of bareheaded cyclists, especially when a celebrity was involved (e.g. Anonymous 1994). A former league president recalled expecting- and receiving - considerable backlash after publishing a picture with even one bareheaded cyclist in a group of dozens (Clarke, 12/7/2015, interview). For helmet expert Randy Swart, the regular publication of articles on helmets in the popular *Consumer Reports* provided another independent source of new data and more broadly indicated the helmets' rise to a common-sense status (Swart 1990).

Helmet legislation increased the industry's profits, motivating it to promote helmet use in Europe. Snell's profits also rose, and it funded at least 12 projects on bicycle helmets between 1992 and 1997, including a large-scale replication of the 1989 Seattle study carried out by the Seattle team.

The CDC and the Johns Hopkins team sought to measure the effectiveness of bicycle helmet laws. Yet like their predecessors they lacked enough data to statistically estimate their effectiveness. To bring the issue under their control, the research teams relied on the mechanical effectiveness of helmets, transforming the problem into a matter of measuring helmet use rather

than measuring public health effectiveness. After several studies found that laws and educational programs raise helmet use rates more than educational campaigns alone (Dannenberg et al. 1993), the CDC added helmet laws to its list of official recommendations in 1995 (Centers for Disease Control and Prevention 1995).

The CPSC's declaration of a federal standard for bicycle helmets provides a fitting conclusion for the formative era of the helmet-oriented account of the risks of cycling in the US. Safe Kids has called for a federal standard since 1989, but the CPSC refused, arguing that the voluntary standards are sufficient and broadly accepted. However, eliminating sub-par helmets was only part of what Safe Kids sought to achieve. Per Safe Kids' other co-founder, Dr. Martin Eichelberger, the standard was another way to enrol parents. A federal standard would deliver 'a clear message to US parents: Bicycle helmets save lives' (Eichelberger, 1989). In its annual 'reports to the nation', Safe Kids returned to the problem of low awareness of benefits, portrayed as part of the parents' poor understanding of risks, leading them to worry about rare events such as kidnapping more than about common mundane risks such as a bicycle crash.

After the failure of a petition to the CPSC, Safe Kids asked congress to pass a law forcing the CPSC to impose a standard. This was supported by the helmet industry, and such a law finally passed in 1994. The need to educate parents was rarely mentioned in the debates on the law; rather, congresspersons justified overturning the CPSC's decision by the need to eliminate sub-par helmets, to reduce confusion among consumers, and to encourage helmet laws by ensuring local policymakers that the products they mandate are up to code ('103rd Congress' 1993, H1248). This demonstrates the network's flexibility and ability to use different representations to support its spread.

Aftermath

On January 1, 2018 more than 20 states and 200 localities in the US had helmet laws (Swart 2018). Helmet education in schools and charitable distributions of helmets at discount prices are

common. Municipal authorities often present helmets as the central measure to reduce the risks of cycling (Culver 2018), and the visual censorship on bareheaded cycling remains influential. On the other hand, the spread of public bike-share programs reinvigorated the helmet debate, suggesting that mandatory helmets would discourage cyclists and hurt these programs' viability. The league, now renamed the League of American Bicyclists, has changed its tone, to the dismay of veteran vehicular cyclists, and encourages 'community cycling' in urban centres.

The case-control method remains controversial. Numerous studies have replicated the design of the 1989 Seattle study, usually finding helmets to have a high mechanical effectiveness, in some cases more than a 60% reduction in risk (Olivier et al. 2014). Yet, the weight of arguments regarding the discouragement of cycling and risk compensation is rising in the academic literature (Blank-Gomel 2017). These arguments are joined by the 'safety in numbers' thesis, which suggests that increasing the number of cyclists on the road would disproportionality decrease their relative risk, and vice versa (Robinson 2005). The effect of these arguments on policymaking is beyond current scope.

Finally, there are also attempts to complement the imaginary accident embedded in US-style helmet standards. Researchers and manufacturers seek to address rotational acceleration and mild injuries. Some suggest that the adherence to the CPSC standard is a central reason for the lack of innovation in the field (Barcott 2013).

Discussion

The results demonstrate that the emergence and spread of traffic safety conceptions cannot be sufficiently accounted for by relying on the automobility framework or by a linear narrative of scientific and technological progress. Moreover, these explanatory frameworks can be misleading when used to account for the rise of such conceptions (e.g. Lutz and Lutz Fernandez 2010; McLaren and Parusel 2011). Several developments described above can be attributed to automobility; for example, the ideology of automobility, and particularly the axiomatic

acceptance of car dominance, facilitated the marginalization of traffic separation (see also Emanuel 2012). Yet, participants did not necessarily perform as prescribed by the automobility framework, and their 'interests' were shown to be fluid and dependent on their network position.

The role of the helmet industry provides one example. The claim that helmets divert responsibility for accidents from drivers to cyclists (Furness 2010, Culver 2018) implies that the helmet industry is an agent of automobility. Activists seeking to discredit helmets often emphasize the helmet industry's role in their spread (Bicycle Helmet Research Foundation 2012). Yet, the results show that it did not orchestrate this process, and even delayed it due to its initial resistance to standardization. The industry's later transformation into a major force for helmet legislation demonstrates the difficulty with using automobility as a pre-defined explanatory factor.

The role of the cyclists offers further complications. While some view cycling as an alternative to the automobile, cyclists are not necessarily antagonistic to automobility and can interact with it in novel ways (Pesses 2010). In the current case, a group of cyclists acted as a central mediator of automobility-like ethics, emphasizing the links between autonomy and mobility when demanding the right to road. Safety was individualized, to be achieved by training and by using appropriate gear (including helmets), similarly to the car-driver's transformation into a capable road user (Packer 2008). The vehicular cyclists' use of safety considerations to curb the mobility of other road users, replicating a mechanism often used against cyclists, emphasizes the need to avoid a monolithic view of 'the cyclist' and consider differences and rifts between groups of cyclists.

The monolithic image of 'standard cyclist' is increasingly criticized (Pesses 2010). It is often argued that it represents the needs and demands of young, fit, middle and upper-class male cyclists while neglecting groups such as the elderly and female cyclists (Horton 2007) or the night cyclist (Cook and Edensor 2017). The study helps to account for the spread of this

traditional image, and more specifically to explain the remarkable success of a small group of thoughtful and committed citizens, to use Mead's term, in influencing and circulating this image, highlighting the role of cycling manuals and training courses.

In addition to familiar participants acting in unexpected ways, the analysis highlights previously hidden participants. For example, the cycling manuals, NEISS, the 1971 Snell standard and WABA's helmet committee all exerted influence on the network's spread and transformations. Their actions diverge from both the automobility framework and from linear accounts of the helmets' rise (Centers for Disease Control and Prevention 1995).

In addition to shaping the phenomenology of hybrid road user, non-humans influenced the mobility of their representations. The cycling manuals provide one example. I focused on the participants' role in reducing the uncertainty enveloping the network's products – their purification – and thus supporting their ability to create new links (Latour 2005). For example, NEISS transformed bicycle accidents from scattered events into a recurring phenomenon, a national problem, drawing various resources into the network.

The bicycle helmets' transformation into mundane, mechanical objects occurred through a series of such purifications, demonstrating the blurred borders between the social and the technical. The rise to power of the initially marginal 1971 Snell standard, through its associations with Snell, WABA, and eventually the 1984 ANSI standard, reduced uncertainty and drove out competing mechanisms of injury. This allowed the Seattle team to transform all bicycle helmets into comparable entities for statistical analysis, and then to use the case-control design to generate a novel form of helmet effectiveness, mechanical effectiveness. This form gained influence through its links with evaluations of helmet laws, Safe Kids, and helmet safety campaigns, obscuring the multiplicity of the term 'effectiveness' and equating it with the 'mechanical effectiveness' in the case of bicycle helmets.

The results demonstrate the need to consider the sociotechnical relations associated with non-humans, even seemingly mundane artefacts such as the bicycle helmet, with regards to both the phenomenology of road users and the movement of ideas and conceptions.

I did not trace latter developments regarding the bicycle helmets' composition (most notably the 'thin shell' debate and the campaign for 'good of fit') due to limited scope. Another limitation is the neglect of utilitarian adult cyclists, a group of unknown size, absent because it was not represented in accounts of major participants. Notably, recent years have seen a significant growth of interest in utilitarian cyclists.

The analysis de-naturalises the helmets' rise and re-raises marginalized uncertainties. However, the results do not necessarily imply that helmet laws or helmet use are wrong. While the results can be interpreted as a narrative regarding the rise of a flawed conception, in the tradition of a 'sociology of error', it is not clear what the error was. Critiques emphasizing risk compensation or the discouragement of cycling challenge the network presumed in US-style accounts of the risks of cycling, by attacking the helmet-cyclist relationship and the reliance on mechanical effectiveness, or by introducing new participants such as 'the potential cyclist'. In contrast, critiques targeting helmet design do not threaten this network. Rather than adjudicating, the analysis aimed to inform and to shed light on the complexity involved in producing everyday mobility.

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Chapter 3. Traffic accidents and traffic safety in sociology, 1940-2017

Abstract

Traffic accidents cause substantial harms and have far-reaching indirect consequences. Yet they have usually been marginal on sociological agendas. I examine how traffic accidents and traffic safety were conceptualized in sociological journals, 1940-2017, drawing on a systematic search in Web of Science, Scopus and JSTOR. While sociological interest in these issues has been sporadic and marginal, several shared themes can be suggested, including the social or sociotechnical conditions facilitating violent road behaviour among individuals or social groups; group differences in traffic risks; the position of traffic accidents on the public agenda; human-technology-environment relations; the production of traffic safety and its unintended consequences. I elaborate these themes, discuss the conceptualization of traffic accidents, and suggest venues for future research.

Keywords: traffic accidents, sociology, motor vehicle fatalities, traffic safety, crashes

Introduction: traffic accidents and traffic safety as sociological subjects

Every year, more than a million people die and at least 20 million are injured on the road. The World Health Organization (WHO) ranks traffic accidents as the 8th global leading cause of death, and they are the leading cause of death among children and young adults in many countries (WHO 2015, 2018b). As a result, governments have introduced traffic safety policies, but in recent years there have also been growing concerns regarding the unintended consequences of these policies, most notably their contribution to the reduction of physical activity levels (e.g. OECD/ITF 2013). Yet, with some exceptions, traffic accidents have been marginal on sociological agendas. There are indications that sociological interest in the issue is growing, partly fuelled by the rise of mobilities on the sociological agenda as well as recent challenges to the traditional road safety paradigm, but it remains marginal. I examine conceptualizations of traffic accidents and traffic safety in the sociological literature, 1940-2017, aiming to explore and potentially link different threads of thought on these issues.

The review is based on 266 studies identified using a systematic search in academic databases. This body of work is sporadic and fragmented, and it would be misleading to refer

to it in terms of an 'agonistic field' (Latour and Woolgar 1979) or a 'social world' (e.g. Clarke and Star 2008) implying ongoing relations, cooperative or confrontational, between actors or schools of thought. Yet, several major threads of thought and interest can be suggested.

After discussing the review's method, I will briefly present the history of traffic accidents and discuss the concept of the "accident" in sociology. I will examine studies focused on the sources of traffic accidents and as well as studies focused on the production of traffic safety and its consequences. Finally, I will suggest some potential sociological contributions to the study and conceptualization of traffic accidents and traffic safety.

Method

After exploratory research, I searched during September 2019 for relevant keywords in the title, abstract or keywords of studies published in journals classified as sociological in Web of Science (WoS) or as relevant to sociology and political science in Scopus, for 1940-2017. I defined journals as 'sociological' based on the classifications of the academic databases. This increased the number of multidisciplinary journals (e.g. *Social Science Quarterly)* and journals not intuitively identified with sociology, e.g. *Bulletin of the History of Medicine.* However, given the assumed marginality of these issues I preferred an inclusive approach.

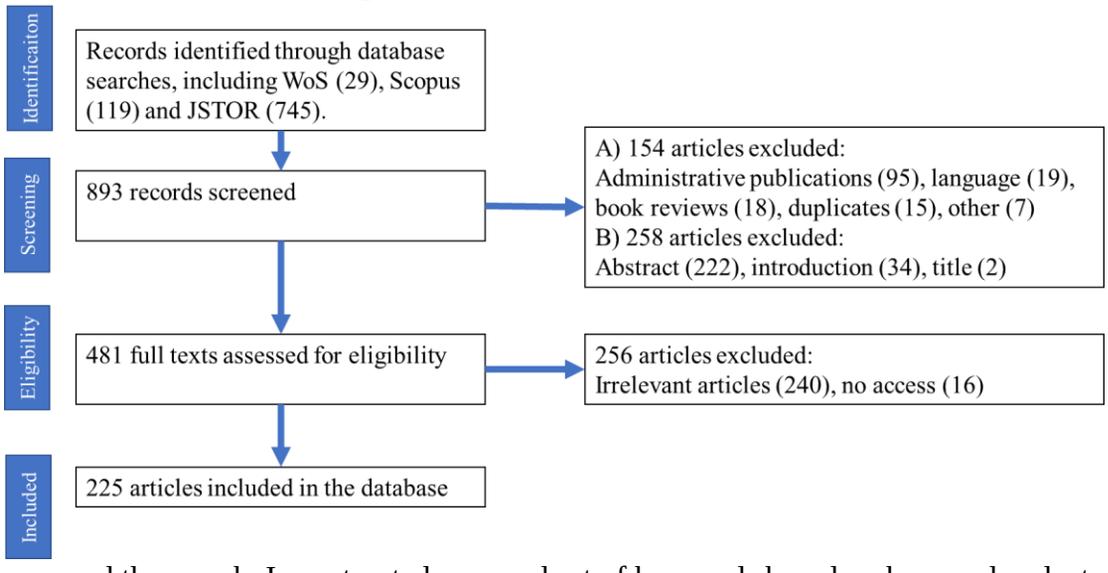
I used 9 keywords (wildcards included): *traffic safety, traffic accident, traffic crash, car crash, car accident, road safety, bicycle safety, pedestrian safety,* and *traffic injury*. This generated 148 records, arguably a low yield. As some suggest that these databases provide low coverage of the social sciences (Mongeon and Paul-Hus 2016), I added JSTOR. Due to the platform's constraints I searched for any appearance of the keywords in journals classified under the subject sociology, generating additional 745 results. Overall before exclusion I had 893 records.

Figure 1 visualizes the exclusion process. In the first stage of screening I excluded 154 articles, including administrative publications (e.g. 'back matter', 'index'), obituaries, book

reviews, book chapters, duplicates and non-English publications. One study was retracted. I then excluded 258 studies based on their title, abstract, or, in lieu of an abstract, the introduction. This included, for example, studies of political coups, wars, or sexual identification. I also excluded 16 studies which I could not access electronically, usually from very marginal journals.[3]

In the eligibility stage I read the articles in full and excluded irrelevant results, defined as cases in which the issues played a minor role in the article and were not elaborated theoretically. Frequent examples include the use of traffic accidents as a potential stressful life event, or using them to set up an ethical dilemma in a vignette (e.g. will you testify against a friend involved in an accident after driving recklessly), or if traffic accidents appeared as a biographical detail. Below I mention some of these as anecdotal examples, but they are not included in the dataset. Research quality varied, but this was not an exclusion criterion, as the review is focused on conceptual issues. I discuss methodical issues to highlight conceptual differences. I included 225 studies in the first database.

Figure 1: Article selection, wave 1

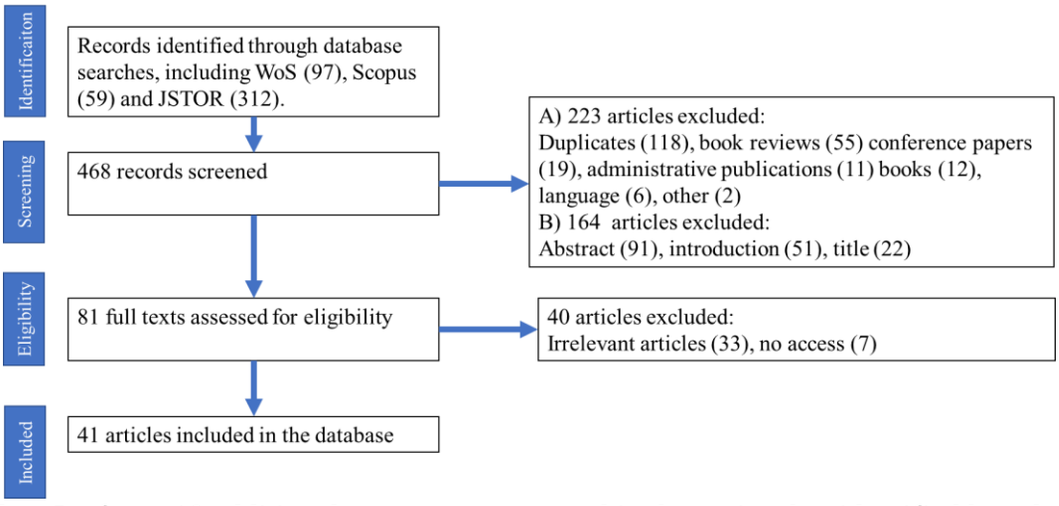


To expand the search, I constructed a second set of keywords based on keywords selected by authors or subject headings selected by the academic search engines. It included 18 new

[3] For example, *Society and Economy* (Q3 for sociology and political science on the Scimago platform), *Polish Sociological Review* (Q4 for social sciences, Scimago), or *Modern Law and Society* (not ranked on Scimago or JCR).

keywords (wildcards included): *motor vehicle accidents, motorcycle fatalities, motorcycle accident, bicycle accident, motor vehicle safety, motorcycle safety, highway safety, highway accident, hit and run accident, pedestrian injury, traffic fatalities, automobile accidents, automobile safety, road traffic accidents, childhood motor vehicle injury, transport injury, traffic safeguard,* and *traffic risk*. During December 2019 I repeated the above-mentioned selection process for WoS, Scopus and JSTOR using these keywords, eventually including 41 additional articles in the database (see figure 2).

Figure 2: Article selection, wave 2



Below I refer to 10 additional sources not captured in the review but identified based on experience and on consultations with an expert in the field.[4] These were not included because they were published in journals appearing in other search engines (e.g. Sage) or because they did not include keywords used in the search (e.g. Beckmann 2004), or because these sources were books. These sources are not included when describing the database.

This method has several limitations. The issues presented here are also discussed in other disciplines, sometimes by the same authors. However, the goal is to identify shared sociological themes across these issues. The review excludes a number of publications by sociologists appearing in non-sociological journals (e.g. Svensson, Summerton, and Hrelja 2014) or in books (e.g. Rothe 1994), while also over-representing publications by non-

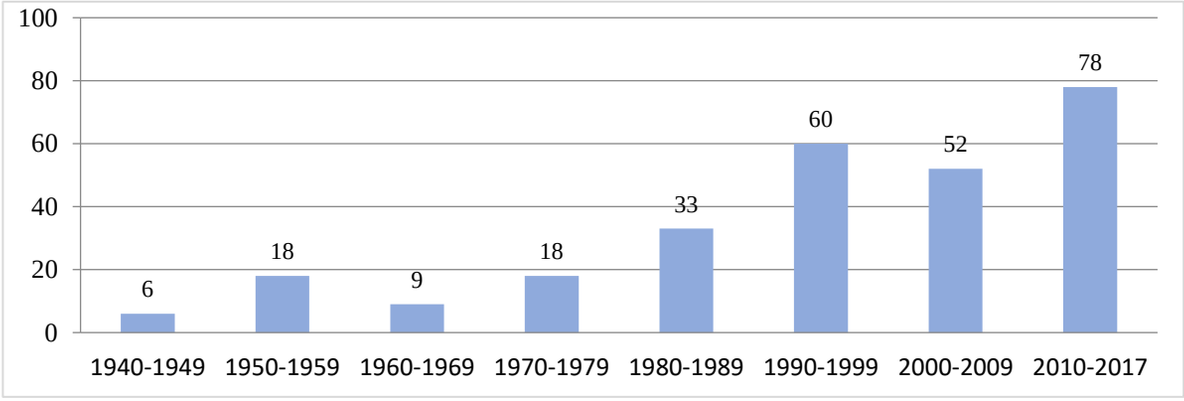
[4] I am grateful to Dr. Igancio Nazif-Muñoz for his valuable assistance.

sociologists. Despite these limitations the data are informative about the magnitude and diversity of sociological interest in traffic accidents and traffic safety.

Database characteristics. The final database included 266 studies (WoS- 22, Scopus- 97, JSTOR- 147), written by 548 different authors. The database, available upon request, includes articles' date, authors, title, allocation in the review, abstract if available, keywords, authors' disciplinary affiliations in the year of publication, countries examined, and the number of citations on Google Scholar on 1 January 2020.

Figure 3 demonstrates a general increase in the number of studies included. Yet the overall number remains low, especially given the growth in academic literature over the period discussed. This supports the impression that the issue is marginal in sociology. This impression is strengthened when considering that only 28% of the studies included were authored by at least one person working at the time at a sociology department.[5]

Figure 3: Articles included in the review, by decade

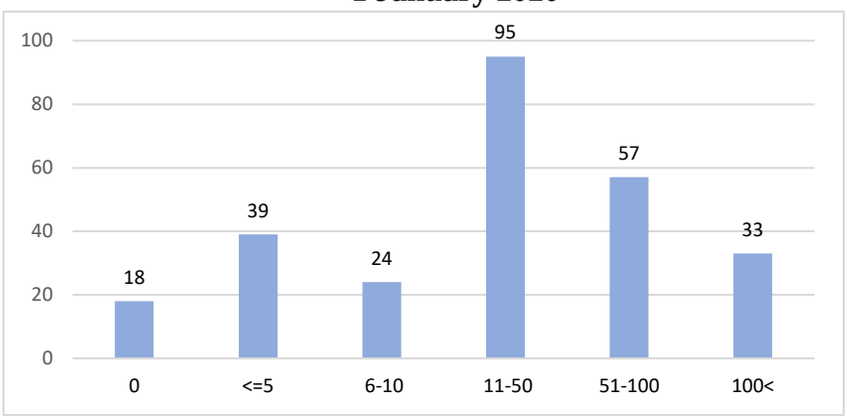


Only 55 authors, about 10% of the total, contributed to more than 1 article, and only 15 contributed to 3 studies or more (2.7%). This supports the impression that sociological interest in traffic accidents and traffic safety, with rare exceptions, is sporadic. The most frequent author, with 8 articles in the review, is H. Laurence Ross (1934-1997), a US sociologist who worked on traffic safety, drinking and driving, deterrence and policy evaluation, and was involved with initiatives to influence traffic safety policy. I discuss his work further below.

[5] Including 3% with an author affiliated with departments for cultural studies, social studies of medicine or social studies of science. In 2% of the articles I could not ascertain all authors' affiliations.

Figure 4 visualizes the number of citations for the articles included in the review, measured by searching on Google Scholar on January 1st, 2020. Google Scholar is considered to provide a broader coverage than WoS and Scopus with regards to the Arts and Humanities, and some studies found it specifically beneficial to track citations in the sociological literature (Halevi, Moed, and Bar-Ilan 2017).

Figure 4: Articles included in the review, by number of citations in Google Scholar on 1 January 2020



About one third of the studies were cited 10 times or less (81 articles, 30.5%), one third were cited between 11 an 50 times (95 articles, 35.7%) and one third were cited more than 50 times (90 articles, 33.8%), including 33 studies which were cited more than 100 times (12.4%). This does not include other studies discussed below which were not identified using the systematic search, e.g. Perrow's *Normal Accidents*. Citations for such studies, when mentioned, are from 4 June 2020.

Almost half of the studies in the review examined the US (48.8%), 7% examined Canada and 6% examined the UK. With some exceptions, until the 1980s studies focused on prevention and on identifying the social sources of traffic accidents. This approach was then complemented by studies of the social construction of traffic accidents and studies of the unintended consequences of traffic safety measures.

Traffic accidents and traffic safety: Introductory notes

A history of traffic accidents is beyond current scope (e.g. Gangloff 2013; Norton 2015; Hakkert and Gitelman 2014), but a brief introduction will be useful in contextualizing the articles discussed. The bias generated by the over-representation of the United States in the review is partly mirrored in the narrative below.

Throughout most of the first half of the 20th century, the dominant paradigm in the US and parts of Europe focused on 'accident prone' drivers, including incompetents and violent drivers (Elvik et al. 2009; Burnham 2008). The second half of the 20th century saw the rise of an epidemiological approach, led in the United States by Dr. William Haddon, first director of the US National Highway Traffic Safety Administration (NHTSA, est. 1966). His famous Haddon Matrix classified preventive measures in three time periods: before, during, and after the collision, and three relevant agents: the individual, the vehicle, and the environment (Haddon Jr 1972). Haddon's legacy has focused on 'crashworthiness', that is, designing cars to mitigate the crash's consequences during the event rather than preventing it (Lonero 2007; Hakkert and Gitelman 2014). Examples include seatbelts, airbags, padded dashboards and crumple zones, parts of the car's body designed to distribute the energy created during impact and reduce the force reaching the occupants. The automobile industry, in the US and elsewhere, frequently resisted making such changes mandatory, with varying degrees of success. During the late 1970s and 1980s scholarly interest in drinking and driving grew especially in the US, attributable to advocacy efforts by civil society organizations.

By the 1970s, traffic fatality rates were declining in most developed countries. With some exceptions this trend has continued, albeit at a slower rate. The decline is attributed to technological, legal, and cultural factors; there is dissensus regarding each factor's relative weight. Calculating this trend depends on the outcome measure chosen; prominent measures include the fatality rate per capita, per number of cars, or per vehicle miles travelled, each reflecting different assumptions regarding the risk involved.

The 1980s saw the emergence of a ‘safe system’ approach, a holistic perspective seeking to recognize and accommodate human fallibility on the road, for example by designing ‘forgiving roads’. The main example is Vision Zero, a policy implemented to its highest degree in Sweden and Norway. Vision Zero is based on the ethical premise that no deaths on the road are acceptable. This approach may be influencing other national policies (Elvebakk 2007), but the focus on the individual driver often remains dominant (Hakkert and Gitelman 2014). This period also saw a growing concern regarding the influence of traffic safety measures on public health, specifically children’s health (e.g. Leslie et al. 2005; OECD/ITF 2013).

The traffic safety literature identifies several persistent inequalities in the distribution of traffic accidents. Internationally, in 2016 more than 90% of traffic fatalities occurred in less developed countries, and males under 25 were almost 3 times more likely to die on the road compared to their female counterparts. The poor, the young, and the non-drivers are also usually at a higher risk (WHO 2018a).

Concepts of accidents

'Accident' is a notoriously ambiguous concept. Green and others attribute this ambiguity to the co-existence of different explanations for accidents (Green 1997, 1999; Douglas and Wildavsky 1982; Vieria 2013). The first explanation is rooted in 16th century Europe, which was dominated by the explanatory frameworks of religion and superstition. These had no conceptual room for accidents: undesirable, unintentional events causing harm were attributed to magic, fate, or divine intervention, and were sometimes interpreted as indicating a moral failing of the injured party.

The second explanation highlights the randomness of accidents. The 17th and 18th centuries saw a growing interest in statistical regularities. Accidents were initially interpreted as external to societal regularities and determinism. With the rise of a probabilistic style of

thought in the 19th century, accidents were re-conceptualized as a constant random element, internal to calculations. To put differently, accident patterns were re-conceptualized as comparable to natural events. The random view of accidents was viewed as a sign of maturity, in contrast to the 'primitive' view explaining accidents using hidden external meanings such as magic or fate. For example, during the early 20th century psychologists used the acceptance of the random view of accidents to measure intellectual development (Green 1997, 1999).

Ewald suggests that the random explanation of accidents was instrumental to modern insurance systems. It provided a residual category for non-classifiable events, thus enabling modern classifications of causes of death. Schemes such as workers' compensation assumed a certain number of accidents and developed mechanisms to compensate for them effectively, bypassing the issue of blame: " […] the only unknown being […] who will draw one of existence's unlucky numbers" (Ewald 1991:202). Attempts were made to prevent accidents, but the emphasis was on compensation.

The third explanation challenges the randomness and unavoidability of accidents and is linked to the development of epidemiology. The mid-20th century saw a shift to prevention brought about by the broadening of the field of epidemiology to include unintended injuries. Accidents were conceptualized as opportunities to generate data to better understand these events and potentially prevent them in the future; to put differently, accidents are transformed into risks using statistical method (Green 1997b, 1999). A similar logic is evident in the attacks against the term 'accident'; for example, in 2001 the British Medical Journal announced that it was banning the term and replacing it with 'crashes' in the case of traffic-related accidents (Loimer and Guarnieri 1996; Davis and Pless 2001).

While presented chronologically, these explanations maintain a tense co-existence (Green 1997b, 1999; see also Douglas and Wildavsky 1984). As Gusfield notes, the two latter explanations of accidents provide a poor answer to those confronted with "Job's Problem", asking "why me?" (Gusfield 1981).

Accidents are also central in Perrow's and Beck's influential works. Perrow (1984, cited more than 13,000 times on Google Scholar as of 4 June 2020) argued that accidents are normal in complex systems, but that some high-risk accidents cannot be accepted, and the social and technical arrangements enabling them should be changed, for example the risk of nuclear malfunctions. Beck's risk society thesis offers a similar interpretation of accidents as a potential engine for change (Beck 1992, cited more than 43,000 times on Google Scholar as of 4 June 2020). Both approaches focused on novel, catastrophic accidents and paid less attention to mundane issues such as traffic accidents. I discuss the use of these approaches to study mundane issues below.

Part I: The social sources of traffic accidents

I classified 163 studies (61% of the survey) as focused on the social sources of traffic accidents. Most can be read as partaking in the project of transforming accidents into risks by identifying factors influencing traffic accidents or risky behaviours on the road. Studies appeared most frequently in four multidisciplinary journals: *Social Science and Medicine* (36 studies), *The Annals of The American Academy of Political and Social Science* (16 studies), *Health and Place* (16) and *Law and Society Review* (9 studies).

I discuss three major themes: individual driver motivation, social factors, and the relations between humans, technologies and environments. In addition, the review includes several studies, published during the 1940s and 1950s, which criticized the term 'accident' as unscientific, discussed the structural causes of so-called traffic accidents, and promoted more rigorous methods and training for traffic safety experts (Eaves and Abercrombie 1946; Damon 1951; Stewart 1958). Similar calls regarding the need for expertise appeared in the review during the early 1990s (Hauer 1991).

Individual driver motivation. The traditional emphasis on the individual and his violent tendencies is evident in many studies reviewed. Some asserted the role of violent tendencies

with little or no elaboration (e.g. Waldron and Eyer 1975; Brenner 1987). Others offered more complex accounts.

Influenced by Durkheim's legacy, some compared traffic fatalities to suicides to determine if both kinds of deaths indicate deviant personalities or structural problems. Porterfield (1960) is an early example of this approach, written in a period of rising motor vehicle fatalities in the US. He hypothesized that suicides, homicides and traffic fatalities respond to a similar phenomenon, the prevalence of a personality type lacking respect for the life of oneself or of others. Finding correlations between rates of these events in several US locations, Porterfield concluded that "…aggressive, hazardous driving is likely to be characteristic of persons like those who have suicidal or homicidal or both tendencies - and vice versa" (Porterfield 1960).

As traffic fatality rates in the developed world were declining, later studies tested Porterfield's thesis and found mixed results. Conceptually, some privileged victimization over aggression, focusing on the contribution of 'hidden suicides' to traffic fatalities (Waldron and Eyer 1975; Holinger and Klemen 1982; Maxim and Keane 1992). Using a similar logic, studies examined whether the risk of a traffic accident is higher on the days surrounding birthdays, a period of contemplation and potentially depression, in the US and Japan (Kunz and Williams 1983; Matsubayashi and Ueda 2016). Others maintained a focus on aggression (e.g. Brenner 1987; Caspi et al. 1997) or suggested that the form of violence expressed on the road varied by age group (Heuveline 2002). Elias conceptualized traffic accidents through the lens of self-regulation: under-civilized societies exert less social control and their drivers suffer from poor self-regulation, giving rise to traffic accidents (Elias 1995; see also Lumsden 2015).

Studies focused on victimization often use changes in single vehicle crashes (SVCs) as a proxy for hidden suicides, seen by some as a more precise measure of driver intent (Bergdahl and Norris 2002). However, determining the magnitude of this phenomenon, and considering

whether multi-vehicle accidents also contain hidden suicides, remain important subjects for future research.[6]

Another perspective on individual driver motivation comes from studies of the effectiveness of traffic safety measures, specifically those drawing on the deterrence framework. The abovementioned conceptualizations of individual driver motivation emphasized the role of violence, directed inwards or outwards. The deterrence framework assumes that road users are rational actors and that risky behaviour follows a rational calculation weighing benefits and risks. Examples include studies of measures against drinking and driving (Ross, McCleary, and Epperlein 1981; Dee 2001) and seatbelt laws (e.g. Maguire and Faulkner 1990; Houston and Richardson 2006).

The logic of deterrence suggests that harsher enforcement will increase compliance. However, a more complex picture emerges. Ross and others argued that deterrence measures are more effective when ensuring the certainty of sanctions rather their severity (Campbell and Ross 1968; Ross 1976; Jacobs 1988). For example, 'certainty' can be increased by shifting from a behavioural test for drunkenness (touch your nose, etc.) to the Scandinavian approach of using a blood alcohol (BAC) test (Dee 2001). However, even thus the effects of deterrence can be short-lived. Ross and others argued that deterrence should be replaced or complemented by a holistic perspective, namely one taking into account social institutions facilitating risky driving and traffic accidents, for example policies regarding alcohol, in-vehicle safety devices, or the organization of transportation services (Ross 1984, see also 1992).

The conceptual framework of deterrence can also be read as relating a form of violence, as the driver is choosing to drive in a risky manner unless deterred. The tendency of such policies to become less effective over time raises questions regarding the usefulness of this

[6] The search also included sociological studies treating traffic fatalities as a threat to the validity of suicide statistics (e.g. Timmermans 2005). These were not included in the review.

perspective. The focus on violence is further complicated by studies highlighting psychological mechanisms, and specifically studies of offsetting behaviour, also known as risk compensation or risk homeostasis. The history of these concepts is beyond current scope (Adams 1995; Hedlund 2000; Wilde 2001), but succinctly they suggest that some individuals desire some degree of risk. When risk is reduced artificially, for example by mandating seatbelts or helmets, individuals 'compensate' and act in a riskier manner, either intentionally or not. To put differently, agency is re-conceptualized as distributed between humans and technologies. This phenomenon was often used to explain why policies were less effective than predicted, for example with regards to the 1966 National Traffic and Motor Vehicle Safety Act in the US (Graham and Garber 1984; see also Peltzman 1975) or to various seatbelt laws and measures (e.g. Chirinko and Harper Jr 1993; Calkins and Zlatoper 2001).

Social factors. Three main social factors were frequently identified in the review as contributing to traffic accidents or risky behaviour: the mass media, group membership, and cultural influences. In addition, the review included several studies, usually published in interdisciplinary or social psychology journals, which discussed the influence of the peer group (Rabow et al. 1990; Curtis, Thurman, and Nice 1991) or the family on risky behaviours on the road (Arnett 1995), as well as studies of how macro-level economic changes (Edwards 2008), such as the recent 'great recession' in the US, influence traffic accident rates; for instance, increased unemployment can reduce driving and exposure but also encourage more risky driving (He 2016).

The mass media. The mass media can influence individuals directly and subliminally, with both desired and unwelcome, unintended consequences. During the 1970s and 1980s, in the context of a national debate regarding media and behaviour in the US, Phillips examined whether traffic fatality rates follow "the Werther effect", which suggests that exposure to stories about suicides and suicidal behaviour is followed by excess suicides (a higher than expected suicide rate). Phillips argued that traffic fatalities contain 'hidden suicides', but he

emphasized the role of imitation rather than attributing it to social structures and institutions generating flawed personalities. To put differently, Phillips focused on the mechanisms influencing an individual's decision to commit suicide, for example higher exposure to suicide stories in the mass media (Phillips 1979, 1982; see also Bollen and Phillips 1981). A recent study used a similar method to examine the association between violent stories (regarding major bombings in Israel) and fatal traffic accidents, suggesting that such stories induce frustration which may lead to accidents. Notably, the authors included both single and multi-vehicle accidents (Stecklov and Goldstein 2010). These examples suggest that subliminal messages can tap both suicidal and aggressive tendencies.

Others examined the media's direct influences, for example whether public media announcements can encourage safe behaviour on the road (Curtis et al. 1991; Murry Jr, Stam, and Lastovicka 1996). The mass media was also analysed as a tool of the automobile industry, using advertisements to encourage risky driving through imitation or by associating the car with risky activities, for example showing a car bungee jumping (Redshaw 2007; Feinberg et al. 2014). Tranter and Lowes (2005) studied the Australian custom of placing motor races in symbolic urban areas, for example the Canberra 400 conducted in the area surrounding the Australian parliament. They argued that the spectacle of dangerous driving in a familiar area may encourage imitation by non-professional drivers. The authors stressed that in principle races can encourage safe behaviour by creating a distinction between racing and regular driving.

Some conceptualized traffic accidents as an unintended consequence of the clash between the image of driving in advertising, emphasizing limitless mobility, freedom, adventure and civility on the road, and the everyday realities of traffic, i.e. congestion and incivility. This tension can cause frustration, lead to aggressive driving and, in its extreme form, road rage (Redshaw 2007; see also Lupton 1999).

Demographic groups. Some social groups carry a disproportionate share of the burden of traffic accidents and fatalities, including children, young adults, males, and the poor. This section is focused on studies of these groups as demographics. Two major theses emerge: the gender convergence thesis and the risk equalization thesis.

Francis (1960) predicted that women's entrance into the labour force would lead to gender convergence in traffic fatality rates, and suggested this would be due to female assimilation in male culture. Tests of this thesis found evidence for partial convergence, with men still at a higher risk (Stewart 1997; Heuveline 2002). Other authors, however, attributed this effect mainly to the increase in women's exposure to traffic rather than to cultural assimilation as argued by Francis (Veevers and Gee 1986; Maxim and Keane 1992; Yang et al. 2012; see also Bergdahl and Norris 2002; however see Waldron and Johnston 1976).

The risk equalisation thesis suggests that socioeconomic differences in risks are reduced during young adulthood, considered a transitory period. Tests of this thesis, mainly examining European developments and using different socioeconomic measures, found mixed results. For example, some found evidence for equalization among pedestrians but not among car occupants (West and Sweeting 2004) while others found evidence for equalization for some risks but not for traffic accidents (Green 2013).

Additional themes examined include group differences in attitudes towards risky behaviour, for example gender or religious differences (Sweetser 1967; Peek, Chalfant, and Milton 1979), and the social determinants underlying the higher risk for accidents among a group of road users, for example pedestrians (Christoffel et al. 1991; Híjar, Trostle, and Bronfman 2003) and motorcyclists (Reeder, Chalmers, and Langley 1996).

Several studies examined whether group differences in accident involvement are due to situational factors and the driving environment, or do they stem from beliefs or behaviours characterizing social groups such as immigrants or young adults (Trovato 1992; French and Gumus 2014). For example, Trovato (1992) found no differences in the risk of a traffic

fatality between immigrants and non-immigrants in Canada, and suggested that this indicates that traffic fatalities are the result of situational factors rather than cultural differences acquired by members of specific groups in an early age.

Cultural factors. The definition of 'culture' is notoriously elusive. For current purposes I relied mainly on the terms used by the authors.

It is frequently suggested that traffic accident rates and risky driving reflect national cultures (e.g. O'Neill 1958; Hayden 1989). With the decline in traffic fatality rates in developed countries, several studies conceptualized traffic accidents as an indicator of societal, political or economic development (Svalastoga 1970; Zapf 1979; Elias 1995; Moniruzzaman and Andersson 2008). One study argued that democracy is more conducive to reductions in traffic accidents (Mackenbach, Hu, and Looman 2013). Tilleczek (2011) criticized youth driving culture in Canada, and attributed this partly to the contradictions in driver education programs: these programs portray driving as both highly dangerous and perfectly normal, generating a tension rendering them ineffective.

Several ethnographies of risk-taking on the road linked it to a rejection of the dominant culture. For example, street racing enabled young males in Helsinki to reject bourgeois culture (Vaaranen 2004) and Australian motorcyclists privileged embodied knowledge gained through riding over expert knowledge, seen as distant and less relevant (Natalier 2001). In a similar vein, Bellaby argued that young motorcyclists in the US occupy a liminal social space in which they are expected to act dangerously (Bellaby 1990). Group members did not necessarily accept the portrayal of these behaviours as risky.

Two studies utilized the persistence of 'dry' counties in the US (estimated at about 10% in the early 2000s) to examine the influence of community norms on alcohol-related motor vehicle fatalities (Winn and Giacopassi 1993) or on "driving under the influence" (DUI) arrests (Powers and Wilson 2004). Others examined the role of workplace policies and regulations (Curtis et al. 1991; Rodriguez, Targa, and Belzer 2006). For example, an

ethnography of Canadian truck drivers found that Hours of Service regulations, which limit daily driving time, are ineffective and encourage risky behaviours. Thus, truckers often drive more hours than they report to curry favour with management or to avoid being stranded in an inhospitable location when the limit is reached (McLean 2016).

Some studies stressed the role of confusion and misunderstandings, breaking with the focus on violence and aggression and raising questions regarding drivers' ability to interact and reach an understanding. Urban-rural differences are a common example (Francis 1960; Swan and Owens 1988; Keohane, Kuhling, and Horgan 2003; see also Dannefer 1977). For example, Keohane and his colleagues argued that some traffic accidents in Ireland are caused by a clash between a rural culture, characterized by low speeds, poor roads and local drivers, and an urban 'global' culture, characterized by higher speeds, well-maintained, lit roads, and urban drivers, many of whom are not local. The authors found a higher risk for traffic accidents in intersections linking rural roads and highways, that is, intersections between cultures (Keohane et al. 2003).

Humans, technologies and environments. The review includes various conceptualizations of how human-technology relations can lead to traffic accidents. Some studies focused on the competence of road users, examining ways to improve it, e.g. teaching children to behave on the road, as elaborated below, or simplifying instructions for child safety seats (Hunter and Hunter 1991; Wegner and Girasek 2003). Others discussed the argument that contemporary driving demands an unreasonable degree of vigilance (Elvebakk 2007; see also Freund and Martin 1997).

As discussed, safety technologies can have unintended consequences. In addition to the abovementioned mechanism of individual risk compensation, the review suggests several ways in which safety technologies can generate new risks, particularly the shift to heavier cars to provide better protection. A 1980 study argued that heavier cars require more fuel, giving rise to a safety-sustainability trade off (Meyer and Manheim 1980), and more recent studies

argued that heavier cars transfer the risk to vulnerable road users, including drivers of lighter vehicles who are more likely to be harmed during a crash with a heavier vehicle. Thus, Demoli argued that higher social groups in France tend to use heavier and safer cars, re-creating and perhaps exacerbating social inequalities on the road (Demoli 2015; see also Bradsher 2002; Redshaw 2012).

Drawing on Actor-Network Theory, Beckmann stressed the reciprocity in human-machine relations. He conceptualized traffic accidents as a breakdown in trust between drivers and vehicles, and suggested transferring responsibilities to the increasingly sophisticated machines (Beckmann 2004). Notably, this resonates with Elias's contention that increased self-regulation would reduce traffic accidents, although in Beckmann's case the regulation is through reliance on machines rather than behavioural control. As autonomous cars spread, this issue is likely to raise more interest.

Randell (2017) suggests that it is necessary to consider the role of the environments in which driving take place. For example, a recent study emphasized the role of the driver's residence, arguing that drivers are less careful outside their neighbourhoods, and that this displaces risk to inner city neighbourhoods suffering from both a higher car volume (as arterial roads) and less careful driving (Yiannakoulias and Scott 2013). Another study suggested that legislative systems may attract riskier drivers, in that case bareheaded motorcyclists in the US preferring to ride in states without universal motorcycle helmet laws, thus artificially increasing the level of risk on their roads (French, Gumus, and Homer 2012). Another study found that road bends may be riskier individually but have a protective effect on the level of the area (Jones et al. 2012).

Part II: Traffic safety as a social construct

I classified 103 studies, or 39% of the survey as dealing with the construction of traffic safety. Prominent journals include *Social Science and Medicine* (14 articles), *Health and*

Place (13 studies), and *Children, Youth and Environment* (9 studies). 100 studies were published since 1980, and 67 were published since 2000. These studies provide a critical, multifaceted perspective on the transformation of (traffic) accidents into risks, including the moral, scientific, social and practical aspects of this process.

Unintended Consequences. Since the 1990s, several studies examined unintended harms of traffic safety, mainly public health losses caused by the children's confinement to the home and their dependence on parental escorting (Hillman and Adams 1992; Björklid and Nordström 2007).[7]

Several studies examined the attempts to accommodate these risks, for example teaching children risk management strategies, Safe Routes to School and Walking School Bus programs. Studies examined whether such attempts were able to influence activity levels, develop a sense of independence, and produce safe, competent road users (e.g. Green 1997c; Collins and Kearns 2005; Hubsmith 2006; Mendoza et al. 2012).

Children are frequently treated as the first victim of traffic safety, although concerns about related health losses refer to the general population. Studies of neighbourhood 'walkability' and active lifestyles examined whether traffic safety concerns are associated with reduced walking or cycling (e.g. Leslie et al. 2005; Vinikoor-Imler et al. 2011; Van Dyck et al. 2012).[8] Traffic concerns were measured in various ways, including objective measures such as collision rates (Pabayo et al. 2012), the number of lanes (Vinikoor-Imler et al. 2011) or accident density (von Wirth, Grêt-Regamey, and Stauffacher 2015), and subjective measures such as individual's perceptions of road characteristics (Handy, Cao, and Mokhtarian 2008; Sallis et al. 2011). Some studies problematized the concept of 'neighbourhood', arguing that

[7] The journal *Children, Youth and Environment* provided an important but not exclusive forum for many of the studies regarding children.

[8] I excluded studies which examined 'neighborhood safety' as a composite variable, grouping together concerns regarding both traffic and crime without elaborating on the former (e.g. Romero 2010).

this geographical unit is not necessarily indicative of actual routes (Carver, Timperio, and Crawford 2008; Villanueva et al. 2012).

The Image of Traffic Accidents. The automobility concept is frequently raised in sociological studies of traffic safety. This concept had different uses, for example designating an ideology or a car-dominated travel mode (Freund and Martin 1993; Volti 1996), but Urry (2004) has emerged as a conventional reference point (cited more than 1,600 times on Google Scholar as of 4 June 2020; see also Bonham et al. 2006; Parusel and McLaren 2010).

Urry described automobility as a historically contingent ‘system' infecting modern societies and re-shaping them in its image. It is composed of several re-enforcing mechanisms, including the car's dominance as a form of mobility, its centrality in the capitalistic mode of production, its influences on the organization of work and family life, and its cultural associations. Simultaneously, automobility is an analytical framework linking identity formation and ethical conceptions regarding autonomy, mobility, and the relations between humans and environments (Sheller and Urry 2000; Urry 2004). Urry subsequently argued that we are transferring into a post-automobility regime, whose contours remain unclear (Dennis and Urry 2009).

There are critiques and correctives for Urry's analysis (Böhm et al. 2006; Manderscheid 2014), but I found that traffic accidents played a similar role in all these approaches, namely the role of a potential threat successfully managed by automobility. Some suggested that highlighting the marginality of traffic accidents on the public agenda exposes the biases of modern risk assessments and debunks their claims of rationality and neutrality (Lance 2000; Parusel and McLaren 2010; see also Böhm et al. 2006). One study found the marginality of traffic accidents on the public agenda to be reasonable given the many benefits of car travel (Roots 2007), while others called for the inclusion of traffic accidents in risk assessments and for a broader conceptualization of their consequences, including who should carry the cost

(Shrader-Frechette 1980; Elvik 1995; Delucchi 1997; Litman 1997; Stringham and Pulan 2006).

The marginalization of traffic accidents is often linked to one or more of three overlapping processes: normalization, preventing their emergence as a political issue; individualization, obscuring their structural sources; and dramatization of some traffic accidents while neglecting other, sometimes more common types of traffic accidents, for example those leading to relatively minor injuries, property damage, or accidents not involving alcohol or drugs, viewed as a normal occurrence.

Individualization and the allocation of blame. I define the individualization of traffic accidents as assigning blame to individuals rather than alternative culprits such as vehicles, roads, or social structures and institutions. The individualization thesis provides a hatch into the broader problem of allocating responsibility for traffic accidents.

The automobile industry is frequently identified as a main proponent of individualization (Brooks 1982; Robertson 1998; see also Norton 2008; Lutz and Lutz Fernandez 2010). For example, Gilbert and Henry (2012) attribute the popularity of the individualized view of traffic accidents in France to the automobile industry's dominant position vis-à-vis others involved in defining traffic accidents.

Others emphasized the influence of societal transformations. Itzen (2016) provides a case of de-individualization, following the transference of responsibility for maintaining safe roads during hazardous weather from drivers to the German state during the early 20th century. Nowak (2016) argued that after WWII traffic accidents in West Germany were individualized due to the influence of a liberal ideology, constructing driving as requiring self-control in order to achieve independence while simultaneously assuming the responsibility to avoid harming others (see also Packer 2008).

Wetmore's analysis of airbags in the US demonstrates the complex configurations supporting individualization. Like other safety features, airbags were resisted by the

automobile industry but forced upon it by activists which successfully lobbied to make them mandatory. During the 1990s, the position of airbags was undermined by a series of infant deaths due to airbag inflation. However, the industry and the activists collaborated in assigning the blame to parent-drivers. The industry strove to avoid liability; the activists sought to maintain public trust in the technology they promoted (Wetmore 2004).

Vision Zero, Sweden's pioneering traffic safety policy established on 9 October 1997 by the social democratic government, provides an interesting case study to examine the individualization theme. Vision Zero seeks the de-individualization of traffic accidents: responsibility for accidents is assigned to the transportation system, seen as a participant rather than an arena; it is recognized that drivers will make mistakes, but the road system is expected to be designed to minimize the outcomes of such mistakes. Yet studies of Vision Zero problematized the role of drivers in the new system. Elvebakk argued that drivers involved in accidents are re-cast as victims, thus justifying a more invasive regulation of mobility and likening drivers to pilots or train drivers, in contrast to the ideal of autonomy identified with driving (Elvebakk 2007; Randell 2017; see also Forstorp 2006).

McAndrews (2013) drew on government publications and interviews with experts and stakeholders and argued that drivers are individualized in new ways: they have less causal responsibility, but are assigned with a new political responsibility, expected to give voice to their demands for safety (2013:757–58). She noted that in practice system engineers reject causal responsibility for accidents and blame individual drivers.

Other analyses suggested additional culprits and perspectives. Thus, a study in *The Annals of Tourism Research* criticized tourism agencies attracting consumers by promoting a risk-taking attitude (Page and Meyer 1996), and an analysis of the terminology used in news stories regarding accidents involving animals, published in *Society & Animals*, found these are more likely to assign responsibility to humans when reporting on land-related traffic accidents compared to boat and aviation accidents (Kuha 2011). Studies measured the

willingness of the American public to assign responsibility for accidents to alcohol providers (Wagenaar et al. 2001), and inter-community differences in the conceptualization traffic risks and in the willingness to act upon them (Butchart, Kruger, and Lekoba 2000; Collins and Kearns 2005). Using data on locations of alcohol sales and motor vehicle fatalities, one study found that binge-drunks are more likely to drive after purchasing alcohol in a bar compared to a store, and suggested that the state should tax such sale points accordingly (Cotti, Dunn, and Tefft 2014).

Normalization. I define normalization as the presentation of traffic accidents as mundane events rather than a basis for political action. This definition excludes studies of the normalization of risk-taking on the road, discussed above as a source of accidents.

The normalization of traffic accidents is supported by the individualized view but goes beyond it. A few studies discussed normalization within the industry, frequently using the case of the Ford Pinto, a famous case in which the Ford Corporation arguably preferred the costs of lawsuits rather than changing a faulty design (a defective fuel tank). Studies suggested that Ford acted within the norms shared by the industry (Swigert and Farrell 1980; Clarke 1988) and the government (Lee and Ermann 1999).

Additional contributors to normalization were also identified. Beckmann notes the role of 'the accident industry', a network of professionals dealing with the aftermath of accidents in a way that would produce traffic as essentially safe (Beckmann 2004; Roberts and Coggan 1994); Vardi (2014) argues that methods of quantification were instrumental in transforming traffic accidents into a pseudo-natural event, comparable to natural disasters; and Schlich (2006) argues that trauma surgery and motorization in pre WWII Germany co-evolved to their mutual benefits: trauma surgery emerged from its relative marginality, and motorization advanced without resorting to measures such as speed limits (re-set in 1939) going against the dominant ideology supporting technological progress.

Some studies discussed the role of insurance schemes, for example no-fault insurance, in streamlining the handling of traffic accidents with minimal damage to the parties involved, including avoiding catastrophic costs to road users and the insurance companies or overwhelming courts' caseloads (e.g. Marryott 1953; O'Connell 1979; Tanase 1990). Relatedly, Baker (2001) argues that the norm among traffic accident lawyers (and other accidents) in the US is to prefer payments from insurance companies over direct payments from individuals, seen as 'blood money'. This creates the risk of individuals purchasing insurance schemes with a low limit, thus limiting their ability to offer compensation.

Another variant of normalization can be found in the institutional attitudes towards traffic violations. In 1960, Ross argued that traffic violations are generally seen as 'folk crimes' requiring less attention. Later studies discussed a gap between harsh traffic safety policies in the US and a lenient practice of the police and courts, often viewing traffic accidents similarly to the random explanation, i.e. something that may happen to anyone (Little 1973; Gusfield 1981; Ross 1992). I did not identify additional studies of this issue published during the last two decades throughout this review. This may be attributable to a generational shift with regards to attitudes regarding traffic violations; this requires further study.

Parusel and McLaren examined a challenge to normalization. Analysing trips to school in Vancouver, they argued that the public image of traffic as safe is an 'illusion' maintained by parental safeguarding, that is by escorting children to school. Parents are aware of this illusion and strive, albeit unsuccessfully, to shift responsibility for safety on such trips to the municipal authorities (Parusel and McLaren 2010; McLaren and Parusel 2012).

Dramatization of (some) traffic accidents. I define dramatization of traffic accidents as disproportionally focusing on some types of traffic accidents, compared to their share in the burden of traffic-related harms, while infusing them with moral significance. The most prominent example for dramatization is drinking and driving.

The review includes several studies arguing against the dramatization of drinking and driving, without necessarily using this term. Before 1980, several studies argued that drinking and driving is common and that the role of alcohol in traffic accidents is exaggerated (Mulford 1964; Little 1973). Since the 1980s, the efforts of civil society organizations such as Mothers Against Drunk Driving (MADD) and Remove Intoxicated Drivers (RID) raised interest in drinking and driving in the US. They also attracted sociological attention, directed at the formation of drinking and driving policies and at the mechanisms underlying the success of MADD and RID.

Gusfield's *The Culture of Public Problems: Drinking and Driving and the Symbolic Order*, probably the most famous sociological study of traffic safety (cited more than 2,700 times in Google Scholar as of 4 June 2020), is an exemplary study of dramatization. Gusfield demonstrated how the contribution of alcohol to traffic accidents is exaggerated by experts, for example by blurring the distinction between a driver who drank and a drunk driver, and by activists and politicians using such analyses to vilify drivers who drank. At the same time, structural conditions encourage drinking and driving, for example the lack of public transportation to concentrations of bars ('alcohol valleys') (Gusfield 1981).

Social movement scholars attributed MADD's success to its ability to conceptualize accidents involving drivers who drank as 'criminal events', rather than random events or mistakes. The re-casting of such drivers as 'villains' enabled the rise of a 'victim-activist' identity as a person who has been wronged, fostering the formation of a viable grievance (Ross 1987; Weed 1990, 1991; McCarthy and Wolfson 1996).

MADD and RID justified the policies they promoted in scientific terms. This suggests that their influence can be read as a shift from the random explanation of accidents to the high-modern explanation viewing them as potential risks in the making. Yet, scholars argued that MADD sought retribution rather an instrumental solution (Reinarman 1988), and even within the deterrence model the focus on harsher punishments was less effective than focusing on the

certainty of punishment (Ross 1987, 1992). The focus on retribution suggests the legacy of the providential explanation and the moral bias against drivers who drank.

Alternative accounts of traffic accident risks. This section partially overlaps with the discussions above, but it is focused on different theme: alternative conceptualizations of traffic accidents and attempts to give voice to marginalized groups (e.g. Christoffel et al. 1991; Gill 2006; Björklid and Nordström 2007; Parra et al. 2010; Fusco et al. 2013).

Studies examined different ways of representing children, for example creating a post for a children's representative in the municipal government (Wilhjelm 1995). Others used technological developments to give children a voice, for example by using GIS to map children's actual routes to school rather than relying on reporting from children or parents (Wurtele and Ritchie 2005; Villanueva et al. 2012; D'Haese et al. 2015; Preto et al. 2016).

Representations of road users and their environment have moral dimensions. Roberts and Coggan (1994) criticized expert interpretations of child pedestrian injuries for victim-blaming, in line with the individualization thesis. Similarly, parents were assigned responsibility for traffic accidents, as drivers (e.g. Wetmore 2004), as authority figures who can enforce children's safe behaviour, and as potential activists lobbying for neighborhood safety (Cloutier 2010). Some suggested that parents are caught in a 'social trap' between allowing their children to develop independence and following the socially promoted image of the responsible parent (Carver et al. 2008; Parusel and McLaren 2010).

Expert claims and their influence on accounts of traffic risks also drew scholarly attention. Studies examined the role of exaggeration and data manipulation with regards to traffic safety policies (Gusfield 1981), while others stressed the contingency involved in the development of such policies and measures (Tolchin 1984; Leonardi 2010; Simpson 2011; see also Reppy 1979). For example, Leonardi (2010) analysed the development of innovative crash testing in the US as a contingent configuration combining statistical methods, organizational changes in the automobile industry, and the industry's legal tactics.

Authors drawing on science and technology studies explored the meanings of seemingly universal concepts such as effectiveness or competence in accounts of traffic risks. For example, the effectiveness of safety devices such as seatbelts can expand from discussing mechanical functioning to include psychological, sociological and legal dimensions (Irwin 1987; see also Blank-Gomel 2017). In another case, the definition of competence in Emergency Medical Services was found to be dependent on historical legacies, national biomedical standards, and different populations in need (Nurok 2001).

Several studies highlighted the role of non-intuitive participants in accounts of traffic risks. For example, a study of emergency medical services called for training drivers in first aid and ensuring that rural drivers carry signal flares to speed up extractions from accident sites (Brodsky 1984). As noted, others emphasized the role of alcohol providers, tourism companies, and other actors. Garber and Bower (1999) discussed the potential future juror. They argued that potential jurors are exposed to media coverage of traffic accident verdicts, and that this coverage is biased against the automobile industry, for example cases in which the industry won are less likely to be reported on. This demonstrates the significant variability in the composition and scope of accounts of traffic risks.

Discussion

The review serves to problematize the mundane view of traffic accidents and traffic safety measures, demonstrating these are complex, multifaceted and non-intuitive issues, which were examined using diverse sociological approaches. I highlight potential sociological contributions to these issues, discuss the conceptualization of traffic accidents in general and as a ‘second modernity’ risk, and offer future directions of research.

The studies reviewed shared the assumption that traffic accidents have a social dimension, although its conceptualization and operationalization varied. It is necessary to explore this dimension further and elaborate its role in specific analyses. For example, the term ‘holistic’

has often been used to describe the alternative to the individualized perspective dominating the traditional approach to traffic safety (e.g. Ross 1984). As the review demonstrates, the whole in which driving takes place can be described in different ways, and it is thus necessary to clarify and justify the boundaries of such alternative analyses of traffic accidents.

Haddon's famous matrix broke down the traffic accident, separating agents and time periods to identify potential sites of intervention (Haddon Jr 1972). The review includes several analyses elaborating components of Hadodn's matrix, for example discussing the role of violence, confusion, and misunderstandings in shaping individual driver motivation and intention, and studies elaborating on the concept of environment, for example considering the influence of cultural, physical and legal environments. Studies have also suggested different links between individuals and their environments, broadly defined, for example the relations between social structures and the prevalence of a risky personality type or macro-economic influences on traffic fatality rates (He 2016).

The review also demonstrates different ways to consider the car as part of the dynamics of human-technology relations. Some studies sought to adapt drivers and other road users (particularly children) to their changing environments via education and training. Others, most notably studies drawing on science and technology studies, highlighted the reciprocal dimension of human-technology relations, demonstrating that these cannot be described only in terms of control or of trust (Chirinko and Harper Jr 1993; Randell 2017; see also Merriman 2006). Studies identified additional (actual or potential) participants involved in accounts of traffic risks, such as transportation engineers, tourism agencies, quantitative methods, 'the accident industry', alcohol providers, and more. Accordingly, I suggest that sociological theories can be beneficial in developing an alternative to the individualized view, suggesting links between the components of Haddon's matrix, and identifying neglected influences.

Many of the studies reviewed can be analysed as part of the high-modern enterprise of transforming accidents into risks. However, the transformation of traffic accidents remains

incomplete. Unlike workplace insurance schemes seeking to free the individual from responsibility for accidents (Ewald 1991), traffic accidents remain individualized. This focus is increasingly challenged but remains common. This may suggest the legacy of the providential explanation (Green 1997b) and the legacy of prohibition (Reinarman 1988; see also Gusfield 1981).

Both Perrow and Beck had little to say about traffic accidents. Some used Perrow's "normal accidents" framework to analyse traffic accidents as members of that category, i.e. as a characteristic of an increasingly complex socio-technical system (Short and Pinet-Peralta 2009). However, Perrow suggests in a footnote that the death of 50,000 in a catastrophe is more severe than 50,000 deaths spread across traffic accidents, because the former involves the destruction of a community (Perrow 1984:308–9). This is disputable; for example, one can argue that the 'spread' condition is more severe because it creates a mass of circles of suffering and loss, each with its own ripples. To put differently, the distinction between a single catastrophe and a mass of accidents is artificial and contingent, as elaborated below.

Beck has been criticized for neglecting mundane risks including traffic accidents (Tulloch and Lupton 2003; Green 2009). I suggest that mundane, familiar traffic risks share much with the novel risks discussed by Beck and illustrate this using the review. Per Beck, 'second modernity' risks emerge from the attempts to bring the social and the technical world under control. Such risks, for example radioactivity, cut across classes and are difficult to understand without expert mediation. Yet their rise is accompanied by a crisis in expert authority and reduced public trust in the ability of experts and states to deal with risks. This leads to the individualization of responsibility for such risks (Beck 1992; Beck and Lau 2005).

Some described the development of traffic safety measures as a positive adaptation to social needs (Carr 1958; Arnett 1995), and many consider them a major success. Yet numerous studies, mainly published after 1990, raised concerns regarding the new risks generated by such safety measures, for example risks to children's development and to

population health, as well as individual-level risk compensation. These novel risks generate new responses, including patchwork solutions such as walking school buses and suggestions for a system overhaul such as Sweden's Vision Zero. Like risks in 'second modernity', both the risks of traffic accidents and the risks generated by the safety measures cut across social classes.

Unlike radioactivity, a traffic accident can be grasped intuitively, and does not seem to require expert mediation. This arguably disqualifies traffic accidents as a second modernity risk, and more importantly raises the question of how traffic accidents are perceived and the role of expert knowledge in this process. The review demonstrates that a significant amount of expert work is invested in studying and representing the indirect consequences of traffic accidents, for example different health-related losses associated with reduced neighbourhood 'walkability' (e.g. Wurtele and Ritchie 2005; Kerr et al. 2010). This suggests that some dimensions of traffic safety do require expert mediation. Moreover, while an informed discussion of the status of expert authority in this area requires additional research, the review includes several examples demonstrating the political, cultural, and economic influences on expert work (e.g. Irwin 1987; Wetmore 2004; Schlich 2006).

The individualization of responsibility for modernization risks makes for a more complex comparison. Critiques of the individualization thesis of traffic accidents date it several decades back (for example the 1970s in West Germany). This suggests that the individualization of traffic accidents can be read as an early self-responsibilization of risk. This interpretation is supported by the connections frequently made between driving and the liberal ethics of autonomy and mobility identified with automobility (e.g. Saupe 2010; Nowak 2016). At the same time, the review demonstrates challenges to individualization, most notably through Vision Zero but also on a smaller scale, for example disgruntled parents in Vancouver lobbying the municipal government (McLaren and Parusel 2012). Still, the individualized view of traffic accidents seems to maintain a dominant position.

Thus, traffic accidents share many or all the characteristics of second modernity risks. More broadly, while risk society marginalizes mundane accidents, it can be relevant to analysing dynamic changes in different accounts of such risks (e.g. Blank-Gomel 2017).

Several authors lamented the sociological neglect of traffic accidents. The subject has long suffered from a dual sociological marginality due to the discipline's neglect of both accidents (Green 1997b) and mobility (Sheller 2017). The recent mobilities turn in sociology (Sheller 2017) gave rise to several studies drawing on the sociology of mobilities to discuss traffic accidents, although the issue remains marginal.

Some point to a general lack of public interest in traffic accidents and the invisibility of its indirect harms (Short and Pinet-Peralta 2009; see also Rothe 1994). Other explanations refer to marginalization, individualization and normalization, working in concert to make traffic accidents invisible. Already back in 1984, Ross suggested that sociologists view drinking and driving as routine, ordinary, "junk crime". He also argued that existing studies on this subject are usually applied, a-theoretical and focused on local issues, making them unappealing to the gatekeepers in sociological literature (Ross 1984:23–24). The review provides several examples for such applied studies, mainly in part 1 (e.g. Anutha and Chladil 1989), but also examples for studies linking the issue to broader sociological themes, for example the shaping of societal attitudes towards risks (e.g. Ross 1960; Elias 1995) or the social construction of some cases but not others as a threat to normative sensibilities, e.g. the Ford Pinto scandal (Lee and Ermann 1999).

The random explanation of accidents partly accounts for their sociological marginality. Green (1997a) argues that sociology emerged as a discipline of modernity, focused on the rationalization of social life. Accordingly, major sociological traditions had little interest in inherently random events existing outside the rationalistic scope. Yet as the review demonstrates such theories can be applied to the subject (e.g. Stinchcombe 1975). Notably several of the studies reviewed include references from sociological luminaries, most

frequently Durkheim but also Parsons, Weber, Mead, Marx and others, to support the claim that these are matters of sociological interest. To put differently, traffic accidents are not inherently outside of the sociological scope.

Based on the review, it is possible to suggest areas which can benefit from a sociological investigation. The database constructed for this review can provide a useful starting point for researchers interested in grounding their work in previous literature or in learning about the potential contributions of sociological perspectives to the study of traffic accidents and traffic safety. More broadly, the review demonstrates the benefits of systematic searches, made possible by the digitization of academic literature, to the study of sociologically marginal issues (see also Mauldin and Fannon 2016).

Sociological studies can further develop our understanding of how the costs of traffic accidents are calculated, which elements are included or precluded (for example, the unintended consequences of traffic safety measures), and why. Such studies can contribute to the ongoing efforts to give a voice to marginalized groups, in this case marginalized road users such as children or the elderly (e.g. Horton 2007).

The relations between membership in social groups and traffic accidents require further sociological attention. Some issues, for example the gender convergence thesis and the risk equalisation thesis, can benefit from the accumulation of data over the years and the development of more sophisticated statistical tools. Studying the pathways through which social differences are replicated on the road can also be of interest, as shown for example by Demoli's analysis of the wealthy's preference for heavier cars which transfer the risk to other road users (Demoli 2015; see also Bradsher 2002). Notably, only few studies in the review focused on age-based divisions (Parra et al. 2010) although it is discussed in the traffic safety literature (e.g. Edwards et al. 2009). The development of some types of 'big data' can be also used, for example, to estimate the role of exposure to various contents, for example

advertising or violent media stories, when discussing the mass media's association with traffic accident rates or with road rage.

As discussed, the concept of 'traffic safety perceptions' in walkability studies is often measured using several items on broader questionnaires. Sociological methods can contribute to developing this concept and linking it specifically to walkability. For example, studies of safeguarding practices can be used to develop the measurement of traffic safety perceptions and assess their influence on neighbourhood walkability. Sociologists can also contribute to the debate regarding the use of objective measures or subjective perceptions by examining the relations between these measures. It is interesting to consider the role of near accidents, as events which may influence subjective perceptions but not recorded in formal statistics.

Ethnographies of safety researchers and accident investigators can provide a useful contribution to our understanding of the chain of interpretation through which traffic accidents come to be represented (what Beckmann called 'the accident industry'), and authors drawing on science and technology studies can examine the spread or suppression of specific safety measures (e.g. alcolocks, bicycle helmets, 'safe system' practices, etc.) to facilitate a more informed discussion of their role and effects. This is particularly relevant in the context of recent efforts to transfer traffic safety technologies to developing countries (e.g. UN General Assembly 2010), which can benefit from studies making explicit the accounts of traffic risks embedded in such technologies and their suitability to new conditions.

The questions raised in the review are also relevant for the study of other unintended injuries. As shown, the view of accidents as causeless events not involving intention can be challenged, for example by problematizing the notion of intent and considering the role of social factors or the road user's position in a sociotechnical configuration. More broadly, the review demonstrates that mundane accidents, in this case traffic accidents and traffic safety, play a larger role than is usually recognized in shaping everyday life (Tulloch and Lupton 2003; Woolgar and Neyland 2013). Further research of these issues can contribute to

challenging the mundane image of traffic accidents and traffic safety and to making explicit the scope and variety of issues involved.

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Conclusion

Summary

The dissertation explored the use of sociological perspectives to investigate traffic accidents and traffic safety, focusing on the production of expert and lay knowledge about the risks of cycling. Drawing on Actor-Network Theory (ANT) this case study was used to examine the role of mundane risks in the sociology of risk, focusing on Beck's risk society thesis, and to examine explanations of traffic safety measures as the result of automobility or of scientific and technological progress.

This is the first study to examine changes in expert accounts of the risks of cycling (Blank-Gomel 2017) and how specific accounts of this risk spread in the United States (Blank-Gomel 2019).[9] It is also the first study to systematically examine sociological investigations of traffic accidents and traffic safety. More broadly, the dissertation adds to the limited body of sociological work on traffic accidents and traffic safety, and specifically studies examining these issues using ANT and related approaches (e.g. Wetmore 2004; Beckmann 2004; Leonardi 2010; McAndrews 2013; Vardi 2014).

Main conclusions

As discussed, Beck's risk society thesis was criticized for neglecting mundane risks, even though these may be of greater significance to individuals (Tulloch and Lupton 2003; Green 2009). However, this critique does not consider the dynamics of such risks, and specifically the possibility that these dynamics can follow the re-modernization thesis (Latour 2003).

The emergence of the US-style of bicycle safety helmets and the spread of a specific variant of a helmet-oriented account of the risks of cycling in the US follow the logic of a first modernity risk. As described in the second chapter, the problem is brought under control using

[9] Culver (2018) treats the rise of bicycle helmets in the US as a result of automobility, but didn't examine this historically. I discuss his work in chapter 2.

new technologies, developed and validated using scientific methods. The uncertainty surrounding bicycle injuries is mitigated by limiting the issue to a fixed number of well-bounded participants, operating in prearranged ways; most notably, the helmet's performance is measured mechanically, with no room for subjectivity. The stable configuration resulting from this process is evident in the maps representing academic discourse during the 1990s and early 2000s.

The disruption of this account follows some of the conditions for re-modernization. The composition of existing participants and their relations with others is challenged, as evidenced by the emergence of a new in-between space in the map representing academic discourse between 2007 and 2015. For example, the cyclist-helmet relationship is disrupted: the mechanical dimension is joined by social and psychological questions, as bicycle helmets become suspect of influencing the cyclist's behavior via risk compensation, and bicycle helmet laws are criticized for their presumed ability to discourage would-be cyclists (e.g. OECD/ITF 2013). Similarly 'the typical cyclist' is increasingly fragmented into multiple cycling identities with different needs, demands and expectations (Horton 2007; Garrard, Rose, and Lo 2008; Pesses 2010; Aldred 2014).

These entities and those populating the loosely defined public health effectiveness of helmets now receive 'risky descriptions' (Latour 2003), characterized by uncertainty. For example, the relations between current and potential cyclists and entities such as air pollution are disputed and contingent, dependent on issues such as the potential magnitude of the reduction in air pollution due to a modal shift to cycling (Rojas-Rueda et al. 2011).

The appearance of new liminal spaces in which the risks of cycling and their benefits are traded can be read as part of the generation of critical reflections on the sociotechnical conditions in which cycling is carried out. The scope of the potential changes varies, for example the addition of bicycle lanes versus a modal shift to cycling and the marginalization of the car. Thus,

some of the reactions to the growing uncertainty meet the tenets defining the re-modernization of risks, i.e. that these reactions encourage a constructive change rather than apathy.

The interpretation of contemporary changes in accounts of the risks of cycling as corresponding to the re-modernization of risks problematizes both the risk society thesis and its critiques. The distinction between first and second modernity risks is blurred, as mundane technologies are increasingly recognized as the source of both familiar and novel risks (e.g. death in a car crash and a loss in public health, respectively). In the third chapter this was elaborated into a more general argument regarding traffic accidents. I demonstrated that, in line with the re-modernization thesis, the newly recognized risks caused by traffic safety practices generate significant challenges for the status quo, i.e. automobility, most notably Sweden's Vision Zero policies (McAndrews 2013). Nonetheless, many safety practices and technologies reviewed do not challenge car dominance but adapt to it, as is the case, for example, with walking school buses (Collins and Kearns 2005) or bicycle helmets. Others promote a gradual change, as shown, for instance, by demands to construct bicycle lanes or to reassign exiting lanes.

The second chapter followed the emergence of the US-style of bicycle safety helmets and the spread of a particular variant of a helmet-oriented account of the risks of cycling, focused on a single catastrophic crash. As discussed, the misleadingly simple question of why did bicycle helmets spread in a specific time and location cannot be attributed solely to the influence of either scientific progress (Centers for Disease Control and Prevention 1995) or automobility (Culver 2018), as well as the imitation of professional cyclists or the intervention of economic interests.

The 1989 Seattle study, led by Dr. Fred A. Rivara, examined what I described as the mechanical effectiveness of bicycle helmets using a case-control design. As discussed, this study serves as the central milestone in accounts of the spread of bicycle helmets in terms of scientific progress. However, the study's failure to reach such a dominant position in other countries, as

well as the skepticism of members of the Seattle team with regards to the study's ability to influence legislation, expressed immediately after the publication, suggest that its latter dominant position was neither self-evident nor inevitable. I argue that the influence of the Seattle study can be attributed to its links to safety advocacy campaigns and studies of the effectiveness of bicycle helmet laws, both of which incorporated the mechanical effectiveness of bicycle helmets as a keystone of their strategies.

The description provided in the second chapter demonstrates some of the difficulties with the use of automobility as an explanatory factor. In addition to the neglected role of non-humans, human participants behave in unexpected ways. The image promoted by the vehicular cyclists, in particular, demonstrates that cyclists may not be antagonistic to automobility (Pesses 2010) and may even adopt its' ethical imperative, linking autonomy and mobility (Urry 2004). As discussed, the vehicular cyclists, a group arguing that cyclists and car drivers should share rights and responsibilities on the road, used concerns for the safety of non-vehicular cyclists to justify their rejection of bike lane networks, thus curbing the latter's mobility. This suggests that in addition to the multiplicity of cyclists it is necessary to consider the potential antagonism between groups of cyclists and develop ways to address multiple needs.

Non-humans played an important part in representing the participants in accounts of the risks of cycling. For example, the deployment of the National Electronic Injury Surveillance System (NEISS) was central to securing the visibility of US bicycle-related accidents, and transformed the issue into a national problem, attracting resources and interest. The reliance on the ANSI standard allowed the Seattle team to represent all helmets as interchangeable and carry out its experiment. The attention to non-humans also makes it possible to account for the remarkable influence of the US vehicular cyclists in promoting the helmet-oriented account, highlighting the role of the cycling manuals and training programs they produced in circulating this account further.

The dissertation analyzes the ambiguity regarding the concept of ‘effectiveness’. Scholars have long noted the multiplicity and various uses of meta-notions in scientific work, for example objectivity (Daston and Galison 1992; Cambrosio et al. 2006), validity, or utility (Smart 2006; Hedgecoe 2008). I stressed the distinction between the mechanical effectiveness of bicycle helmets, a well-bounded concept with a fixed number of participants, and the public health effectiveness of bicycle helmets, which links their performance to a host of additional psychological and sociological factors, e.g. the ability of helmets to encourage risk, to discourage cycling, or to prevent popular demands for other safety technologies such as bicycle lanes.

The review in the third chapter demonstrates that while sociological interest in traffic accidents and traffic safety is limited and sporadic, it is also diverse, with regards to both the subjects examined and the theories and methods used. The review also supports the arguments advanced above regarding how traffic accidents and traffic safety measures are intertwined with a variety of issues, bringing together psychological, sociological, technical, political, and ethical dimensions in complex, far-reaching and often unexpected ways.

I distinguished between two main types of sociological analyses. First, I considered studies focused on the social sources of traffic accidents, including flawed individual personalities, problematic socialization of some groups, the sociotechnical conditions in which driving occurs, and the interaction between social or sociotechnical conditions and certain types of personalities (e.g. Phillips 1979). Second, I examined studies focussed on traffic safety as a social construct, including studies of the unintended consequences of traffic accidents (e.g. with regards to physical and psychological development) as well the mechanisms through which traffic safety perceptions are formed, specifically the individualization, normalization, and dramatization of (some) traffic accidents. I also examined attempts to provide marginalized groups with a voice in debates about traffic safety policies.

As discussed, one of the major contributions of sociological perspectives lies in their ability to develop alternatives to the traditional focus on individual road users. However, the composition of such holistic perspectives can vary, for example it can include legal or cultural dimensions (e.g. Hayden 1989; Tranter and Lowes 2005), economic conditions (He 2016), the organization of the transportation system (Ross 1992), or the relations between humans and cars (Beckmann 2004). It is thus necessary to clarify and justify the borders of such alternative analyses of traffic accidents.

The analytical review and the database of relevant articles discussed in the review provide a starting point for researchers interested in the application of sociological methods and theories to traffic accidents and traffic safety and in grounding their work in the previous literature. The review identifies recurring subjects of interest, for example the gender convergence hypothesis or the risk equalisation hypothesis, now amenable to a more sophisticated analysis using new types of data, and suggests heuristic directions for further analyzing these topics.

Finally, the dissertation contributes to individuals interested in the heated controversy regarding bicycle helmets and bicycle helmet laws, including policymakers, safety advocates and cyclists' organizations. The dissertation provides a simplified guide to the development of the views of the scientific debate on the risks of cycling and can be useful in clarifying seemingly contradictory claims, most notably with regards to the effectiveness of bicycle helmets.

Limitations

The research discussed in this thesis has several limitations. Generally, the reliance on English-written studies biases the visual representations of academic debates presented in the first chapter as well as the results of the analytical review in the third chapter. The focus on bicycle helmets in the first and second chapters marginalizes other developments, for example

changes in bicycle design. However, this focus developed from the data. In addition, I did not follow some latter developments regarding the bicycle helmets' composition (e.g. the campaign for 'good of fit') due to limited scope.

The analytical review presented in the third chapter did not include studies authored by sociologists and published in non-sociological journals (e.g. Factor, Mahalel, and Yair 2007; Svensson, Summerton, and Hrelja 2014; Nazif-Muñoz 2015). This limits the review's ability to represent sociological interest in traffic accidents and traffic safety. The review also over-represents publications by non-sociologists, due to the use of inclusive criteria for relevant journals. However, the alternative of focusing on a core set of 'sociological' journals risked ignoring a significant body of work. This is especially so given the subject's sociological marginality, which increases the likelihood that relevant studies will be published in multidisciplinary rather than strictly sociological journals. The review could be extended by searching in other databases (e.g. Sage) or using additional keywords. Despite these limitations the review is both comprehensive and informative about the magnitude and content of sociological interest in traffic accidents and traffic safety.

Further research

The analysis above supports the argument that mundane risks can have far-reaching, albeit often neglected, consequences. Studies of mundane risks, for example using their representation in academic discourse or in policy documents, can aid in making explicit the social and technical assumptions embedded in accounts of such risks. It is also interesting to consider whether the dynamics of such risks follow all or some of Latour's conditions for identifying a re-modernization of risk, as was demonstrated with regards to the risks of cycling. Additional examples would support the applicability of Beck's risk society to mundane accidents and thus support this thesis.

The development of traffic safety perceptions provides an interesting site for sociological investigation. For example, ethnographies of what Beckmann called ‘the accident industry’, i.e. the work of safety researchers and accident investigators can provide a useful perspective regarding the chain of interpretation through which traffic accidents come to be represented. It is interesting to consider the role of images of road users in these processes, and specifically whether academic experts dominate the representations of road users, as suggested by Beckmann, or whether laypersons and other groups shape this process in significant ways, as was the case with the image of the responsible cyclist promoted by the vehicular cyclists. Such analyses can also contribute to the efforts to give a voice to marginalized road users such as children or the elderly (e.g. Horton 2007).

Notably, the relations between traffic safety and neighbourhood ‘walkability’ are drawing increased scholarly as well as commercial interest, and sociologists can contribute much to the specification of this relationships in a systematic manner. The notion of a ‘near-accident’ provides an example for the complexities involved: a formally non-existent event which may yet influence an individual’s decision to allow his children to play outside. Understanding how such events influence individuals and communities can be both interesting and beneficial.

The spread of traffic safety policies and measures across the globe provides an opportunity to examine policy diffusion, as well as the interaction between expert knowledge and local circumstances. More specifically, future research can be used to elaborate on the peculiar case of the bicycle helmet, including the challenges to the US-style of helmets (e.g. Depreitere et al. 2007) as well as the concerns discussed above. As mentioned, national policies vary; as a result, comparative analyses of changes in national cycling safety can be instructive with regards to how policies are formed and specifically the role of local and external experts and expert claims.

I did not focus on the reasons for the sociological marginality of traffic accidents and traffic safety, although the traditional marginality of mobility and accidents, and the ambiguous status of the accident, provide a partial explanation. Accounting for this marginality requires additional research, for example analysing the history of some the studies and the trajectory of scholars cited in the review (e.g. H. L. Ross). Yet it is evident that the sociological marginality of traffic accidents is not an inherent property of this topic and that studies of these subjects can be grounded in prominent sociological theories and paradigms. As discussed, there are indications that sociological interest in the issue is growing (e.g. Vardi 2014; Lumsden 2015; Demoli 2015; McLean 2016; Strumpf et al. 2017), but it has not yet consolidated into a coherent research programme. It is my hope that this dissertation will contribute to this process.

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