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Who cares about AVs?
Insights from French media discourse on Twitter and in the press

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Abstract:

Experiments with autonomous vehicles continue to proliferate. And yet, their broader public profile remains low. Commissioned by the French Ministry for Transport, this research examines the image of autonomous vehicles with the public at large. The methodology employed includes a thorough review of the French media discourse, in order to analyse the ways in which autonomous vehicles are presented and perceived in the press and social media. Over 2,600 press articles and 43,000 tweets in French were gathered and analysed in a period stretching from December 2017 to May 2018, supplementing a historical corpus of 2,200 articles appearing in the national press in the period 2012-2017. Analysis of this material yielded quantitative and qualitative information on autonomous vehicles. We attain a statistical description of the dissemination of information relating to autonomous vehicles and a dynamic analysis of the content shining a light on the process by which opinions are formed.

The results reveal steadily growing but fluctuating media interest. Peaks correspond to widespread press coverage and substantial interest on Twitter, but never attained the critical mass required to constitute a media-hype. We also observed a significant homogenisation of content at these times. The same sources of information were widely shared. Economic stakeholders are at the centre of discussions, and they are also the principal sources of information. This predominance of the views espoused by private stakeholders shapes the prevalent framing of all of the subjects considered here. It leads us to conclude that autonomous

vehicles are yet to achieve the level of general public interest that we associate with real issues of public interest. This point is of particular importance to the government agencies concerned with the deployment of autonomous vehicles and the social acceptability of such technologies.

Keywords: autonomous vehicles, public opinion, press, Twitter, media discourse, France

Highlights:

- This research examines the image of AVs with the public at large
- Economic stakeholders are at the centre of discussions on Twitter and in the press
- Economic stakeholders are also the principal sources of information on both media
- AVs remain a technical concern and not yet an issue of general public interest

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1 Introduction

Experiments with autonomous vehicles continue to proliferate, and manufacturers have now clocked up considerable mileage with their test vehicles. Nonetheless, the general public profile of these tests remains weak. News of these experiments generally reaches us via the narratives they inspire. As such, it is primarily through their framing in the media that autonomous vehicles are gradually beginning to "exist" in the public sphere. The public perception of these vehicles is of interest to the French government agencies responsible for implementing the national strategy pertaining to the development of driverless technologies. With this context in mind, the French Ministry for Transport decided to finance a research project (Thébert et al., 2018), focusing on the social acceptability of autonomous vehicle technologies and the expectations and uncertainties encountered in the general public in the pre-commercial phase of the first driverless vehicles with a degree of autonomy classed as Level 4 or 5.

It was decided to approach these issues without having recourse to opinion polls, focus groups, expert reports or workshops with stakeholders. These methods make useful contributions to assessments of the governance (Cohen & Cavoli, 2019) of autonomous vehicles or their social acceptability (Panagiotopoulos & Dimitrakopoulos, 2018). However, they may run the risk of inciting some respondents to formulate opinions on a subject which may not be of any real interest to them. The methodological option preferred here is to conduct a review of the French media discourse in order to analyse the ways in which autonomous vehicles are presented and perceived. In order to gain an overview of the broader public discourse, we analysed general media titles appearing in print and online, as well as Twitter, a major social network which is at once public and shaped by the social dynamics of connections and shared links between users. Digital social media provide an insight into the way people consume information. Our aim here is not to simply assess how Twitter users feel about the deployment of driverless technology (Kohl et al, 2018), but rather to ascertain the public response to media depictions disseminated in the press, looking at the ways in which they are received, consumed, assimilated and shared. This insight is necessarily partial, as is the representativity of Twitter

users, who represent a sub-section of the population with their own specific characteristics (Médiamétrie, 2017). Twitter users are primarily young, educated urbanites. Nevertheless, in spite of this limited representativity, the content circulating on the network provides a means of observing the process by which public opinion is formed. Twitter has become a major component of the digital agora and the collective production and dissemination of information (Roese, 2018). Twitter activity involves the reception and dissemination of information produced outside of this social network, as well as the potential creation of information specific to this "techno-discursive" context. It allows us to compare the pluralism of available information with the pluralism of information consumed (Rieder & Smyrnaios, 2012). It also provides a window onto the activities of opinion leaders, who are strongly represented on the platform (Boyadjian, 2016).

The media coverage of autonomous vehicle technologies and their corresponding socio-technical systems thus provides the raw material for the present article, as we seek to comprehend the representations constructed and disseminated throughout French society. We begin with a literature review, discussing the role of media discourse in shaping issues of public interest. We present our data gathering process and analytical framework. We describe our results, i.e. the informational landscape with regard to autonomous vehicles. We discuss the results: observing the framing and circulation of information casts light on the process by which opinions are formed. We conclude with our evaluation of the current scope and standing of autonomous vehicles in French public opinion.

2 Literature review

2.1 A constructivist approach

As an object of analysis, "spontaneous" discourse is held to pre-exist the research process and to emanate from outside its specific framework. Using such materials can help us to overcome certain forms of bias introduced when questions are imposed and opinions artificially elicited in "laboratory conditions" (Boyadjian, 2016). But the term "spontaneous" must not be allowed to obscure the constructed, strategic dimension of such discourse. On the contrary, analysing media discourse is itself a constructivist approach, in the sense that emphasis is placed on the way subjects construct their own reality. In order to report on social phenomena, journalists must construct a coherent, intelligible narrative from a multitude of disparate elements (different knowledge, actions, discourses, norms etc.) (Jacquez & Arnoult, 2016).

Media discourse is thus produced within a certain social context, and this includes the virtual realm of the internet. This discourse reflects and feeds into the current state of knowledge, representations and social norms existing within a society at a given moment in time. It is at once a matrix and a mirror of social and individual representations, a manifestation of the dynamics which shape the production, consumption and circulation of information (Comby, 2016). In the case of Twitter, and digital social media in general, the circulation and sharing of information are consubstantial with the discourse produced: both form and content are shaped by the relations between users of the network, the essence of "social" media (Paveau, 2013). Finally, the declamatory function of media discourse means that it assumes a certain role in the political organisation of society. Discourse is at once a representation of reality and a manner of shaping that reality. By disseminating information on a broad scale, the media alter the course of events and are actively involved in the construction of social realities (Thompson, 1995). They play a particularly important role in defining the contours of social issues (Jacquez & Arnoult, 2016; Neveux, 1999).

2.2 "New" and "old" media

Offering access to a vast and constantly updated flow of information, Twitter is an informational medium in its own right. It is widely used by journalists, for example, who turn to the Tweets of political figures for material for their articles (Jungherr, 2014). Beyond such professional circles, numerous though they are among users of this digital platform (Rieder & Smyrnaios, 2012), Twitter has contributed to the development of a form of "citizen journalism"[1] or "ambient journalism" (Hermida, 2010). Citizens and journalists coproduce fragments of information which, collated by the media, make the news (Rebillard & Smyrnaios, 2010). This concept reflects the triangular interaction which occurs between sharing platforms, groups of individual users and the production and dissemination of content by the mass media. Through exchanges formatted by the technical and economic constraints of the platforms, these different media serve to connect a heterogeneous plethora of information with a diverse demand (Ibid.). Twitter is also a communication tool used by politicians and businesses. Many organisations rely on it to publish information, often of a promotional nature.

Twitter users [2] thus fall into a number of specific categories. These categories are organisations, professionals from the fields of communication (Comby et al., 2011) and the media, and citizens

[1] https://www.numerama.com/startup/twitter, retrieved 5 March 2021

[2] The rate of uptake among the French population at large remains modest: 22% of French internet users over the age of 18 had a Twitter account in 2018 (Pratviel, 2018). That proportion had virtually doubled since 2012 (IFOP,

with an interest in current affairs. One particularity of these users is the contribution they make to defining current affairs (determining the media agenda, shaping the production and dissemination of content). Another – and this hypothesis has been advanced in numerous academic studies of Twitter – is their role in informing public opinion, with opinion leaders over-represented on the network.

Do tweets thus constitute a reliable barometer of public opinion, more trustworthy than the surveys whose limited predictive capacity has been widely exposed and publicised by the experience of several electoral campaigns in both France and the USA? This is the postulate explored by a number of academic studies, looking at correlations between activity on the social network (number of tweets and/or tone of the messages) and the emergence of certain social phenomena (Asur & Huberman, 2010; O'Connor et al., 2010; Tumasjan et al., 2010).

Opinions vary as to the value of this hypothesis. The claims made for Twitter's predictive power are largely dependent on the idea that the concentration of opinion leaders – liable to influence a sufficiently large number of individuals – on the platform makes up for the non-representativity of Twitter users as a population (Comby et al., 2011). Nevertheless, it seems that an increasing number of analysts are distancing themselves from this hypothesis, albeit without entirely abandoning their interest in the content posted to the social network. Firstly, Twitter continues to be viewed as a barometer of public opinion by public stakeholders. It thus has the potential to shape the course of events. Secondly, the true value of such analyses lies in their capacity to observe fluctuations in media activity.

2.3 The dynamics of media activity

Studies of media activity focus on three major dynamics, summarised hereafter:

1) The increase/decrease of media activity: tracking peaks in media activity in order to measure response times and the long tail effect (Rieder & Smyrnaios, 2012), and to assess the impact of the media-hype phenomenon (Vasterman, 2005). This phenomenon is initiated by a triggering event (a minor incident or extraordinary occurrence) which receives unusually intense media attention and which then defines the implicit framing of the issue, severely homogenising subsequent informational content (Giasson et al.,

2012), closing in on the level of uptake seen in the USA, where 24% of adult internet users are on Twitter (Pew Research Center, 2018).

2010). The reach of the event is thus inversely proportional to the diversity of the coverage it receives, since the media tend to be largely self-referential.

2) The co-production of agendas: different types of agendas (political, media, industrial etc.) exist in a state of interaction. They are connected by bonds of mutual influence. While the media play a role in putting certain subject on the political agenda, this dynamic works in both directions, thanks in no small part to the sort of "citizen journalism" which has developed on Twitter. This demands a systematic examination of the bilaterality or multilaterality of these links, with reference to the concept of reverse agenda-setting (Neuman et al., 2014; McCombs, 2004) and with particular focus on the timeframes within which information circulates within different spheres of communication.
3) Occupation of the media landscape: analysing these dynamics allow us to identify the actors involved in the production and dissemination of information, including the opinion leaders who hold the key to the process. Per Katz and Lazarsfeld's (1955) theory of media influence, this process involves two phases. To begin with, the vertical dimension takes precedence: the media share information with opinion leaders. Thereafter, a horizontal dynamic comes into play: opinion leaders spread the information to their entourage.

3 Materials and methods

3.1 Data gathering

Our data gathering efforts focused on two main categories of materials: press articles and tweets. They represent two discrete, French media landscapes: general media in the form of the printed press and recognised websites, and social media in the form of Twitter.

Articles from the printed press were taken from three distinct groups of sources. The first group comprises the six biggest national dailies in France, with four generalist daily newspapers (Le Monde, Le Figaro, Libération and La Croix) and two daily papers with a greater focus on economic matters (Les Echos and La Tribune).

The second group contains articles from other selected publications, a set of sources emerging from the Google News aggregator. This bottom-up approach provides an insight into web-specific informational resources relating to autonomous vehicles. It includes content from 'pure play' specialist news providers, along with sites which aggregate different sources of

information (online and offline) or else produce their own editorial content alongside commercial material.

The third group presents non-selected publications. It refers to a set of sources identified by the Google News feed. It provides an overview of web-specific resources for information related to autonomous vehicles. It includes pure players as well as aggregators or sites producing their own editorial content alongside commercial offers.

We used AMI software. This commercial web-crawling software allows to search and collect documents according to a given query, to archive and classify them, and finally to analyse them using lexicometric and cartographic tools. It includes sources already connected, including the social network Twitter and the infomediary Google News, and allows the connection of specifically identified sources. The majority of our selected publications were incorporated via RSS flows or, where RSS flows were not available, by indexing pertinent pages from their websites. When these links did not yield satisfactory results, manual data gathering was scheduled after consultation of the Factiva and Europresse databases, then the resulting articles were manually uploaded to AMI.

We created a Boolean combining the noun "vehicle" (or "driving," "car," "taxi," "shuttle," "bus," "truck," "helicopter," "aeroplane") and the adjective "autonomous" (or "automatic," "driverless," "automated") and adding the neologism "robotaxi" (or "robot taxi"). This Boolean was rapidly stabilised for Twitter, but required multiple attempts for the press. With Google News, using the operator "NOT" allowed us to eliminate a large proportion of the classified advertisement websites. For our selected press titles, we added the indicator "~5" to identify documents containing certain expressions within a 5-word radius, e.g. "cars without drivers," or "semi-autonomous driving."

Automated data gathering began on 1st December 2017 and concluded on 4 May 2018. A system of classification was used to gather and sort the data, allowing us to eliminate irrelevant and redundant documents. The material collected in this manner forms the contemporary corpus shown in Table 1.

The corpus of data sourced from Twitter underwent specific processing in order to reflect the potential audience and influence of different user accounts. For each account we noted the total number of publications, the number of accounts followed and the number of followers, as well as the number of retweets obtained by each tweet. Daily publication rate corresponds to the

number of accounts posting one or more tweets on a given day, as a proportion of the total number of accounts included in this corpus.

Finally, in the interests of diachronic analysis, we produced a historical corpus comprising articles published in the six national daily newspapers between 1st January 2012 and 30 November 2017.

Table 1 presents the results of our data gathering exercise. Representing a tiny fraction of the 10 million French-speaking tweets posted every day[3], the corpus of tweets on the subject of autonomous vehicles observed between 1st December 2017 and 4 May 2018 (43,363 tweets) is nonetheless of sufficient size to examine the French media coverage of autonomous vehicles.

Based on analysis of all of these tweets, we manually established a sub-category containing 692 tweets which expressed "an opinion," i.e. a few lines of commentary. Simple retweets of these opinions were discounted.

	Type of media	Sub-category	Articles	Tweets
Historical corpus (1 Jan 2012- 30 Nov 2017)	Print media	National dailies	2,236	
Contemporary corpus (1 Dec 2017 - 4 May 2018)	Print media	National dailies	324	
		Other selected publications	452	
		Non-selected press	1,840	
	Twitter	All, excluding opinion tweets		42,671
		Opinion tweets		692
Total			4,852	43,363

Table 1 – Materials collected, by media format and date

Information circulates on Twitter via two main channels: transfers in the form of "retweets" (identified by the acronym RT at the start of the message) and references via hyperlink to content from Twitter or elsewhere (identifiable by their inclusion of an URL). These channels are not mutually exclusive. With 47% of Retweets and 78% of tweets and retweets with hyperlinks, our corpus is testament to the intensity with which information circulates (see Table 2). Less than 10% of the whole corpus makes no use of either channel. Retweets and hyperlinks

[3] According to the online service provider W3Techs quoted by *Le Monde,* the volume of French-speaking tweets represents around 2% of the daily 500 million tweets. https://www.lemonde.fr/pixels/article/2018/10/11/le-combat-quasi-perdu-de-la-francophonie-dans-la-culture-internet_5368072_4408996.html, retrieved 17 March 2022.

offer an insight into the consumption of information by Twitter users, providing a means of measuring influence.

	Tweets		Retweets	
With external references (URL domain name)	18 ,044	41%	13,377	30%
With internal references (URL twitter)	1,344	3%	1,723	4%
No references (no URL)	3,822	9%	5,662	13%
Total	23,210	53%	20,762	47%

Table 2 - A French corpus of tweets, retweets and hyperlinks

3.2 Creating the thematic table

Work was required in advance to establish a system of classification for the themes encountered, allowing for automatic decoding of topics relating to autonomous vehicles. Terms which frequently cropped up in strategic positions within the source texts (titles, introductory paragraphs etc.) were automatically picked up by the AMI software tool. They were then sorted manually into eight major themes, of varying importance: “Stakeholders” (187 terms); “Vehicle as a Product” (60); “Sustainable mobility” (52); “Smart city” (37); “Safety” (31); “Uses” (29); “Economy” (12); “Governance” (12). The variation in the number of terms associated with each theme illustrates the imbalance of media coverage. These terms were not defined *a priori*, but were in fact identified automatically by the software because of the frequency with which they cropped up in the documents.

Our thematic table was cross-referenced with other variables such as publication date and source. It delivers effective coverage of the range of themes addressed in the press articles, allowing us to classify virtually all of the articles: 96% for non-selected publications and 98.5% for our selected publications. Twitter content, on the other hand, is more difficult to categorise: around a quarter of the tweets did not correspond to any theme.

“Stakeholders” is the most frequently-referenced theme. This category includes all actors cited by name in the texts. Generic mentions of “local authorities” and “industrial firms” were added to the “Governance” and “Economy” categories.

3.3 Framework for the analysis of media discourse

Our analysis of this media discourse was a two-step process, following the preparatory work. The preparatory work consists of data gathering (cf. 3.1) and creation of thematic table (cf. 3.2). Figure 1 sums up the analytical framework explained in greater detail hereunder.

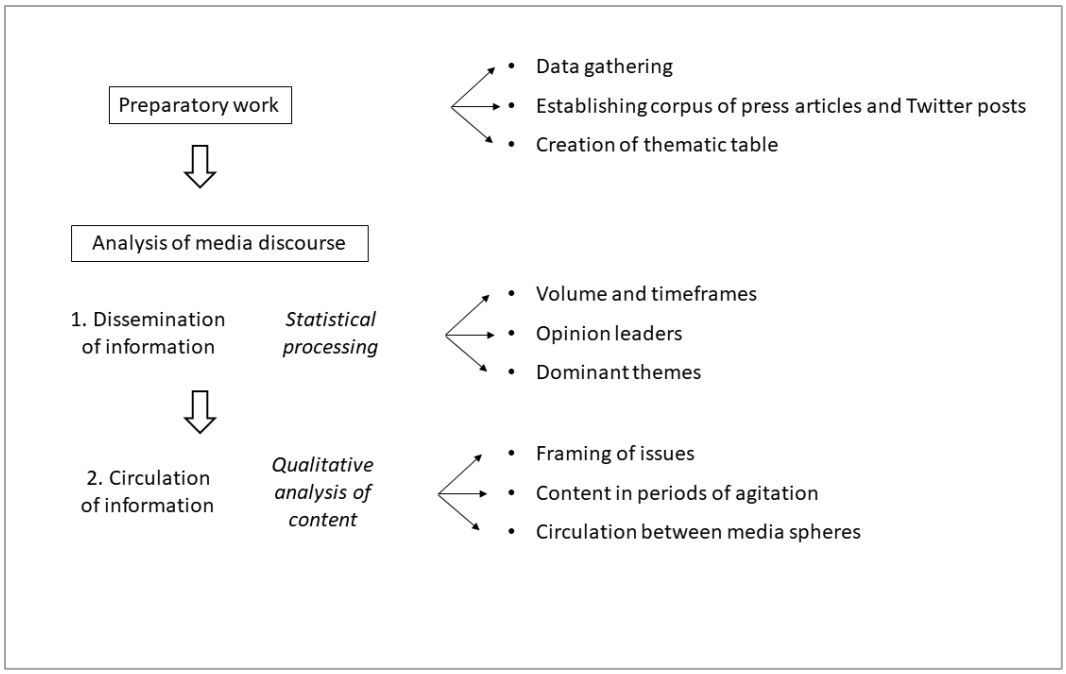


Figure 1- Analytical framework for media discourse

The first round of analysis yielded a quantitative overview of the information circulating about autonomous vehicles in different media spheres, examining its volume and temporal distribution, its sources and semantics. Using the AMI software, we employed various methods to count posts, conduct textual analysis and visualise the state of the networks. Our goal was to answer a number of key questions: what volume of information was disseminated on this subject via these channels, and in what timeframe? Can we observe phenomena connected with media-hype? Who was behind this information? What themes are associated with autonomous vehicles in the media?

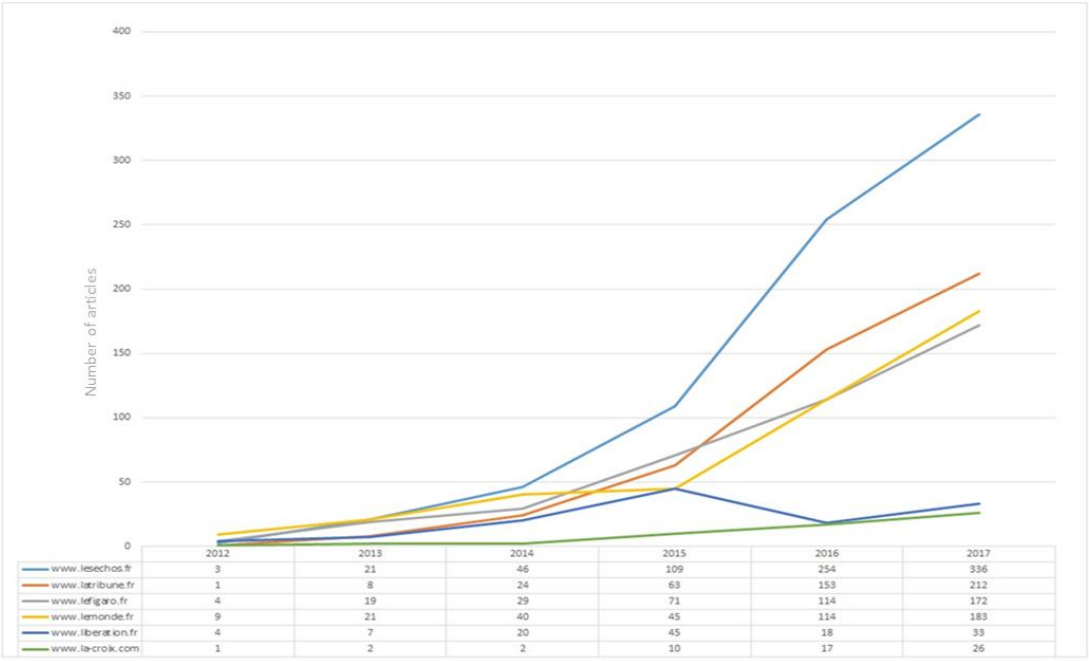
The second phase of analysis looked more closely at the dynamic construction and circulation of this information. It focused on a detailed examination of the framing of autonomous vehicles as a subject of discussion, the way in which different media respond to stimuli in current events and the various ways in which representations circulate between different media spheres. We conducted qualitative analysis of the content, with particular attention devoted to in-depth study of extracts from the corpus of press articles and tweets.

4 Results

4.1 Volume and timeframes

Autonomous vehicles have been a growing presence in the media discourse since 2012. Gradual at first, this growth gained pace in 2015, when the number of articles published on the subject

in the six selected French daily newspapers increased substantially (Figure 2). In 2017, almost 1000 articles on this topic appeared in the French daily press, three times more than in 2015 and fifty times more than in 2012.



	2012	2013	2014	2015	2016	2017
www.lesechos.fr	3	21	46	109	254	336
www.latribune.fr	1	8	24	63	153	212
www.lefigaro.fr	4	19	29	71	114	172
www.lemonde.fr	9	21	40	45	114	183
www.liberation.fr	4	7	20	45	18	33
www.la-croix.com	1	2	2	10	17	26

Figure 2 - Evolution of volumes (number of articles published) 2012-2017 in selected titles from the national French daily press N.B. since 2012 former daily newspaper La Tribune has switched to a once weekly physical edition.

This sudden increase in volume corresponds to the public unveiling of prototypes developed by the leading car manufacturers. This elicited greater interest from economic and financial papers than the political and general interest dailies.

Between 1st December 2017 and 4 May 2018, 20,000 French-speaking Twitter accounts mentioned autonomous vehicles, generating an average of 280 tweets per day (with a median of 230). Over the same period, an average of 17 documents written in French and addressing this topic were published every day, 70% of which were online-only.

On Twitter as in the printed press, media interest in autonomous vehicles fluctuates. Both Twitter and the news rooms are prone to bouts of silence and excitement.

The temporal distribution of tweets illustrates this fluctuation. The most notable peaks of activity came in response to stimuli from current events (Figure 3). In the period studied here, two major peaks (exceeding 1000 tweets per day) came in the wake of the Consumer Electronics

Show (CES) in Las Vegas (January 2018) and an accident in Arizona involving an Uber vehicle in which a pedestrian died (March 2018). Eight peaks of middling intensity (450 to 600 daily tweets) can be connected to other prominent public events (auto trade shows), government announcements regarding driverless experiments, new developments in the investigation into the Uber crash and a second fatal accident involving a Tesla vehicle. This second incident, in which the driver died, provoked a smaller peak in media interest than the first crash. The peaks of media activity observed on Twitter are mirrored in the output of press articles, with peaks of over 50 articles per day (Figure 3). During these peaks, virtually all of the major publications cover the event in parallel.

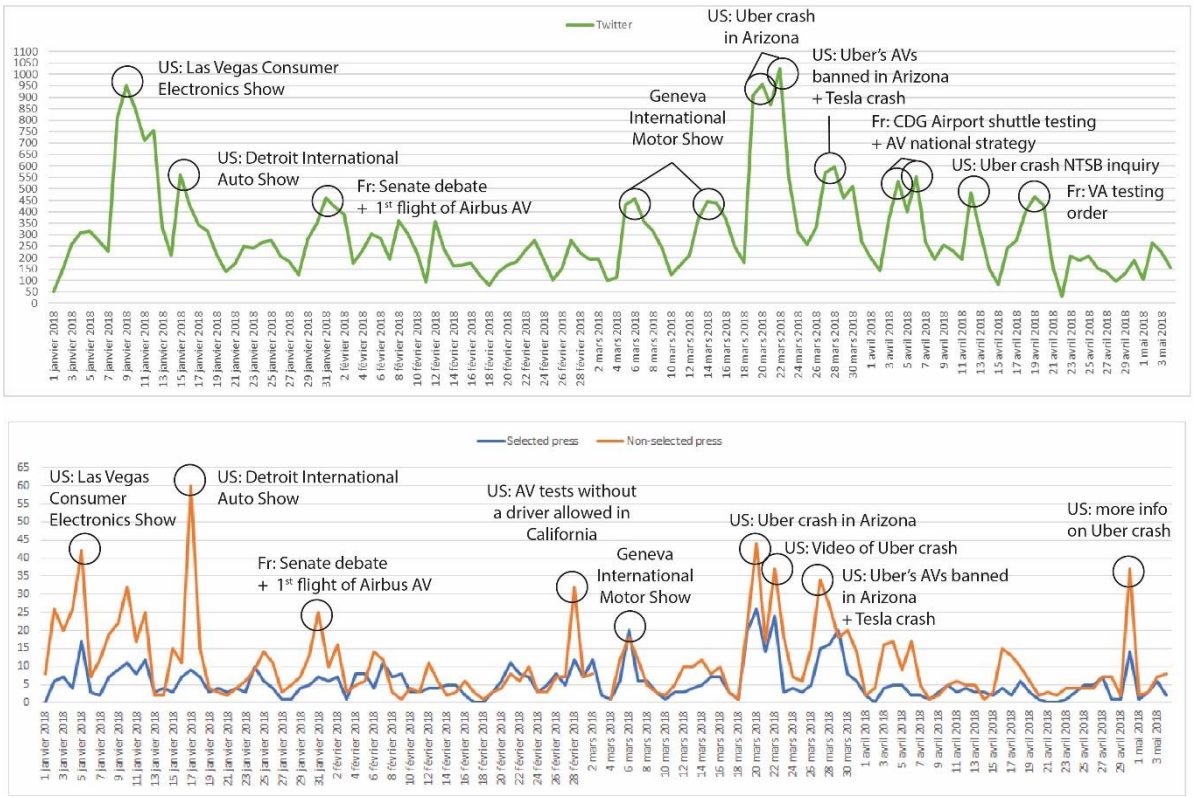


Figure 3 – Daily volume of tweets and articles published in French between 1st January and 4 May 2018.

4.2 Opinion leaders

The leading national dailies (particularly Les Echos, Le Monde and Le Figaro) clearly dominate the rankings of the principal sources of information on autonomous vehicles (Figure 4). They are followed by weekly and monthly magazines aimed at the general public, both general interest and specialist (primarily car magazines or economic magazines with an interest in the automobile sector). Absent from the table at the start of the data gathering exercise, Challenges magazine saw a spectacular rise to second place following an investment by Renault in which

the manufacturer acquired a stake in the magazine's publisher (December 2017). The prominence of the automobile sector in the informational landscape is also reflected in the presence of the official website of the Committee of French Automobile Manufacturers (Comité des Constructeurs Français d'Automobiles)[4] in this list, along with various multiservice platforms connected with the automobile sector (Lesfurets.com, largus.fr, caradisiac.com et al.). These sources are joined by pure player news websites, including two websites dedicated to consumer technologies (lesnumériques.com and numerama.fr) which stand out on account of the regularity and volume of their reporting on this subject. The presence of two websites linked to radio stations (France Info and Europe1) suggests that, within the traditional mass media family, the printed press does not have a monopoly when it comes to reporting on autonomous vehicles. The regional daily press is scarcely present in our table, a state of affairs which reflects the enduring lack of driverless experiments at local level.

[4] This website probably plays a much more important role in the dissemination of information than one might infer from its ranking in 21st place over the period as a whole. It was in second place in the monthly rankings for November and December 2017, and its subsequent slide is most likely a result of technical problems encountered from January 2018 onwards.

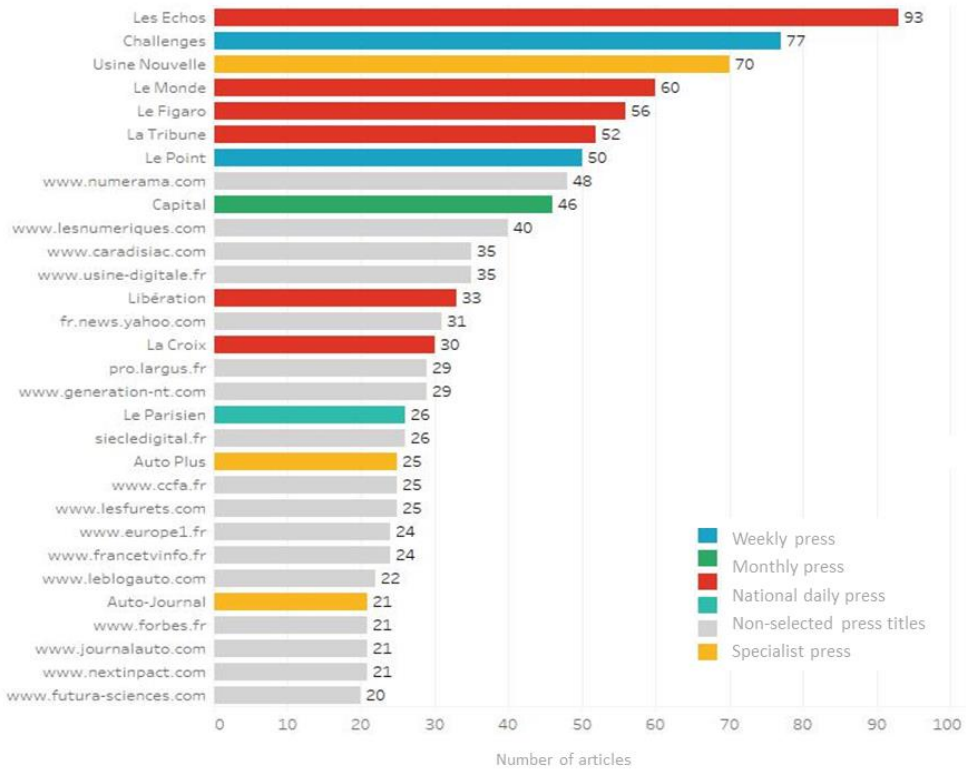


Figure 4 – Number of press articles by source (December 2017 – May 2018)

Our corpus of tweets related to autonomous vehicles emanates from around 20,000 users. In reality, most activity concerning autonomous vehicles hinges on around fifty prolific accounts (0.24% of the total) who accounted for 10% of total tweets on the subject, while three-quarters of users mentioned the topic only sporadically (less than one tweet over the whole period). The most prolific tweeters (more than 50 tweets over the period) include a mixture of individual and institutional accounts, most of whom have a reasonable number of followers (over 1000). The individual accounts in this category mostly belong to professionals using Twitter for work purposes. Their areas of interest are directly linked to their professional activities. Their intensive use of social media has earned them a certain reputation. Institutional accounts are more diverse. They include accounts from traditional media outlets (such as daily national newspaper Les Echos) or large corporations (such as the motorway infrastructure operator VINCIAutoroutes), alongside accounts operated by "small, 'independent' producers of opinions and information" (bloggers, journalists for online media sources - fanzines, web radios etc.).

Nevertheless, the most active tweeters on this subject are not the most widely-followed. They also attract relatively few retweets. The true opinion leaders are to be found among the less active accounts (30 to 50 tweets on the subject during this period), accounts which have large

numbers of followers (several thousand) and attract numerous retweets. It is these accounts that have the greatest impact in terms of shaping the image of autonomous vehicles. Singling out accounts on the basis of this measure of influence, we find a proliferation of institutional accounts and only a handful of individual accounts belonging to tweeters with high media profiles. These institutional accounts mostly belong to media outlets, either traditional (Le Parisien), online (Numerama, L'Usine Digitale or 01net) or televised (BFMBusiness). Their audience on the platform, and on the subject of autonomous vehicles, is firmly established, forming a circle of influence which leaves little room for other actors. Professionals from the automobile industry, although frequently quoted in the content of tweets and articles shared by these influential tweeters, are marginalised in terms of the interest in their own individual accounts.

4.3 Dominant themes

Applying our thematic analysis table (see 3.2) to the corpus of press articles reveals that they are rarely monothematic (less than 6%), unlike the tweets. Twitter's 280-character limit clearly explains why each post only covers an average of 1.7 themes. On the contrary, the large number of themes (approximately 5) addressed in press articles (Historical corpus and Contemporary corpus) is noteworthy. It indicates an appropriation and generalisation of the thematic frameworks defined in our table, although automated textual analysis does not allow us to assess the depth of engagement with each theme.

The graphs below serve to illustrate the relative prominence of each theme over the years, in the major national publications (Figure 5) and in a cross-section of online sources and Twitter (Figure 6).

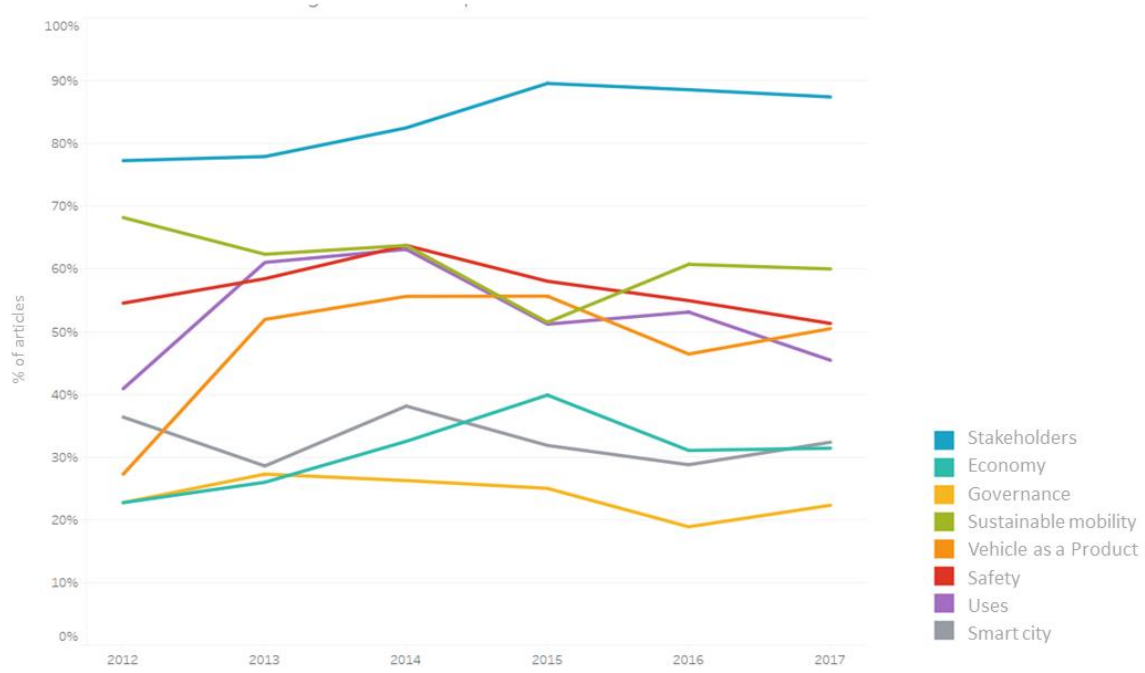


Figure 5 - Proportion of articles addressing each theme, per year, in the historical corpus

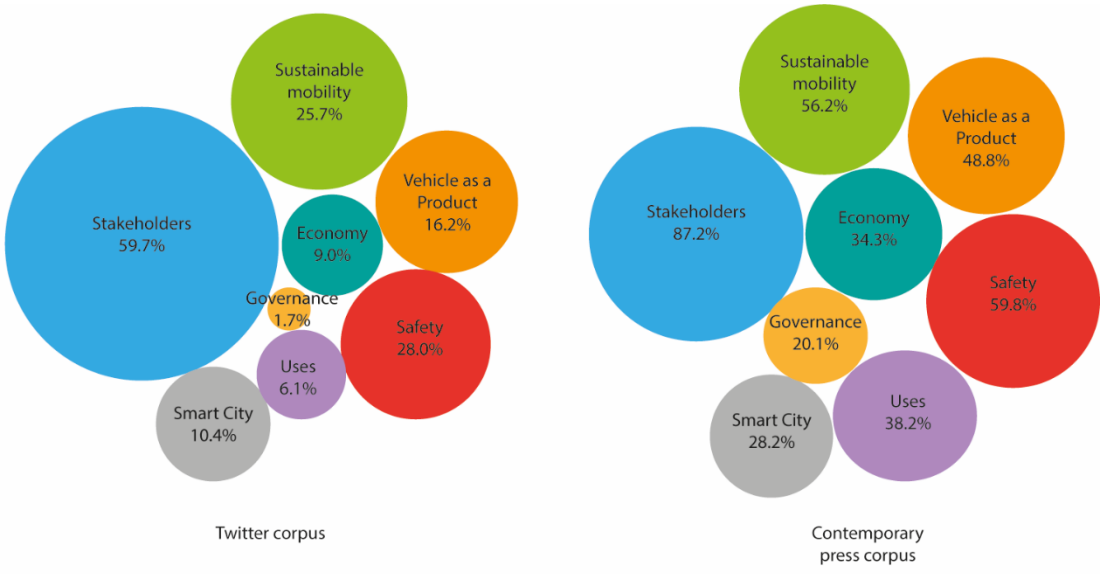


Figure 6 – Relative weight of each theme in the contemporary corpus on Twitter (left) and in the press (right)

The theme of "stakeholders" is omnipresent. In the contemporary corpus, it crops up in almost nine out of ten articles and 60% of all tweets. The proportion is lower for Twitter content because tweets are much more likely than articles to be monothematic, but the relative weight

of this theme in relation to the seven others is even more massive in the tweets than it is in the articles. The “stakeholders" in this context are companies and (albeit much more rarely) institutions mentioned by name and involved with the ecosystem of driverless technologies. The vocabulary used in the press and on Twitter is heavily skewed towards Google, Tesla, Uber and other automobile manufacturers, whereas public sector stakeholders are rarely mentioned, particularly since 2012. Governance is the poor relation of the themes present, particularly on Twitter. Technological developments made by the aforementioned companies also occupy a significant position within the media landscape, and are certainly not restricted to the specialist press. The theme “Vehicle as a product,” poorly represented in 2012, cropped up in half of all articles in 2017 (with a comparable relative weight on Twitter). This increase mirrors the increasing publicity devoted to new technologies. Sustainable mobility is mentioned in almost 60% of all articles. This strong showing, which nonetheless declined slightly over time (Figure 5), demonstrates widespread familiarity with the terms and concepts of sustainability. The prevalence of safety as a topic of media and social media attention has been in decline since 2014, but still appeared in half of all articles in 2017 and was particularly present in the first half of 2018, following the aforementioned accidents. The theme of uses is secondary, but on the rise, and is apparently of more interest to Twitter users than to the press.

4.4 Tweets and retweets of a press article

Financial daily Les Echos is the most frequently-referenced external source in our Twitter corpus. We identified 194 hyperlinks containing the domain name lesechos.fr, linking to one of the 94 articles on this topic published in Les Echos between December 2017 and May 2018. 1424 tweets or retweets referenced these 194 links, accounting for, in volume terms, 3.3% of the total corpus of French tweets, and double the number of tweets containing opinions (1.7% of the corpus).

Among the 194 hyperlinks referencing Les Echos, the most tweeted link was shared 160 times. It refers to an article published in the paper’s Industry and Services – Automobile Section on 28 December 2017 under the title *How robotaxis are set to change the car industry,* presenting the conclusions of a study published by consultancy firm Roland Berger. The first tweet was launched by the official Twitter account of Les Echos’ automobile section (@EchosAutos) on the morning of Thursday 28 December 2017. The time of posting (6:50) suggests that it was posted automatically by a bot. The Tweet reproduced the title of the article word for word. It was then retweeted 8 times, including once by the journalist who wrote the piece. Later that morning, 28 December, another journalist from Les Echos posted a new tweet referencing this

article. He did not quote the article title, but instead put in some editorial work by citing the major finding of the study: “the spread of robot taxis could cause sales of new cars to fall by 32% by 2030.” He then addressed the economic consequences, adding “And car manufacturers aren’t even worried.” This tweet was retweeted 10 times, including a retweet from the author of the article.

Four days later on 2 January 2018, Fabienne Billat (@fadouce), one of the most influential commentators on autonomous vehicles in the French Twitter landscape referenced the same article in a tweet. She also picked up on the key figure of 32%. Whereas the editors of Les Echos used the conditional mood, envisaging a potential decline in car sales, Billat opted instead for the future tense: “self-driving taxis will cause global sales of new cars to fall by 32% by 2030.” She rounded off her tweet with a message aimed at consumers (rather than manufacturers, as in the original tweet): “consumers are starting to realise that buying a car and then only using it for 20 minutes a day is ridiculous,” reformulating for her own ends one of the quotations from the director of the study included in the article. Her tweet thus contained two messages – “car sales will fall” and “using cars is ridiculous” – and met with greater success. It was retweeted 130 times, mostly by personal accounts. Peak activity was reached on the day after the tweet was posted, declining sharply over the ensuing days. A modest rebound in interest (14 tweets) was observed ten days after publication.

5 Discussion

5.1 Framing of the issue still dominated by the perspectives of private stakeholders

The media discourse surrounding autonomous vehicles is primarily concerned with the technologies themselves and the companies who develop them. The most prolific sources on this subject are newspapers with a particular focus on economic and financial news, websites devoted to innovation (particularly digital innovation) and the Twitter accounts of innovation specialists.

The content found on lesnumeriques.com and numerama.com provides a good example. Ranked among the top 10 sources in the contemporary corpus, accounting for 3.4% of that corpus, these two sites specialise in high-technology consumer goods. Their articles are tech-savvy and well-informed, written by expert and well-staffed editorial teams.[5] Their articles and special features primarily focus on innovative objects related to autonomous driving and the

[5] 25 journalists and almost as many staff members at lesnumeriques.com; seven employees including 5 journalists at numerama.com.

user experience they offer, as well as latest "product news" and internal news from companies. They also publish articles exploring social and political issues, but less frequently.[6] Particularly revealing is the fact that the majority of titles start with a company name, reporting a recent announcement from an economic agent. We also observed a glut of headlines announcing the arrival of such or such a vehicle for a given year, with little use of the conditional and a speed of publication hardly conducive to proper checking of sources.[7]

This focus on stakeholders defines the way in which information is framed and presented. The driverless vehicle economy is viewed through the prism of international industrial giants and their latest pronouncements. Articles addressing themes such as smart cities and localised economic consequences are in the minority. Public authorities and the local ecosystem, including mobility systems and territories, are underrepresented. A lexical analysis of the terms used in relation to sustainable mobility issues reveals that notions such as pollution, congestion, urban sprawl and the sharing of public space are not frequently employed. The issue of shared mobility services (primarily taxis and private-hire vehicles, and to a lesser extent shuttle services) hogs the attention in this field, in the press and particularly on Twitter. New perspectives opened up by autonomous vehicles are considered primarily in terms of facilitating mobility (responding to individual demand) rather than regulating mobility.

This non-contextualised approach to the international system of stakeholders is also fragmented: stakeholders are considered individually, not as a category of players united by shared interests. It is rare indeed to come across an article which attempts a cross-cutting analysis of the strategies employed by different types of stakeholders, with reference to their core business or national context, for example. The thematic category we have defined as "Economy," which could have been swelled by such articles, remains sparsely-populated. Terms such as "alliance," "partnership" and "strategy" did not emerge spontaneously from our automated analysis. Finally, articles focusing on accidents often offer a retrospective analysis restricted to the company involved (Uber or Tesla), as we can see from the nature of the information produced in periods of agitation (see 5.2 and 5.3).

6 Addressing issues such as the acceptability of artificial intelligence, the resolution of ethical problems and attempts by digital industry lobbyists to co-opt them, and the race for development being pursued at the expense of safety by manufacturers with the backing of the American government.

[7] For example, in August 2013 Numerama published an article entitled: Google and Uber launch self-driving taxis, derived from an article which was not correctly referenced in the text and turned out to be a speculative prediction. A correction was published in response to comments from readers.

5.2 Periods of agitation: the uniformization of press content

Media interest in autonomous vehicles fluctuates strongly over time, in response to stimuli in current events. On the face of things, the Uber crash of 19 March 2018 appears to have given rise to a media-hype phenomenon (Vasterman, 2005), arising when a specific event triggers the rapid emergence of a very large number of articles covering the incident in a similar manner. The event in question (which occurred on 18 March in the USA, and hence the early hours of 19 March in France) attracted a particularly high level of media attention within 24 to 48 hours, which rapidly spread to all of the major publications. The total number of articles relating to autonomous vehicles exploded after the accident, showing a particularly strong uptick in the online-only press and peaking on the second day (Figure 3). These "day after" articles were written with reference to the accident without being entirely devoted to it, and their editorial content was les standardised. They address, for example, the question of responsibility for accidents and the control systems installed in remotely-controlled vehicles. Media interest had dropped off by the third day, but was reinvigorated on 22 March when the American police shared a video of the accident. This video provided easily-accessible material for further investigation, and elicited a new wave of articles commenting upon it. After another lull in interest (23-26 March), a further development occurred on 27 March: the previous day, state authorities had banned Uber from operating autonomous vehicles on Arizona's roads. This ban coincided with a second fatal accident which occurred on the same day (a Tesla in Autopilot mode crashed on a highway, killing the driver), but few articles drew the connections between the two incidents.

The uniformization of news content can be observed by tracking the fate of the AFP dispatch published on 19 March 2018. It was cited at length in articles published on that same day by all of the major French media titles. Some added titles which modified the initial text to insist upon the recurring accidents and the economic stakes of experiments with autonomous vehicles. In articles published after 19 March, during successive waves of interest, we can still observe considerable uniformity in terms of the fundamentals (all of the articles mention the same basic facts and include the same quotations from the police and from Uber). But we observe a greater variation in terms of editorial format. The various AFP dispatches are deployed in fragmentary fashion, combined and fleshed out with commentary from the authors and quotations from experts, particularly in sources which were not included in our selected publications. Abundant use was made of the video of the accident. These new variations in turn inspired a new wave of "day after" articles, many of which reused whole paragraphs taken from other publications and

added their own embellishments. The wave of 27 March again produced a glut of remarkably similar documents. Many of them once again recycled paragraphs first published on 19 March (about the economic consequences and the involvement of the stakeholders in a technological development race), albeit without making reference to the subsequent Uber crash. They did, however, mention previous accidents involving Tesla vehicles.

This series of waves chimes with the concept of a "media tsunami" developed by Giasson et al. (2010). It builds upon Vasterman's idea of media-hype with a greater emphasis on the cumulative dynamic which raises their profile and cements the problematisation of the issue, wave after wave. However, the waves observed here did not progressively increase in either size or strength. The media coverage of these accidents remained disconnected: articles written about accidents involving Tesla vehicles seldom contain references to the crash involving the Uber prototype. The overwhelming majority of reporting does not focus on the accident record of autonomous vehicles in general, preferring to treat the technologies developed by different stakeholders entirely separately. The peaks observed in press coverage do not truly correspond to Vasterman's model of media-hype (2005). The drop-off in interest was very abrupt, and subsequent waves were more like moderate "rebounds" of interest which did not inspire the sort of cumulative phenomenon required to form media-hype. Twitter followed a similar trajectory (Figure 3). On 4 April 2018, French twitter saw a "jolt," but there were fewer responses to the online release of a video reconstruction of the fatal accident of 23 March 2018 than there were to other events unrelated to the accident.

Autonomous vehicles therefore occasionally intrude upon public debate. Nonetheless, the recurrence of a comparably dramatic incident (another fatal crash) did not engender any sort of cumulative phenomenon in the intensity of media reactions, in any of the spheres of communication we looked at. This would suggest that autonomous vehicles are not yet a genuine subject of interest for society at large.

5.3 Periods of agitation: short-lived democratisation on Twitter

The net temporal correlation between the intensity of the media agenda and the productivity of Twitter users, established by other studies (Yang & Leskovec, 2011), can be observed here. The principal triggers of upswings in attention are the same for the press as they are for Twitter. Nevertheless, these two spheres of communication do not always react with the same intensity and in the same terms.

The Geneva International Motor Show (8-18 March 2018), despite receiving abundant coverage in the national daily press (47 articles), had a (proportionally) weak impact on Twitter (327 tweets) (Figure 3). The CES event in Las Vegas (9-12 January 2018), on the other hand, witnessed a mass amplification phenomenon (7,685 tweets vs 26 articles) far outstripping that observed after the crash involving the self-driving Uber on 19 March of the same year (5,998 tweets vs 106 articles). In this case, the heavily tech-leaning dimension and prevalence of professional usage of this particular social network are plain to see. Many of the tweets associated with the CES were self-promotional in nature, or consisted of experts expressing individual opinions on tech subjects. At the other end of the spectrum, the public debate organised in four large French cities on 27 January 2018, in spite of very limited press coverage (7 articles), generated a disproportionately large number of social media interactions (506 tweets). Last but not least, there are certain response dynamics which are specific to Twitter, as illustrated by the example of two French television programmes[8] which generated 97 tweets but not a single article. These two media, television and Twitter, feed off each other mutually and simultaneously (Jeanne-Perrier, 2010).

These examples hint at the existence of a certain indecisiveness in the otherwise close connection between the press and Twitter (Neuman et al., 2014), in spite of the near-total transferral of symbolic capital from the analogue world to the digital world, partly owing to the strong level of media engagement among Twitter users (Rieder & Smynaios, 2012). This breach raises questions as to Twitter's true capacity to act as an alternative to the traditional press, an issue much debated in the literature (Moats & Berra, 2018; Watson, 2016). The present study should fuel further discussion of these questions.

To begin with, the very small proportion of opinion Tweets in our corpus (1.7%) lends weight to the idea that this social network is above all an echo chamber for the discourse formulated by the print media. Journalists generally have little direct contact with their readership, but use Twitter as a means of promoting their articles (Boyle & Zuegner, 2017). A large majority of tweets make reference, without comment, to information from a source outside the network, linking to an article from the print media, or in some cases a self-published article on a blog or website.

Nonetheless, this state of affairs does change during peaks of activity, as the Twitter conversation becomes more democratised. This phenomenon sees accounts which are usually

[8] C dans l'air (20 March 2018) et On n'est pas couché (24 March 2018).

silent awaken from their slumber, with publication rates soaring[9] and a doubling of the proportion of tweets (still clearly in the minority) expressing an opinion. Over the four days which followed the Uber accident in Arizona on 19 March 2018 the daily publication rate exceeded 4%, compared with a mean value of 1.22% over the whole period studied here. The proportion of tweets containing opinions jumped from 1.01% at the start of the observation period to 1.71% in March and 2.85% in April, buoyed by the Uber incident (in March) and sustained by French rail strikes (in April). This strong increase in the number of participants in the digital conversation serves to make it more representative of public opinion at large. But it is not possible to scientifically determine this representativity on account of the lack of systematic information regarding the socio-economic profiles of individual contributors. Nonetheless, reading all of the tweets containing opinions provided an opportunity to look into the counts from which they emanated. It reveals a different type of user from those who regularly post in response to the latest innovations in the fields of digital technology and automation. Users falling into the former category, more limited in number, have a broader and more personal range of interests (unrelated to their professional activities). They periodically display a keen sense of citizenship, or even militancy, on matters relating to the practical organisation of daily mobility (with less interest in institutional questions, which are more rarely addressed), the positioning of autonomous vehicles within this ecosystem and their social and spatial impact. These accounts sometimes spark a flurry of tweeted responses, bringing three or four other Twitter users into the conversation.

Analysing the content of these tweets expressing opinions also revealed Twitter's occasional capacity to politicise the issue of driverless vehicles. A clear divide emerges between users enthusiastic about this technology and others who are (highly) sceptical about the potential of autonomous vehicles to change our day-to-day lives. Autonomous vehicles thus rapidly go from being a source of surprise (catalysing the exchange of information) to being the subject of jokes and then a topic of debate, or even condemnation. Grounds include the unfair treatment of certain professional categories and the incapacity of public authorities, prevented from preparing for the future by their blinkered perspective.

Nevertheless, this does not suffice to make autonomous vehicles a fully-constructed subject of public debate. The three-step process described by Felstiner, Abel & Sarat (1991 and cited by

[9] Number of accounts posting one or more tweets on a given day, as a proportion of the total number of accounts in the corpus (Boyadjian, 2016).

Jacquez & Arnoult, 2016) distinguishes between naming, blaming and claiming.[10] At present, autonomous vehicles feature as one aspect of broader (and sometimes distant) debates, such as the pertinence of lowering speed limits, or else virulent criticism of public transport systems and/or their operators. Autonomous vehicles thus cropped up in debates over speed limits, rail strikes or the future of local train lines. The common feature shared by these debates is that they involve criticism of public policies or services. Autonomous vehicles are thus used as a pretext or scapegoat in discussions of social tensions and problems which have already been politicised, such as street harassment.

5.4 Dynamics of transmission and impact on information

These dynamics of transmission, between different media spheres and between users of a social network, impose their own distinctive logic. There is a clear continuity between the two media spheres, whose activity is structured by the same leaders. However, the forms of interaction inherent to the social network generate specific conditions which redefine the contours of the information and the influence of those who provide it.

Many leading titles from the print media occupy a dominant position in the dissemination of information on Twitter which is comparable to their offline position. Nonetheless, the relative influence of the most prolific sources in our contemporary corpus is modified by the specific context of Twitter exchanges. Drawing up a table of the most frequently-referenced domain names, we can observe the dominance of national dailies such as Les Echos and Le Monde, but also the significant reach of webzines and other media such as Youtube and rolling news channel BFMTV. The dominant position of the magazine Challenges in the print media landscape (see Figure 4) stands in stark contrast to the weak uptake of its articles on Twitter, and the infrequency with which the magazine's domain name appears in links.[11] Finally, by calculating a synthetic indicator for influence[12] we can clearly observe the overwhelmingly dominant position enjoyed by Le Parisien, a general interest newspaper with only a modest number of articles on this subject but a very large Twitter following (2 million followers), whose every tweet on this topic was retweeted 20 times. The closest rivals, albeit far behind Le Parisien, are the Twitter accounts of the BFM news channel and specialist magazines both print

[10] The first phase, naming, means identifying a given situation as problematic and unfair. The second phase, blaming, involves the transformation of factual injustice into a grievance against a designated guilty party (or parties). The third phase, claiming, evokes the transition from individual responsibility to challenging the workings of an unjust or effective social or political system, and thus demanding solutions / compensation.

[11] An average article published in Challenges gets mentioned in 2 tweets, compared with 15 for Les Echos and 11 for Le Monde.

12 Number of followers multiplied by number of retweets and divided by number of tweets (Boyadjian, 2016).

and online-only (01net and UsineDigitale). The latter are neck-and-neck with individual accounts belonging to three women who consider themselves to be, and the figures back them up, "influencers" on the subject of autonomous vehicles. [13]

As the most prolific source in our corpus of press articles, financial daily Les Echos is also the most frequently-referenced external source in our Twitter corpus. The circulation of the hyperlink to an article by the Echos on Twitter (cf 4.4) is an illustration of the theory advanced by Katz and Lazarsfeld (1955), the two-step flow model of communication. To begin with, the article was mentioned by accounts affiliated with Les Echos, an example of vertical dissemination. Thereafter, the link to the article was included in a tweet by the influencer F. Billat which earned multiple retweets. F. Billat acts as an opinion leader on Twitter. The numerous retweets from personal accounts are evidence of horizontal dissemination. Analysis indicates that simply quoting the title of an article and including a hyperlink does not make for a successful tweet, in terms of retweets generated. There first needs to be a degree of editorial intervention, whereby the information is reframed and summarised into an eye-catching message which is easy to understand and remember. It thus appears that the initial promotional efforts undertaken by media-linked Twitter accounts tend to reproduce the original media pronouncement. Thereafter, influential media players tend to modify that pronouncement, evoking other opinions. The choice of linguistic register, grammatical moods and tenses and overall tone all play a role in this process of adjustment. In spite of the constraints imposed by the character limit, Twitter is more than just an echo chamber for the press, allowing for the production and circulation of other opinions. The conditions and dynamics of circulation specific to this sphere partly define the contours of the content shared.

6 Conclusion

The French government authorities tasked with deploying a national strategy on autonomous vehicles are keen to assess public opinion on the matter. The purpose of this article is to offer a response by examining the manner in which autonomous vehicles are presented and represented in French media discourse. We thus monitored the discourse encountered in the printed press and online publications, as well as on Twitter, between December 2017 and May 2018, to which we added a corpus of press articles published between 2012 and 2017.

[13] https://socialmediaoptimization.fr/le-top-des-influenceuses-marketing-sur-twitter-en-france/ retrieved 5 March 2021

We produced a quantified overview of the current state of information available on autonomous vehicle in different media spheres, examining its volume and temporal distribution, and the sources and semantics encountered. We subsequently focused on the construction and circulation of this information, particularly by means of detailed analysis of extracts from the corpus of press articles and tweets. The results serve to illustrate the dynamics of growth and decline observed in media activity surrounding autonomous vehicles, as well as the co-production of news agendas and the lay of the media landscape.

Although the general trend is for growth, media interest in the subject continues to fluctuate significantly. We observed several peaks of media activity, particularly in response to fatal accidents involving Uber and Tesla vehicles. These peaks correspond to intense press coverage and a more widespread interest on Twitter, with considerable homogenisation of the content disseminated. Nonetheless, these peaks did not grow in size over the period in question and cannot truly be considered to constitute a media-hype. Both of the communication spheres considered here respond to the same event-related *stimuli*, but their sensitivity to such events may vary.

Across all sources and spheres of communication, we observed the emergence of parallel narratives constructed around the actions, positions and declarations of economic stakeholders with an interest in driverless technologies. The media agenda and the industrial agenda are intertwined. Comparisons are made between the companies in question, whose public profile is especially high in those cases where the personality of the CEO lends itself to such epic narratives. But their stories are often considered in isolation: cross-cutting analyses are thin on the ground. The prioritisation of the viewpoints of private stakeholders dominates the way in which these issues are framed. Sometimes pulled into debates where its relevance is decidedly tenuous (speed limits, rail strikes, investment in public transport), driverless technology still serves as a straw man in debates about social or political hot topics, and criticism of public services.

Opinion leaders play an important role in the dissemination and circulation of information. The press coverage makes extensive use of sources from within the automobile industry. On Twitter, the official accounts of media outlets often find themselves on even terms with opinion leaders endemic to this social network, many of whom are technophiles. While the former are concerned with amplifying their media impact, the latter are liable to distort their messages, adjusting the linguistic register, tense and tone. As such, the co-dependent relationship between the print media and Twitter does leave a certain degree of freedom and room for manoeuvre,

something which emerged from both the temporal analysis and analysis of the content of messages.

Close inspection of our sources revealed that the leading national newspapers have clearly led the way in terms of media output on the subject of autonomous vehicles since 2015. But the sheer diversity of sources available online has made a massive contribution to overall output. The multitude of digital sources allows for a relative diversity in the content produced. Webzines and comparison sites have their own editorial teams who bring their own expertise to bear on this subject, and are well-informed while remaining primarily focused on technology. These sites are also present on Twitter, where they reach an audience at least proportional (and perhaps superior) to their share of overall media output. It is different for leading print titles. They do not always succeed in reproducing their influence from one sphere of communication to the next.

With regard to our corpus of sources, a number of further perspectives remain to be explored, particularly with regard to the analysis of co-occurrences. Co-occurrences of terms (not themes) could cast new light on this issue, moving away from our thematic table to reveal other forms of problematisation. Moving beyond this corpus, sizeable though it is, it would be useful to expand both the period studied and the geographical zone considered. The period studied here allows us to conclude that driverless technology remains a relatively under-publicised subject, but it is nonetheless difficult to situate autonomous vehicles in terms of the technological maturity curve (Gartner, 1995). It would also be interesting to compare the public image of autonomous vehicles in France with that observed in other countries in Europe, North America or East Asia.

Ultimately, with a lack of political problematisation and radio silence from the government on the subject, driverless technology is neither a real topic of public interest nor a clearly-defined public policy issue. The predominance of perspectives originating with (private) stakeholders leads us to conclude that driverless technology remains a technical concern which does not yet have the sort of social resonance we associate with issues of real public interest. The research agenda on autonomous vehicles has a role to play to contribute to the general public profile of autonomous vehicles (Milakis & Müller, 2020). This point is of particular importance to the government agencies concerned with the deployment of autonomous vehicles and the social acceptability of such technologies.

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