



A dual-focus analysis of wikipedia traffic and linguistic patterns in public risk awareness Post-Charlie Hebdo

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ABSTRACT

This study investigates the dynamics of public risk awareness in the aftermath of the Charlie Hebdo terrorist attack on January 7, 2015, through a dual-focus analysis of Wikipedia traffic and Google Trends data. Analyzing the temporal patterns of Wikipedia page views in both English and French, sheds light on how significant media events, anniversaries, and related incidents influence public engagement with terrorism-related content over time. The study highlights the critical role of linguistic and cultural factors in shaping these patterns, revealing that Francophone regions, particularly France and its former colonies, exhibit a more sustained and consistent interest in the Charlie Hebdo event compared to Anglophone regions. The heightened engagement in French-speaking areas suggests that cultural and historical ties influence public risk perception and awareness. Complementing this analysis with geographic insights from Google Trends, the study provides a more comprehensive understanding of how people in different regions perceive and respond to terrorism. The findings underscore the importance of digital platforms in gauging public awareness and suggest practical implications for designing targeted risk communication strategies. These strategies could be timed to coincide with moments of heightened public interest, such as anniversaries, to enhance public resilience and preparedness in the face of terrorism. This study contributes to the broader understanding of digital media's role in shaping and sustaining public risk awareness in a global context.

1. Introduction

The tradition of political cartooning can be traced back to the times of Leonardo da Vinci, when cartoons, functioning as illustrations rather than fine art, played a significant role in European public life for centuries. Notably, the 19th-century French artist Honoré Daumier faced imprisonment for an unflattering 1831 cartoon of King Louis Philippe, highlighting the historical acceptance of even the most critical caricatures as a legitimate expression of political propaganda in the Western world (Navasky, 2013). In the modern historical context, a pivotal event occurred on September 30, 2005, when the Danish newspaper Jyllands-Posten published a series of editorial cartoons depicting sensitive Islamic community topics. These cartoons were deemed highly offensive by the Muslim community, and seen as blasphemy against Islam. The publication led to widespread protests, including the burning of Danish flags in Pakistan and the tragic loss of over a hundred lives

globally (Navasky, 2013). The safety of the cartoonists was compromised, forcing them into hiding. Subsequently, on New Year's Day in 2010, an assassination attempt was made on one of the Danish cartoonists amid numerous death threats.

Following this case, the controversial Danish cartoons were republished by the French satirical magazine, Charlie Hebdo, in 2006. The periodical's name is a fusion of the French word 'Hebdomadaire', representing its weekly publication, while 'Charlie' serves as a humorous jab at the former French President, Charles de Gaulle. On the night of November 2, 2011, a Molotov cocktail was thrown into the Charlie Hebdo office. Despite the firebombing, the magazine continued publishing satirical cartoons in 2012, even after several attacks on US embassies in the Middle East. The editor, Stéphane Charbonnier, defended the cartoons, highlighting the magazine's practice of caricaturing everyone regularly. The attack escalated on January 7, 2015, when the Paris office was assaulted, resulting in the deaths of eight Charlie Hebdo

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staff members, including Charbonnier. The global response included increased security measures in Paris and a massive demonstration throughout France. The phrase “Je Suis Charlie” became a global slogan in support.

Charlie Hebdo provided insights into the role of media reporting about such events, including both traditional media and social media. It became evidence that information on Wikipedia has a significant influence and serves as a tool to gauge public risk awareness (Yosipof et al., 2023). Public interest in searching through Wikipedia pages for information regarding natural and man-made disasters, such as the Charlie Hebdo attack, increased significantly during the last years and shows the need to research its influence on public discourse and its role in shaping risk perceptions. This paper aims to explore the search patterns in Wikipedia about such topics as the Charlie Hebdo, the shooting attack, and subsequent events in connection with the Charlie Hebdo Wikipedia pages.

Wikipedia is the largest online encyclopedia and plays a pivotal role in shaping public awareness and knowledge, especially in the aftermath of significant events such as terrorist attacks. Primarily because of its crowd-sourced information and continuous updating, it is a primary destination for individuals seeking detailed and reliable information. Wikipedia’s traffic patterns offer a unique window into public interest and concern, reflecting how and when people engage with particular topics. Wikipedia traffic data is therefore a useful tool for understanding the temporal and regional variations in public perception, which are central to addressing the research questions focused on the interplay between media events, public awareness, and cultural context.

We therefore propose the first research question: how does the timing of significant media events impact the public’s search behavior and risk awareness as reflected in Wikipedia page traffic related to the Charlie Hebdo terrorist attack? [RQ1]

Google Trends is a crucial tool in understanding public interest and search behavior over time, providing valuable insights into how specific events resonate across different regions and cultures. Google Trends is instrumental in investigating the Charlie Hebdo terror attack, as it offers a complementary perspective to Wikipedia traffic data, revealing the geographic and cultural dimensions of risk awareness and information-seeking behavior. The ability to track and compare search queries across regions and languages enables a deeper understanding of how public awareness and perceptions evolve in the aftermath of such events, thus highlighting the intersection of media impact, public consciousness, and regional differences in risk perception.

We therefore propose the second research question: what role do linguistic and cultural factors play in the temporal patterns of Wikipedia traffic following the Charlie Hebdo terrorist attack? [RQ2]

2. Wikipedia traffic data

Analyzing Wikipedia page views provides valuable insights into the persistence and dynamics of public risk awareness, particularly concerning terrorism. By tracking how traffic fluctuates over time, we can gauge the ongoing relevance of these events in the public consciousness, identify key moments of heightened interest, and assess the impact of media coverage.

In the realm of disaster risk reduction (DRR), comprehending risk awareness assumes paramount significance as a foundational element for effective mitigation strategies and resilience-building efforts. The intrinsic link between risk awareness and the successful reduction of disaster risks underscores the critical role of understanding human perceptions, attitudes, and knowledge regarding potential hazards. Risk awareness serves as the linchpin in fostering community engagement, preparedness, and the adoption of adaptive measures (Erokhin et al., 2022). A populace that is well-informed and conscious of the specific risks prevalent in their geographic area is better equipped to make informed decisions, act promptly during emergencies, and collaborate with authorities in implementing proactive measures. Furthermore,

understanding risk awareness aids in tailoring communication strategies and educational initiatives that resonate with diverse communities, ensuring that information is accessible and comprehensible. This background section posits that an in-depth exploration of risk awareness within the context of disaster risk reduction is indispensable for formulating targeted interventions, enhancing community resilience, and fostering a proactive culture of preparedness in the face of potential disasters.

The advent and widespread use of social media have ushered in a paradigm shift in the landscape of risk awareness and perception, particularly within the domain of disaster risk reduction. This phenomenon has introduced new dimensions to the dissemination of information, community engagement, and the shaping of public attitudes toward potential hazards (Komendantova et al., 2023). Social media platforms serve as dynamic channels that facilitate real-time information sharing, allowing users to access and contribute to a continuous stream of updates related to disaster events. The impact of social media on risk awareness is underscored by its ability to swiftly disseminate critical information, providing timely alerts, evacuation procedures, and situational updates during emergencies. Moreover, these platforms enable individuals to actively participate in discussions, share personal experiences, and collaboratively contribute to community resilience efforts. However, the influence of social media on risk perception is multifaceted, encompassing both positive and negative aspects. While social media can amplify the immediacy of risk communication, it may also contribute to the spread of misinformation (Vicari & Komendantova, 2023). The understanding of the interplay between social media, risk awareness, and risk perception is imperative for developing targeted and effective strategies in the realm of disaster risk reduction. Investigating the dynamics of social media’s impact on risk-related cognition is crucial for optimizing communication efforts, fostering informed decision-making, and enhancing overall community resilience.

Social media are playing a significant role in shaping public awareness after such events as the Charlie Hebdo attack. On one hand, acts of violence often seek attention, and Juergensmeyer (2017) notes in his work “*Terror in the Mind of God*”, that terrorism, lacking an engaged audience, becomes akin to a purposeless performance without spectators. The audience for such acts is not confined by geography or time, and the message endures until the political objective is attained. On the other hand, communal memory retention of political violence is crucial for honoring victims and cultivating a lasting personal sense of risk awareness within the general public, a factor susceptible to degradation with the passage of time or misinformation (Dallo et al., 2023; Elroy et al., 2023; Elroy et al., 2024; Elroy & Yosipof, 2022, 2023; Erokhin et al., 2022; Komendantova et al., 2023; Vicari et al., 2024)

Wikipedia, being the largest online encyclopedia, holds significance in the digital world as a primary source of information. Emphasizing continuous co-creation for crowd-sourced authenticity and accuracy, Wikipedia differs from social media platforms where information is often brief and biased (Selwyn & Gorard, 2016). This platform plays a pivotal role in information retrieval behaviors.

The relationship between sustained traffic on specific Wikipedia pages related to a disaster and risk awareness is grounded in the assumption that individuals accessing these pages are representative enough of the regional population for meaningful inferences. The enduring interest in historical events contributes to sustained risk awareness among the public, influencing their alertness to similar events in the future. Public risk awareness is integral for authorities, impacting operational effectiveness and behavior in emergencies as well as the level of trust in public authorities in their capacity to manage emergencies and mitigate risks. To assess the persistence of risk awareness, analyzing Wikipedia traffic data is instructive.

Yosipof et al. (2023) previously investigated the May 22, 2017 Manchester suicide bombing and positive feedback has spurred the current investigation. An examination of Wikipedia page views over five and a half years after the terrorist attack reveals a sustained and

enduring interest in the Manchester Arena bombing over consecutive days. The consistent viewership suggests a recurring pattern wherein individuals accessing the Wikipedia page on a particular day may revisit it in the subsequent days, potentially influenced by media coverage or the act of sharing information with others. Preceding noteworthy events related to the Manchester Arena bombing, such as media broadcasts and print coverage, may contribute to heightened attention on the Wikipedia page for an extended period. This enduring engagement highlights an opportunity to address a potential gap in public risk communication. Leveraging the sustained interest, supplementary campaigns focusing on terrorism risk awareness could be strategically timed to coincide with this persistent attention. While the current focus revolves around the Manchester Arena bombing, there exists an avenue for further exploration into the effectiveness of similar risk awareness campaigns in diverse contexts beyond this specific incident. The publicity associated with events like the 2017 Manchester bombing, with many young victims, or the 2015 Charlie Hebdo attack, amplifies public awareness.

3. Methodology

3.1. Data

For data collection, we gathered Wikipedia page views traffic for both the Charlie Hebdo main page and the dedicated page on the 2015 terror attack, in both English and French, during the period between July 1, 2015, and June 20, 2023. We collected access data from the Charlie Hebdo and the Charlie Hebdo shooting pages, each in both English and French.

The dataset includes time series for each page, and basic statistics of the time series for each page are presented in [Table 1](#).

3.2. Methods

In this study, we used the following methods of analysis: auto-correlation analysis, language cross-correlation analysis, trend and seasonality analysis, and Google trends analysis.

The auto-correlation analysis constitutes a rigorous analytical methodology deployed for the in-depth investigation of individual time series within the context of web page traffic data. This analytical procedure involves an exhaustive exploration of autocorrelation, a fundamental metric that quantifies the statistical association between the current page traffic observations and their antecedent values. Autocorrelation, in this context, serves as a pivotal indicator of the temporal dependencies inherent in the dataset, specifically gauging the degree to which the present page traffic is influenced by its historical patterns. Elevated autocorrelation values, as identified through this analysis, manifest as indicative of a pronounced consistency in viewer behavior from one temporal point to the subsequent day for the specific event page under scrutiny. Such heightened autocorrelation values elucidate a persistent and discernible temporal pattern, thereby signifying a robust correlation between the observed page traffic on consecutive days. This empirical insight, embedded within the framework of auto-correlation analysis, contributes substantively to the scientific understanding of temporal dynamics and recurrent behavioral patterns exhibited by users engaging with event pages. Consequently, this analytical approach assumes a pivotal role in the realm of scientific inquiry, furnishing

valuable insights for elucidating the temporal intricacies and behavioral regularities within time series data associated with web page traffic.

The language cross-correlation analysis represents a methodological exploration entailing the comprehensive examination of cross-correlation dynamics between distinct time series associated with the same subject matter but presented in different languages. As exemplified by the English and French pages covering the Charlie Hebdo shooting, this analytical approach seeks to discern the interlanguage relationships and temporal dependencies inherent in the respective datasets. Cross-correlation, employed as a fundamental metric within this analysis, functions as a quantitative measure facilitating the assessment of correlation or interrelationship between the time series under consideration. Specifically, cross-correlation scrutinizes the patterns exhibited by two distinct time series at various temporal lags, offering a nuanced understanding of their temporal associations. This analytical framework serves the crucial purpose of identifying correlations between time series and determining the precise temporal lag at which these correlations manifest. In the context of multilingual analysis, such as the examination of English and French pages dedicated to the Charlie Hebdo shooting, language cross-correlation analysis assumes a paramount role in unraveling the intricate interplay of temporal patterns between disparate linguistic representations of the same event. Consequently, this scientific methodology contributes substantively to advancing our understanding of linguistic influences on temporal dynamics within cross-cultural datasets.

The trend and seasonality analysis involves a meticulous examination of the trend and seasonality components within the relevant Wikipedia time series data. A critical aspect of this investigation is the application of the Seasonal-Trend decomposition using the Loess (STL) method, which proves instrumental in dissecting the time series into its fundamental constituents—namely, seasonal, trend, and remainder components. The STL method leverages the Loess locally weighted regression technique, offering a robust means to estimate the trend component. This approach ensures a flexible representation of the underlying data pattern, capturing nuanced variations and deviations. Specifically, the trend component at a given time t signifies the extended and continuous progression of the series, reflecting a sustained directional shift in the data over time. By employing the STL method, this analysis enhances the interpretability of the time series data by disentangling its inherent components, thereby providing valuable insights into the long-term trends and recurring patterns present in the Wikipedia dataset.

The Google trends analysis allows examining and interpreting patterns in the popularity of search queries on Google's search engine over time and can provide insights into user interests, regional variations, and temporal trends associated with specific keywords. Google Trend analysis allows users to observe how the popularity of a search term changes over different time intervals. This temporal dimension is critical for understanding seasonality, identifying emerging trends, or tracking the impact of specific events on search behavior. Users can also compare the popularity of multiple search terms in a single graph. This feature is particularly useful for assessing the relative interest in different topics, products, or events. Google Trends can also provide information about the regional interest in a particular search term. During crises or major events, Google Trend analysis can provide insights into how public interest and search behavior are evolving. This information can be

Table 1

Descriptive statistics of the 'Charlie Hebdo' and 'Charlie Hebdo Shooting' pages time series, both in English and French. The total number of days of the dataset, together with the minimum and maximum daily view frequencies, and the average daily view frequency and standard deviation (Std.).

Event	Language	Number of dataset days	Minimum frequency	Maximum frequency	Average frequency \pm Std.
Charlie Hebdo	English	2912	289	78115	1131.47 \pm 3219.40
	French	2912	114	13757	485.67 \pm 712.34
Charlie Hebdo shooting	English	2912	564	292,548	1622.93 \pm 6332.53
	French	2912	210	79,552	907.54 \pm 2149.58

important for crisis management, public relations, and understanding the impact of events on various sectors.

4. Results

4.1. Pages traffic and picks

We analyzed and compared the page traffic of the Charlie Hebdo (Fig. 1) and the Charlie Hebdo Shooting (Fig. 2) pages in both English and French. Table 2 presents a comparison between the peaks in the pages traffic.

4.1.1. Charlie Hebdo page traffic

We analyzed the pages traffic time series of the Charlie Hebdo in both English and French. The page views are shown in Fig. 1, where we can see several picks in the page traffic. The peaks are annotated, and the most plausible explanations are given.

The initial peak on September 15, 2015, is evident in both English and French Wikipedia page view frequencies, with a slightly more pronounced presence in the English data (Fig. 1, annotation a). This surge, while modest in volume, can be attributed to global criticism directed at the magazine following the publication of two contentious cartoons.

A significant peak occurred on November 14, 2015, observed prominently in both English and French page view frequencies (Fig. 1, annotation b). This surge followed coordinated ISIS attacks in Paris during the previous evening, resulting in 130 fatalities and over 400 injuries. These events likely evoked memories of the earlier Charlie Hebdo attack in Paris that occurred at the beginning of the same year.

The recurrent peaks on January 5–7 of each year are associated with commemorations of the terrorist attack (Fig. 1, annotations c, o). Despite CNN providing comprehensive English language coverage, the profound impact of the Charlie Hebdo attack was more deeply and enduringly felt in France. Consequently, while the English page exhibits a peak only on the first anniversary, the French page registers peaks annually since the attack.

The peak on July 15, 2016, in the English time series (Fig. 1, annotation d) corresponds to the day following a terrorist attack in Nice during the Bastille Day celebrations. The attack involved a large truck driven into a crowd, resulting in 86 casualties. Notably, Nice has been a favored vacation destination for the English. The perpetrator had preserved a newspaper photo of a similar incident in Nice from December 2015 on his cell phone. Subsequently, two copycat terrorist vehicle-ramming incidents occurred in London in March and June 2017.

Several peaks of interest are discernible in the English time series but not in the French counterpart. These peaks are typically associated with

Charlie Hebdo publications satirizing global disasters. The British satirical magazine, Private Eye, renowned for its historical tradition of satire, maintains a distinct approach by poking fun at the ruling class while maintaining greater respect for disaster victims.

The peak on December 28, 2016, may be associated with the criticism directed at Charlie Hebdo for satirizing a Russian military aircraft crash a few days earlier (Fig. 1, annotation e). The incident resulted in the loss of 92 lives, including journalists and humanitarian workers. Similarly, the peak on August 31, 2017, can be linked to a Charlie Hebdo cover satirizing the victims of Hurricane Harvey, which impacted Texas at the end of August. The corresponding cartoon garnered widespread criticism on social media (Fig. 1, annotation f).

A notable peak is evident on September 2, 2020, following the controversial decision of the magazine to republish cartoons depicting the Prophet Muhammad, coinciding with the commencement of the trial of 14 alleged accomplices in the earlier attack (Fig. 1, annotation g). Another peak on September 25, 2020, may be explained by a terrorist knife attack near the former offices of Charlie Hebdo, resulting in two injuries (Fig. 1, annotation h). Subsequent media reports suggested that the assailant expressed anger over the publication of cartoons depicting the Prophet Muhammad on October 28–29, 2020 (Fig. 1, annotation i).

The minor peak on November 23, 2020, in the French time series corresponds to the resumption of the trial over the Charlie Hebdo shooting after a temporary suspension due to several defendants testing positive for coronavirus (Fig. 1, annotation j). On December 8, 2020, a slight increase in the French time series was linked to advancements in the trial of the attackers, during which substantial sentences were sought (Fig. 1, annotation k). Another modest increase on January 26, 2021, may be associated with discussions involving one of the survivors of the attack who was promoting a new book (Fig. 1, annotation m).

The publication of a controversial cartoon by Charlie Hebdo on March 14, 2021, depicting Queen Elizabeth II kneeling on Meghan Markle's neck drew substantial criticism (Fig. 1, annotation n). The cartoon, potentially suitable for the British satirical magazine Private Eye, alluded to the tragic killing of George Floyd.

On January 5, 2023, the surge in interest in the Charlie Hebdo page in English following the publication of cartoons depicting Iran's leader, Ali Khamenei (Fig. 1, annotation o), coincided with the commemoration of the terrorist attack (Fig. 1, annotations c), potentially driving the observed peak.

The February 7–8, 2023 peak in both English and French pages may be attributed to two key events (Fig. 1, annotation p). First, media reports incriminated Iran for multiple cyber-attacks against Charlie Hebdo, generating widespread attention. Second, the surge in interest is associated with the publication's controversial mockery of the disastrous earthquake in Turkey and Syria on February 6, 2023, which faced

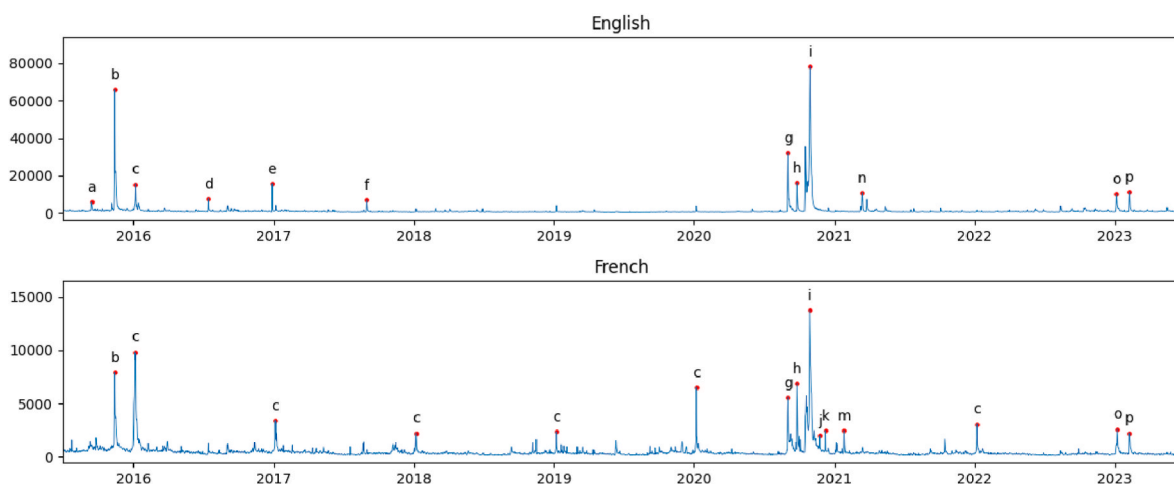


Fig. 1. Charlie Hebdo page views in English and French [July 1, 2015–June 20, 2023].

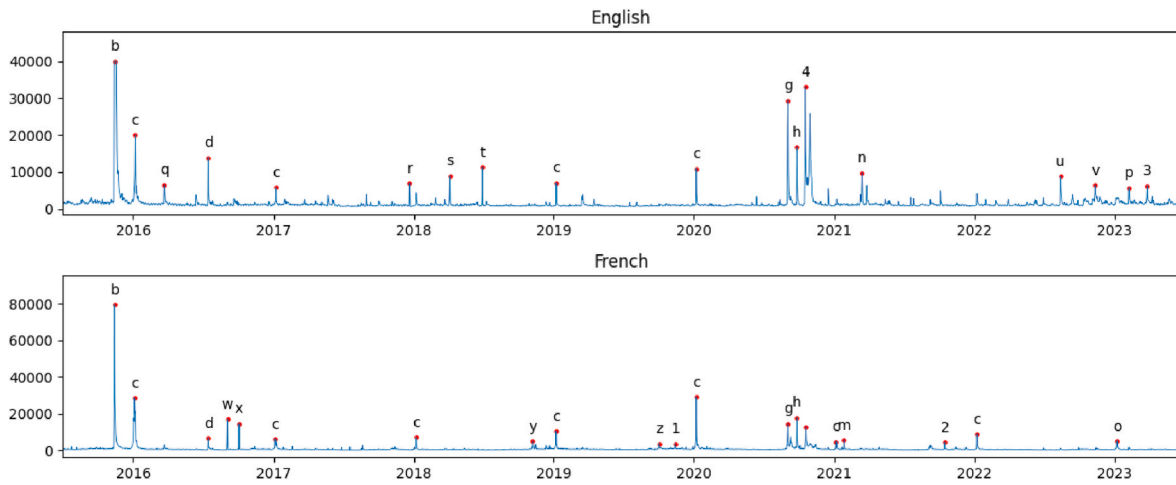


Fig. 2. Charlie Hebdo shooting page views in English and French [July 1, 2015–June 20, 2023].

Table 2

Comparison table between peaks in the ‘Charlie Hebdo’ and ‘Charlie Hebdo Shooting’ pages in both English and French. The annotations can be seen in Figs. 1 and 2.

(Annotation) Date	Charlie Hebdo		Charlie Hebdo Shooting	
	English	French	English	French
(a) 15 Sep. 2015	Criticism over contentious cartoons		–	–
(b) 14–15 Nov. 2015	–		ISIS Paris attacks	–
(c) 5–7 Jan. Recurring	–		Attack commemorations	–
(q) 22 Mar. 2016	–	–	Brussels attack	–
(d) 15 Jul. 2016	Nice attack	–	Nice attack	–
(x) 3 Oct. 2016	–	–	–	Kim Kardashian
(e) 28 Dec. 2016	Russian aircraft crash	–	–	–
(f) 31 Aug. 2017	Hurricane Harvey	–	–	–
(r) 21 Dec. 2017	–	–	ISIS sympathizer conviction	–
(s) 5 Apr. 2018	–	–	Protests against Islamophobia	–
(y) 7 Nov. 2018	–	–	–	Philippe Lançon
(1) 13 Nov. 2019	–	–	–	ISIS attack commemoration
(z) 2 Oct. 2019	–	–	–	Laurent Sourisseau
(g) 2 Sep. 2020	–	–	Republishing Prophet Muhammad cartoons	–
(w) 3 Sep. 2016	–	–	–	Italy earthquake
(h) 25 Sep. 2020	–	–	Knife attack	–
(i) 28–29 Oct. 2020	Subsequent media reports	–	–	–
(j) 23 Nov. 2020	–	Resumption of trial	–	–
(k) 8 Dec. 2020	–	Advancements in trial	–	–
(m) 26 Jan. 2021	–	Survivor book	–	Survivor book
(n) 14 Mar. 2021	Queen Elizabeth	–	Queen Elizabeth	–
(o) 5 Jan. 2023	Cartoons Iran’s leader, Ali Khamenei	–	–	Cartoons Iran’s leader, Ali Khamenei
(p) 7–8 Feb. 2023	Iran cyber-attacks, Turkey/Syria earthquake	–	–	–

substantial criticism in the media, contributing to heightened interest and discussions surrounding Charlie Hebdo during that period.

4.1.2. Charlie Hebdo shooting page traffic

There is a dedicated Charlie Hebdo page for the terrorist attack on January 7, 2015. The English and French time series of the Charlie Hebdo shooting page were inspected, and the page views are shown in Fig. 2. (The 14–15 November 2015 peak in the time series which reached 292,548 views of the English page and 79,552 views of the French page, was capped at 40,000 page views for optimal visualization). The peaks are annotated, and the most plausible explanations are given.

4.1.3. Peaks that are common with the Charlie Hebdo page

The most pronounced peak across both pages and both languages occurred on 14–15 November 2015 (Figs. 1 and 2, annotation b), following coordinated ISIS attacks in Paris the previous evening.

The annual peaks on January 5–7 in both the Charlie Hebdo page and shooting-dedicated pages, corresponding to the attack’s commemoration. The peaks are observed in both the magazine-dedicated pages and

the shooting-dedicated pages in both languages (Figs. 1 and 2, annotations c).

The peak on July 15, 2016, which is linked to a terrorist attack in Nice, France, (Figs. 1 and 2, annotation d), is evident in both the English and French pages of the shooting pages, as well as the English version of the Charlie Hebdo page.

Peaks on September 2, 2020 followed the Prophet Muhammad cartoons, and on September 25, 2020, the terrorist knife attack (Figs. 1 and 2, annotations g, h) are common to both the Charlie Hebdo and Charlie Hebdo shooting pages in both languages.

The minor peak on January 26, 2021 (survivor book) is observed only in the French time series, evident in both Charlie Hebdo and Charlie Hebdo shooting pages (Figs. 1 and 2, annotation m).

The Queen Elizabeth cartoon on March 14, 2021 (Figs. 1 and 2, annotation n) is more pronounced in the time series of the English pages for both Charlie Hebdo and the Charlie Hebdo shooting.

The peak on January 5, 2023, observed on the Charlie Hebdo page in English, and French and the Charlie Hebdo shooting page both in French following the publication of cartoons depicting Iran’s leader, Ali Khamenei, is associated with the commemoration of the terrorist attack

(Figs. 1 and 2, annotation o). The causes of this peak may differ between the English and French pages of the shooting.

The peak on 7–8 February 2023 (Figs. 1 and 2, annotation p, Iran cyber-attacks and Turkey/Syria earthquake) can be seen on both English pages and on the Charlie Hebdo page in French.

4.1.4. Peaks on the shooting page but not on the Charlie Hebdo page

Peaks on the English page for the Charlie Hebdo shooting are less conspicuous on the French page, predominantly aligning with stories of distinctively UK or international focus. For instance, the terrorist attack in Brussels on March 22, 2016 prompted increased interest in the Charlie Hebdo shooting page (Fig. 2, annotation q). On December 21, 2017, a peak followed the UK conviction of a terrorist planning an attack and the sentencing of an ISIS sympathizer plotting to behead a blogger depicting the Prophet Muhammad (Fig. 2, annotation r). Protests against Islamophobia in the UK on April 5, 2018 led to another peak (Fig. 2, annotation s).

Similarly, events with Parisian content dominated peaks on the French page, except for a peak on September 3, 2016, when Charlie Hebdo faced severe criticism for a cartoon referencing the earthquake in Amatrice, Italy (Fig. 2, annotation w). On October 3, 2016, the gunpoint robbery of media personality Kim Kardashian in Paris caricatured in Charlie Hebdo, resulted in a peak (Fig. 2, annotation x). Philippe Lançon's receipt of the Prix Femina award on November 7, 2018 for his memoir detailing the attack led to another peak (Fig. 2, annotation y). Laurent "Riss" Sourisseau's publication of his story on October 2, 2019 prompted a peak (Fig. 2, annotation z). The commemoration of the fourth anniversary of the ISIS terrorist attack in Paris on November 13, 2019 also corresponded to a peak (Fig. 2, annotation 1)

4.2. Statistical analysis

4.2.1. Auto-correlation

The findings from the autocorrelation tests indicate that the temporal dynamics of viewer behavior are contingent upon the preceding day across all analyzed pages. Specifically, for both the English and French Charlie Hebdo pages, the autocorrelation coefficients exhibit positive and considerable values, measuring $r = 0.823$ and $r = 0.85$, respectively. Similarly, the Charlie Hebdo shooting pages in English and French also display positive and relatively high autocorrelation coefficients, registering $r = 0.52$ and $r = 0.615$, respectively. The heightened autocorrelation values signify a robust persistence in page view behavior from one day to the next, indicative of the sustained temporal interest in the respective event. The amplified autocorrelation values observed for the Charlie Hebdo pages may be attributed to a prolonged interest stemming from the magazine's typically contentious and provocative editorial content.

4.2.2. Language cross-correlation

In the case of both the Charlie Hebdo pages in English and French, the most substantial cross-correlation was identified between their respective time series on the same day, yielding a correlation coefficient of $r = 0.793$. Similarly, the cross-correlation between the English and French pages of the Charlie Hebdo shooting was found to be highest on the same day, with a correlation coefficient of $r = 0.812$. These outcomes signify a pronounced association between the time series at the identical time point, featuring a robust positive correlation between the English and French pages in both instances. This correlation is explicable by the fundamental observation that the information or events represented in these time series share similarities and common characteristics or themes.

4.2.3. Trend and seasonality analysis

The derived results were employed to ascertain the robustness of the trend and seasonality within each time series. Specifically, the strength of the trend and seasonality for the English and French pages of Charlie

Hebdo were calculated. Both time series exhibited a pronounced trend ($F_t = 0.804$ and $F_t = 0.838$, respectively) coupled with a relatively weak seasonality ($F_s = 0.274$ and $F_s = 0.276$, respectively). A parallel pattern emerged for the Charlie Hebdo shooting pages in English and French, with strong trends ($F_t = 0.637$ and $F_t = 0.609$, respectively) and diminished seasonality ($F_s = 0.351$ and 0.325 , respectively). These findings signify that the viewership of the pages over time is influenced by both seasonal and trend patterns. The seasonal component is linked to the commemoration of the Charlie Hebdo shooting on January 7, a significant recurring date in public remembrance. Conversely, the trend effect is associated with the continuous influx of new information or news related to the attack, similar terror events or discovered terror plots, episodes of Islamophobia, or other cartoon publications throughout the years.

This contrasts with findings by Yosipof et al. (2023) in their analysis of the Manchester Arena bombing attack, where the primary source of fluctuations was attributed to a yearly seasonal systematic pattern (May of each year) surrounding the anniversary of the event. In that case, the seasonal effect was substantial (0.66), while the trend strength was comparatively low (0.15), indicating that the time series was predominantly influenced by the seasonal pattern. In contrast, the Charlie Hebdo shooting attack has spurred numerous events not directly tied to the shooting itself, leading to a discernible trend of increased information-seeking behavior about the event. Consequently, a notably higher trend was observed for Charlie Hebdo and the shooting event in comparison to the Manchester Arena bombing event.

4.2.4. Google Trends

While the examination of temporal public persistence was pursued, the available Wikipedia data lacked specifics on page viewership, leading to an absence of geographical resolution for page views. To address this void, an exploration of search trends on Google was conducted. Google Trends served as a valuable resource, offering insights into trends within the broader Google ecosystem. This investigation focused on discerning patterns in web searches related to the Charlie Hebdo shooting during specific time frames corresponding to previously identified peaks in Wikipedia page view frequency. Analyzing search patterns allows us to observe the temporal peaks in public interest, particularly around significant media events such as terrorist attacks.

The analysis delved into the examination of search trends across European and North African countries from 2015 to 2023. Fig. 3A provides a world map highlighting countries with heightened interest, indicated by darker blue shading. Unsurprisingly, Francophone countries prominently feature on this map. The findings reveal that France, along with its overseas territories of Guadeloupe and Martinique in the Caribbean, and Réunion in the Indian Ocean, exhibited the highest levels of interest in the subject. Beyond these French territories, notable interest was observed in Europe and Northern Africa. Fig. 3B offers a more detailed map of Europe, North Africa, and Asia, showcasing countries with heightened interest in darker blue shades. Regions linguistically, culturally, or politically closely associated with France until recently, such as Côte d'Ivoire, Senegal, and Lebanon, as well as Mauritius, displayed elevated interest.

Algeria emerged as a notable point of interest in the topic, with factors such as colonial history and being one of France's longest-held overseas territories contributing to this heightened interest.

5. Discussion

The Charlie Hebdo terrorist attack on January 7, 2015, remains an indelible marker in the landscape of contemporary global terrorism. Our comprehensive analysis delving into the dynamics of Wikipedia traffic, conducted in both English and French, uncovers a discernible and enduring interest, particularly coalescing around anniversaries of the incident and analogous attacks. This sustained engagement in the public sphere suggests that the victims of the Charlie Hebdo attack are not

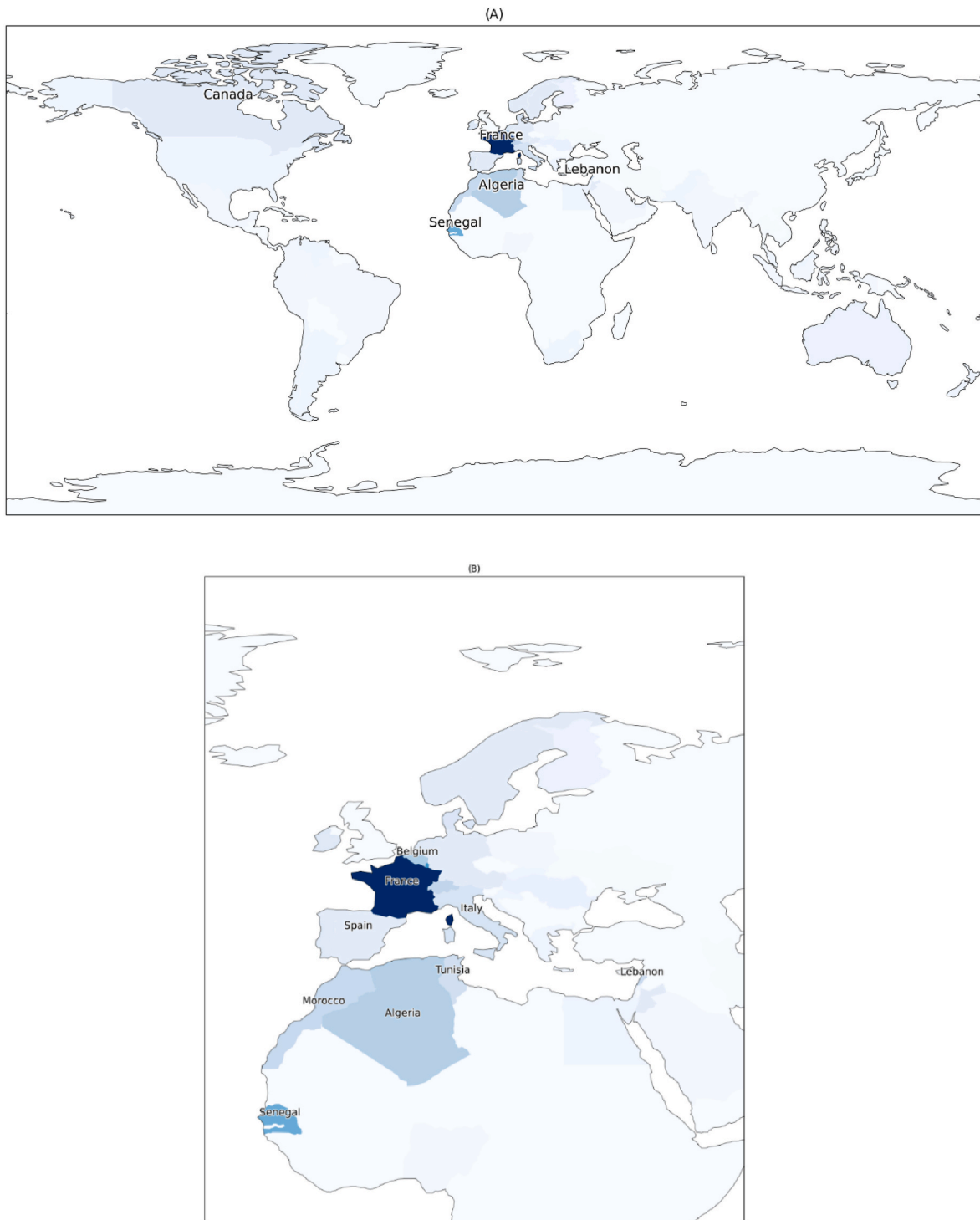


Fig. 3. Google Trends interest in web searches about the Charlie Hebdo shooting by country. Darker blue indicates higher interest. Fig. 3A represents the world map and Fig. 3B represents Europe, Africa, and Asia zoom in map. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

merely remembered but rather commemorated with meaningful significance.

Understanding risk perceptions is crucial for the effective mitigation of terrorism risks. The way individuals and communities perceive the threat of terrorism influences their behaviors, responses, and the overall resilience of a society. Individuals make decisions based on their perception of risks. Understanding how people perceive terrorism risks enables authorities to tailor information campaigns and policies to

ensure that the public is well-informed. This can lead to more rational decision-making in response to potential threats. Policies aimed at preventing and responding to terrorism are only effective if they align with public perceptions. If there is a disconnect between the perceived threat and the policies in place, there may be resistance or non-compliance. Tailoring policies based on an accurate understanding of risk perceptions increases their effectiveness and public acceptance. Effective communication is crucial in managing terrorism risks.

Authorities need to convey accurate information, address misinformation, and provide reassurance to the public. An understanding of how different segments of the population receive and interpret information helps refine communication strategies for maximum impact. Notably, the Wikipedia traffic patterns indicate a continuous interest, reflecting an ongoing societal dialogue about these events. This sustained engagement serves as a foundation for effective public risk communication. Tailoring awareness campaigns to coincide with periods of heightened interest, such as anniversaries, presents an opportunity for impactful risk mitigation.

Regarding RQ1, we found that the timing of significant media events has a pronounced impact on public search behavior and risk awareness, as evidenced by the peaks in Wikipedia page traffic. These peaks typically occur during anniversaries of the terrorist attack, when related incidents take place, or when media coverage revives public interest in the event. This suggests that media events serve as triggers for renewed public engagement and risk awareness, reinforcing the lasting impact of terrorism on societal consciousness.

The role of media in shaping public perception and awareness of terrorism is undeniably profound. The importance of media, both traditional and online platforms, in shaping public perception is evident. Terrorism leverages media coverage for the recruitment and dissemination of ideologies. Wikipedia's ability to provide accessible and up-to-date information contributes to public knowledge and understanding. As our analysis has illuminated, terrorism, often regarded as the language of being noticed, exploits media coverage as a powerful tool for the recruitment and dissemination of ideologies. The political messages intended by terrorists might be overlooked by a population at large, but the resonance of these messages is amplified when accompanied by acts of violence. Our exploration into the persistence of terrorism risk awareness, conducted through an analysis of Wikipedia traffic related to the Charlie Hebdo attack, has revealed nuanced insights. The public's information-seeking behavior extends beyond the immediate incident, intertwining with broader events and news. This interconnectedness underscores the complex nature of terrorism's impact on public consciousness and highlights the need for comprehensive policy.

Regarding RQ2, we found that linguistic and cultural factors play a significant role in shaping the temporal patterns of Wikipedia traffic following a terrorist event. The analysis revealed that Francophone regions, particularly France and its former colonies, showed a higher and more sustained level of engagement with the Charlie Hebdo-related content compared to Anglophone regions. This can be explained by the cultural and historical context. This is reflected in the more frequent and consistent peaks in the French Wikipedia page traffic, especially around anniversaries and culturally significant dates. These findings highlight the importance of cultural and linguistic ties in influencing public interest and risk perception.

Our exploration of the persistent viewership of Wikipedia pages, coupled with an insightful analysis of geographic search patterns using Google Trends, brings to light the high levels of public risk awareness within French-speaking regions. Moreover, the Google Trends analysis provides a geographic perspective on public risk awareness. Regions historically linked with the events, such as France, exhibit heightened awareness, fostering a vigilant public that actively participates in fortifying security measures. The nuanced examination of Google Trends data elucidates that a predominant share of web searches on the subject emanates from territories historically, culturally, or politically aligned with France. These regions, including Côte d'Ivoire, Senegal, Lebanon, and Mauritius, stand out for their heightened public risk awareness. This heightened awareness is pivotal, fostering enhanced communication channels between the public and first responders, thereby proving instrumental in the identification of suspicious activities and behaviors.

Delving deeper into the aftermath of the Charlie Hebo attack, it becomes evident that the resonance of this tragic event extends far beyond its immediate temporal confines. The analysis of Wikipedia traffic unfolds a narrative of sustained interest that underscores a societal

commitment to keeping alive the memory of the victims and the principles they stood for. The examination of Wikipedia data, while invaluable, is complemented by the nuanced insights derived from Google Trends. The geographic patterns in search behavior paint a vivid picture of how regions intricately linked with France showcase a heightened awareness of the Charlie Hebdo attack. The resonance of the attack, reflected in sustained public engagement and heightened risk awareness, amplifies the importance of commemorating and remembering such incidents.

One of the key avenues for mitigating terrorism's impact is through media education initiatives. By fostering media literacy among the public, we can enhance the understanding of how media coverage contributes to the propagation of terrorist ideologies. Responsible reporting guidelines must be cultivated, emphasizing the importance of balanced reporting that informs the public without inadvertently amplifying terrorist messages. Collaborative efforts between governmental bodies and media outlets are crucial to developing and implementing such guidelines effectively. From media education to strategic communication, responsible reporting to international cooperation, each component plays a crucial role in building a resilient society that stands united against the threats posed by terrorism. As we navigate the complex intersection of media, terrorism, and public consciousness, informed and adaptive policy approaches will be pivotal in risk awareness and informed behavior during disaster situations.

6. Conclusions

This study highlights the significant role that online platforms such as Wikipedia and Google Trends play in understanding public risk awareness and information-seeking behavior in the context of terrorism. Analyzing the sustained interest in the Charlie Hebdo terrorist attack over a long period demonstrates how the public's engagement with information about such events extends beyond the immediate aftermath, continuing to influence societal consciousness during anniversaries and related incidents. The persistence of this engagement underscores the deep and lasting impact of terrorism on public perception, as well as the importance of media in shaping and maintaining that awareness.

The findings also reveal the intricate interplay between linguistic, cultural, and regional factors in the way public awareness evolves. The comparison between the English and French Wikipedia pages and Google search data shows that regions with cultural or historical ties to France exhibited higher levels of interest, reflecting a localized dimension of risk perception. This suggests that public awareness and subsequent behavior are not solely driven by the global media narrative but are also influenced by regional and cultural contexts.

Moreover, we found that combining multiple digital data sources of different natures to gain a more nuanced understanding of public engagement with terrorism-related content was beneficial for answering the research questions. While Wikipedia provides insights into the temporal dynamics of public interest, Google Trends offers a geographic perspective, allowing for a comprehensive analysis of how different populations respond to and process information about terrorism. Our findings present the complex factors that influence public risk awareness, offering valuable lessons for policy-makers and communicators aiming to enhance public resilience to terrorism through targeted information campaigns and education efforts.

This study contributes to the growing body of literature on risk communication and public awareness in the digital age, particularly in the context of terrorism. It expands the understanding of how digital platforms like Wikipedia and Google Trends serve as critical indicators of public interest and risk perception. Integrating the data from these sources, we offer an approach to studying the persistence of risk awareness. We highlight the importance of considering both linguistic and cultural factors in understanding how different populations engage with and interpret information about terrorist events and emphasize the need for cross-platform and cross-cultural analyses in future research.

The findings presented in this study are significant for policy-makers, media professionals, and public safety officials, as understanding the patterns of public engagement with terrorism-related content can inform the design of more effective risk communication strategies. For example, the identification of temporal peaks in public interest around anniversaries or related incidents suggests that these moments present opportunities for targeted communication efforts aimed at enhancing public resilience. Another practical implication is that in periods of heightened terrorist threats, the anniversary of the Charlie Hebdo attack should be taken as a public policy opportunity to raise terrorist threat awareness. This targeted approach can lead to more effective public awareness campaigns, improving the overall preparedness and responsiveness of communities to potential terrorist threats.

The limitations of the research include the reliance on digital data sources like Wikipedia and Google Trends, which may not comprehensively capture the full spectrum of public awareness or behavior due to their inherent biases in user demographics and internet access. Furthermore, the lack of granular geographic data in Wikipedia traffic restricts the ability to analyze localized public awareness trends in detail.

CRedit authorship contribution statement

Or Elroy: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation. **Gordon Woo:** Writing – review & editing, Writing – original draft, Conceptualization. **Nadejda Komendantova:** Writing – review & editing, Writing – original draft, Conceptualization. **Abraham Yosipof:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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