Graphicon evolution on Bilibili: A historically informed socio-technical approach

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Abstract
Introduction. Digital technologies have transformed the way we communicate, yet research on digital communication has often focused on either social or technical factors in isolation and has generally lacked a historical perspective.
Method. This study integrates a historical perspective with a socio-technical approach to examine the trends and factors driving the evolution of graphicons (kaomojis, emojis, and stickers) on the Chinese social media platform Bilibili.
Analysis. The analysis involves two parts: first, identifying graphicon evolution patterns from a 14-year corpus and irregularities in relation to a predicted rise-and-fall model, and then using digital archaeology to reconstruct the history and usage of graphicons on Bilibili, classifying them into social or technical categories.
Results. Findings show that only kaomoji usage follows a clear rise-and-fall trend, while trends for emoji and sticker use are less clear. The evolution of graphicons is influenced by both social factors, like user discourse behaviour and graphic arts, and technical factors, such as design and input interfaces.
Conclusion. The historically informed socio-technical approach offers a feasible framework for future studies of digital phenomena. Its quantitative aspect allows the identification of longitudinal patterns and irregularities in the data, while its qualitative aspect enables greater depth through considerations of the events underlying the data.

Key words:
Graphicon, Evolution, Emoji, Sticker, Socio-technical Approach, Bilibili, Digital Archaeology

Introduction

Digital technologies have dramatically transformed communication, enabling the creation, sharing, and interpretation of visual content in more dynamic and multimodal ways across diverse platforms and at unprecedented speeds. As part of this transformation, graphicons – graphical icons used in text-based computer-mediated communication (Herring & Dainas, 2017) – have emerged as particularly powerful tools, significantly reshaping how people express emotions, share ideas, and convey cultural nuances in digital spaces. It is thus crucial to understand how graphicons evolve and the implications of that evolution for technology-mediated communication.

Graphicons, as technical artefacts used in computer-mediated communication (CMC), comprise both social and technical dimensions. Studies thus far, however, have focused mainly on social perspectives, such as graphicon meanings and functions (e.g., Herring & Ge-Stadnyk, 2024; Logi & Zappavigna, 2021), gender and age usage patterns (Koch et al., 2022), and cultural influences (e.g., Chik & Vásquez, 2017; Zhang et al., 2021). That is, the focus has primarily been on how people use graphicons to communicate in various social contexts, while less attention has been paid to the technical factors that influence the use and evolution of graphicons. This oversight mirrors broader trends in digital communication research, where the role of technological aspects such as algorithmic design and platform interfaces has been underexplored, despite their significant impact on shaping how communication unfolds in digital environments (van Dijck, 2013).

Both perspectives are important when seeking to understand the factors that condition changes in graphicon use over time. Broadly, graphicons have evolved from simple, schematic ASCII (American Standard Code for Information Interchange) emoticons composed of keyboard symbols to more representational emojis, and further to diverse and colourful stickers on social media platforms. Konrad et al. (2020) propose that the evolutionary trends of these graphicons follow a rise-and-fall pattern, where a newer category of graphicon gradually replaces its predecessor. However, their proposal was inferred from synchronous, self-reported data. It remains largely unexplored how well their model aligns with actual graphicon usage and what mechanisms drive the progression in practical contexts of use.

The present study seeks first to identify trends in graphicon evolution on the Chinese social media platform Bilibili and then to discover the factors that contribute to those trends. It adopts a historically informed socio-technical approach, incorporating methods from digital archaeology – the use digital technology to investigate the past – to reconstruct the history and usage of graphicons on Bilibili. Through analysing a 14-year longitudinal corpus of Bilibili comments, we identify several key social and technical factors that arguably contributed to the observable trends and irregularities. More generally, this approach provides significant explanatory power for understanding graphicon evolution and can be applied to the study of digital communication across other platforms and cultural contexts.

Literature review

Graphicon evolution

Graphicon studies have focused mainly on the meanings and functions of individual categories of graphicons (typically emoticons, emojis, or stickers) (see the review in Tang & Hew, 2019) rather than considering graphicons in relation to one another as part of a larger ecology, as recommended by Herring and Dainas (2017). Even fewer studies have explored the changes that take place over time within this ecology.

An exception is Konrad et al. (2020), who posited that graphicons typically pass through three phases: an early phase, a peak phase, and a phase of decline or conventionalisation. In Western contexts, Konrad et al. (2020) situated emoticons in the third phase, based on their reduced frequency and their conventionalised use as punctuation; emojis in the second, peak phase; and stickers in the first, earliest phase. They also predicted that the trajectory would be more advanced

in Asian countries, with stickers in ascendance and emojis starting to decline. Their predictions were based on interviews and surveys conducted with English-speaking Facebook messenger users rather than longitudinal data, however.

Studies with actual longitudinal data so far have confirmed that emoji have overtaken emoticons in the West (Pavalanathan & Eisenstein, 2016). As emoticons have declined in frequency of use, their functions have become conventionalised as a type of punctuation (Markman & Oshima, 2007; Provine et al., 2007), with the conventionalisation further demotivating their usage (Albert, 2020; Konrad et al., 2020). A longitudinal study in a Chinese context that examined the frequencies of kaomojis (Japanese-style emoticons), emojis, and stickers found only partial support for the prediction of Konrad et al. (2020), however. Kaomojis exhibited a rise-and-fall pattern, but their decline was not accompanied by an increase in emojis or stickers (Zhang et al., 2022).

The discrepancy between model-based predictions and actual data highlights the need for further investigation into the factors influencing these trends. Konrad et al. (2020) propose that popularity (frequency of use) and shift in pragmatic function are the primary drivers of the transition between graphicon categories. However, these could be seen as effects rather than as causes of the rise and fall of graphicon categories. It remains to be determined what factors, especially technical ones, drive their evolution.

Additionally, although an increasing number of new graphicon designs within each graphicon category are available, little is known about how each unique graphicon is used in practice. Several quantitative studies have identified the top 20 most frequently used emojis in different corpora (e.g., Liu et al., 2020; Wang et al., 2024), but little is known about the use of less frequently occurring emojis. Zhang et al. (2022) found in their longitudinal corpus that the trends in graphicon types differ significantly from those for graphicon tokens; however, no reasons for this discrepancy were given.

Graphicons on Chinese social media and Bilibili

Graphicons on Chinese social media constitute a unique ecosystem with distinctive designs and usage. The graphicons incorporate the logographic features of Chinese characters (Li & Zhu, 2019; Zhang et al., 2022) and convey rich cultural messages from Chinese idioms and traditions (de Seta, 2018; Zhang et al., 2021). The culturally enriched designs of graphicons on Chinese social media are preferred over Unicode emojis (e.g., 😀) by users of different platforms (de Seta, 2018). Chinese users tend to use emojis more frequently in contexts involving family and social relationships compared to their Western counterparts, who also use emojis extensively in professional and casual settings (Guntuku et al., 2019). Although several studies have pointed out that stickers are now very popular among Chinese social media users (e.g., de Seta, 2018; Ge, 2020; Ge-Stadnyk et al., 2025; Sandel et al., 2019), we have been unable to find comparable information on the frequency of sticker use.

Graphicons on Bilibili are distinctive in several ways that make the platform a valuable case study for graphicon usage. Bilibili is one of the most popular social media platforms in China, featuring high stickiness and interactivity (Gao, 2021; Sun et al., 2023; Tian, 2021). As we argue here, graphicons play a significant role in user interaction, cultural expression, and community building. Bilibili has released platform-specific sets of emojis and stickers that have been overwhelmingly popular – for instance, a TV set icon that is the symbol of Bilibili, and the Popular Words Series, which are graphic representations of selected popular verbal expressions from comments or *danmu* (short messages overlaid on the video itself) (Zhang et al., 2022). These platform-specific graphicons, which are associated with Bilibili's fandom cultures, enhance user engagement through expressive visual communication, allowing users to indicate their membership and build a sense of identity within the platform community (Wu et al., 2018). The platform also monetises graphicons by offering exclusive packs for purchase, encouraging users to invest more in their online presence (Yang, 2021).

A socio-technical perspective on graphicon evolution

The development and widespread adoption of graphicons, as with other social media affordances, are the result of ongoing interactions between the digital platform's capabilities and the social needs and practices of its users. This interplay is what Trist (1978) called socio-technical systems theory, which emphasises the interaction of social and technical subsystems. The social subsystem focuses on human factors such as people, relationships, and norms, while the technical subsystem involves tools and technologies, such as hardware and software, required for tasks (Bostrom & Heinen, 1977; Kling, 2007). Both aspects are crucial for understanding digital communication.

A socio-technical perspective has been found useful in exploring the evolution of digital communication, which is marked by the mutual influence of social practices and emerging technologies. For instance, it has shown how digital maps transitioned from traditional cartographic methods to web-native media forms that reshape social practices and spatial awareness (Hanchard, 2024). Studies in this line demonstrate the potential of the socio-technical approach to shed light on the complexity in evolving digital communication.

To the best of our knowledge, this perspective has not been explicitly applied in graphicon studies, although the focus of most existing graphicon research could be categorised as either social or technical. Studies from the social perspective explore topics such as the meanings and functions of graphicons (Herring & Ge-Stadnyk, 2024; Logi & Zappavigna, 2021), usage patterns in relation to user demographics and profiles (Koch et al., 2022), and cultural influences on graphicon use and interpretation (e.g., Chik & Vásquez, 2017; Zhang et al., 2021). In contrast, the technical perspective has been considerably less studied. Yet technical factors such as the design and availability of graphicons clearly have an impact on their usage. For instance, Unicode, as a technical standard, distinguishes emojis from emoticons and other iconographic formats, enabling their use across devices, operating systems, and Internet platforms, thereby facilitating their widespread circulation (Berard, 2018). The layout of the emoji keyboard has an impact on the time required for emoji selection (Pohl et al., 2017), thereby affecting its usage. Stickers, unlike emojis, are not supported by Unicode or standardised formats, which could hinder the development of widespread conventions of sticker use (Tagg & Lyons, 2021). While social and technical perspectives both offer valuable insights into graphicon usage, studies investigating their interactions within the same longitudinal corpus are notably lacking.

Research questions

This study extends the socio-technical perspective by integrating a historical analysis of both social and technical influences in a large corpus of graphicons. Specifically, we explore the following research questions: 1) What are the trends over time of the relative frequencies of Chinese graphicons on Bilibili? 2) What irregularities in the trends are observed when compared to the rise-and-fall model of graphicon evolution proposed by Konrad et al. (2020)? and 3) What socio-technical factors in the platform's history explain the trends in the Bilibili corpus, particularly the irregular frequencies that deviate from the predictions of Konrad et al. (2020)?

Methodology

Data collection

Our corpus consists of 14 years of longitudinal comment data collected from the Bilibili platform. Bilibili is a video-sharing platform that, like YouTube, allows users to post comments below the videos and features short *danmu* messages that are overlaid on the video itself.

The Bilibili platform was chosen for several reasons. Firstly, it is one of the most popular Chinese social media platforms, with average monthly active users reaching 0.315 billion (around one-fifth of the Chinese population) in the first quarter of 2023 (https://www.Bilibili.com/read/cv24070769/, retrieved July 9, 2024). Secondly, the comments

can include kaomojis, emojis, and stickers. Lastly and most importantly, Bilibili preserves a historical record of the comments posted below the videos, including the graphicons in the comments, and the comments can be captured automatically.

The data consist of comments and replies to comments from the channel of Bilibili's annual Spring Festival Gala Show (hereafter, the Bilibili show) (https://space.Bilibili.com/1868902080, retrieved April 5, 2022). This channel was chosen because it is the only one that includes consecutive comments dating back to 2010. The show consists of a mash-up video of content provided by professional users to celebrate the Chinese New Year, and it is released on the eve of the Chinese New Year. Besides the show videos, the Bilibili show channel includes videos related to the gala show, such as trailers, teasers, and outtakes. Like the Bilibili show videos, these videos include older comments and replies and thus are included in our data.

Comments and replies from all 54 videos available in the channel, covering the years from 2010 to 2023, were captured and stored in March 2023 using Python and the Scrapy tool. A total of 992,856 messages (including both comments and replies) were collected. *Danmu* messages were excluded from the data due to their limited use of graphicons.

Data analysis

The analysis was conducted in two stages. To obtain the trends of kaomojis, emojis, and stickers in use, we first identified their occurrence in the messages using a semi-supervised process of deep learning (Qin et al., 2019) and manual identification and calculated their frequency. The frequencies were normalised based on the total number of messages each year. We also applied Voyant (https://voyant-tools.org/), a web-based text analysis tool for analysing word frequencies and trends in comments. We derived patterns for the corpus as a whole, as well as identifying deviations from the model predicted by Konrad et al. (2020).

In the second stage, to account for the patterns in the frequencies, we adopted a historically informed socio-technical approach. We conducted digital archaeology to reconstruct the history and usage of graphicons on Bilibili, based on which we identified factors that could plausibly be related to irregularities and classified them into social or technical categories. Digital archaeology refers to '*the use of digital technology to investigate and communicate the past*' (Morgan, 2022, p. 214); in this case, the past being examined is also digital. Specifically, our search for historical information included the following major sources: 1) information available on Bilibili for the timeline of events, platform practices, and culture; 2) annual Bilibili financial reports for user numbers and profiles; 3) media reports about Bilibili for major events in its development and its social impact; 4) the internet archive Wayback Machine for old Bilibili webpages; and 5) questions and answers about Bilibili on platforms such as Zhihu (Chinese Reddit) for graphicon input settings and graphicon accessibility.

We recognise that our backgrounds as researchers influence our analysis of Bilibili's user communities and platform dynamics. Our approach is informed by cross-disciplinary perspectives from computer-mediated communication, linguistics, and information science. Further, the third and fourth authors are native Chinese speakers who are users of Bilibili, and the first and second authors have previously researched Bilibili and other Chinese social media platforms. While we believe these perspectives enrich our analysis, we acknowledge that our interpretations may be shaped by our familiarity with Chinese cultural contexts. Concerning data collection and use, the study followed the platform's guidelines for data access, scraping, and us for academic research.

Findings

This section presents the frequencies of graphicon usage on Bilibili over time and explores how irregularities in the frequencies can be explained with reference to key historical events associated with the platform, which we classify into social or technical categories.

Trends in graphicon evolution on Bilibili

The normalised frequencies of all graphicon tokens for each of the 14 years are displayed in Figure 1.

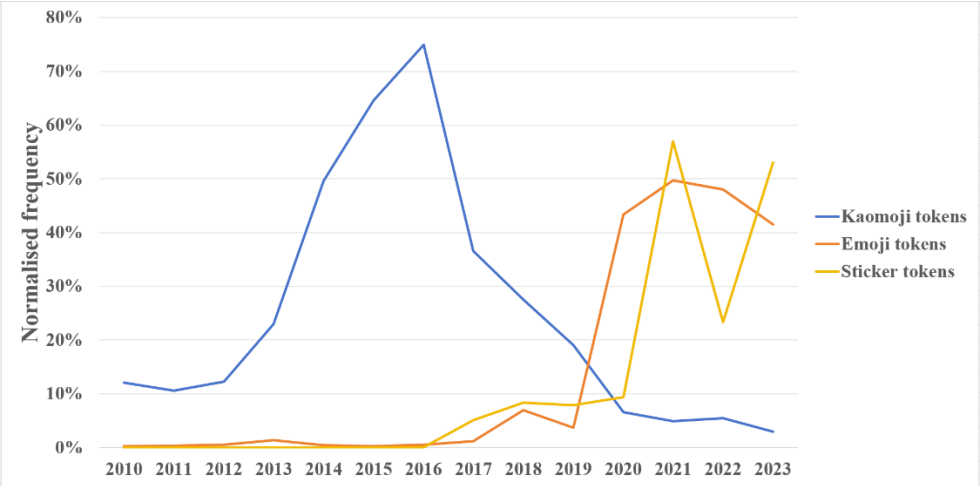


Figure 1. Frequencies of graphicon tokens by year (normalized in relation to the number of messages for each year)

These trends provide partial support for the evolutionary trajectory of graphicons proposed by Konrad et al. (2020), particularly as regards kaomoji. Deviations from Konrad et al.'s (2020) predicted rise and fall of each graphicon (emoji replacing emoticons (kaomojis) and stickers replacing emojis) include the following:

1) Although kaomoji rose and fell from 2010 to 2019, the decrease in kaomoji was not replaced by emojis or stickers, leading to a significant drop in graphicon use in 2017.
2) Emojis were not popular on Bilibili between 2010 and 2019, despite being popular on other social media platforms in China during that same period. Emoji tokens increased significantly in 2020 but remained level for the following three years.
3) Stickers, which first appeared on Bilibili in 2016, showed a steady increase except for a dramatic spike in 2021.

History of the platform

As part of the findings from our digital archaeology, a brief overview of the platform's history is essential to understand the socio-technical factors contributing to the irregularities in graphicon evolution. Bilibili was founded in 2009 as a non-profit video-sharing community for Anime, Comics, and Games (ACG) fans (Sun et al., 2023). The platform derives its name from the popular anime *A Certain Magical Index*, where the protagonist Mikoto Misaka's electric attack produces a sound humorously referred to as *Bilibili*, which later became the nickname given to her by the male protagonist (https://www.Bilibili.com/read/cv154805/, retrieved June 4, 2024). In 2013, Bilibili received its first investment from Tencent, was listed on the NASDAQ stock index in 2018, and was listed on the Hong Kong Stock Exchange in 2021. Along with its increasing commercialisation, Bilibili has seen changes in its policies, content, and the number and profiles of its users.

Bilibili released open registration in 2013 with a strict membership test to familiarise the newcomers with the platform's culture and practices. Only individuals who passed the test were granted permission to interact with comments or *danmu*. The test was discontinued in 2015 to accommodate a broader group of users. Not long after, a paid membership was implemented in 2017, suggesting the platform's full commitment to commercialisation. Together with these developments, the video content on the platform expanded from pure ACG to pan-ACG (including general games and animations, then movies and TV programs), then further to a broad spectrum of videos. Alongside the expansion of video content categories, the main user groups also shifted

from ACG fans to pan-ACG fans, and then to pan-entertainment users. By 2023, the monthly active users had increased to over 300 million. The expansion of the platform from a closed community for ACG lovers to a massive pan-entertainment site is illustrated in Table 1, alongside trends in graphicon use.

Stage	1	2	3	4
Time	2010-2012	2013-2016	2017-2019	2020-2023
Platform commercialisation	Non-profitable community for ACG	Investment from Tencent	Listed on NASDAQ in 2018	Opened to all brand partners in 2020; listed on the Hong Kong Stock Exchange in 2021
Platform policies	Time-limited registration system	Strict membership test started in 2013, but removed in 2015	Paid membership in 2017	Hardcore membership test in 2022
Video content on the platform	ACG	Moving from ACG to pan-ACG, including general games and animations, then to movies and TV programs	Non-ACG videos outnumbered ACG videos; the largest online community for professional user-generated video, vlogs, and classroom sessions	A broad spectrum of videos
User profiles	ACG fans	Pan-ACG fans	Pan-ACG fans, Generation Z	Pan-entertainment users
Graphicon trends	Kaomoji relatively stable	Kaomoji increased	Kaomojis decreased, not replaced by emojis or stickers	Platform-specific emojis and stickers increased sharply

Table 1. Bilibili history

Socio-technical factors influencing trends in graphicon use

Social factors: User discourse behaviour

User discourse behaviour refers to the patterns and tendencies in how users communicate and interact within a particular context, platform, or medium (Herring, 2004). Variations in user behaviours can contribute to the observed irregularities in graphicon usage. Specifically, message valence (positive or negative) contributed to a significant drop in graphicon use in 2017 on Bilibili.

The valence of messages was examined because the emotional tone of messages has been found to be related to graphicon usage (Tang & Hew, 2018). Through close reading of the messages in 2017, we found that the content was predominantly serious and negative due to two major events that occurred that year. Firstly, comments were dominated by intense and serious discussions about the plot design of the 2017 show, which featured a sci-fi mystery story with three different endings. Secondly, during the 2017 gala show, the website's credit system was hacked. As a result, users at advanced experience levels 5 and 6 had their credits removed and were unable to interact on the platform, including posting comments or *danmu*. In reaction to these events, two distinct focuses were observed in the 2017 comments: a concentration on the plot design of the Gala Show (Extract 1), and criticism of the hackers (Extract 2). Both sets of comments were generally serious in tone and tended to avoid the use of graphicons.

Extract 1 (2017-1-30 11:25)
我看完也是这么想的，不然男主活的解决就说不通了；活下的男主没绳索没打火机去拯救一下女主是不可能的，楼里也没男主尸骨。这样解释个人感觉比较合适。 (Translation: I had the same idea after watching it. Otherwise, the resolution of the male protagonist surviving doesn't make

sense. Without a rope or a lighter, it would be impossible for the surviving male protagonist to save the female protagonist, and there were no remains of the male protagonist in the building. This explanation feels more fitting to me personally.)

In Extract 1, the commenter attempted to make sense of the plot design by ruling out various possible interpretations. No graphicons were used in the comment, and several negations were used in ruling out possibilities. Graphicons have always tended to be used in playful and positive settings (e.g., Zhang et al., 2021), but they were absent in this serious discussion. Similarly, the commenters who posted messages to the hackers in Extract 2 intended for their messages to be taken seriously, so they also avoided using graphicons, which might suggest a playful tone, as highlighted in many studies (Konrad et al., 2020; Zhang et al., 2021).

Extract 2 (2017-01-28 01:26)
致敬攻击 B 站的人：你们越这么闹，我反而越爱这个网站！(Translation: A salute to those attacking Bilibili: The more you cause trouble, the more I love this website!)

The use of negation in Extract 1 prompted us to examine the negativity of the comments more systematically. We identified occurrences of the Chinese character for negation 不 [BU] in the corpus along the timeline using Voyant for analysing word frequencies and trends in comments. The normalised frequency of the negation character, as shown in Figure 2, peaked in 2017, indicating that the degree of negativity in the comments was most prominent that year. This is the relative frequency of the term in the document, calculated by dividing the raw frequency by the total number of terms in the document and multiplying by 1 million (https://voyant-tools.org/docs/#!/guide/documentterms). The seriousness and negativity of messages in 2017 plausibly explains the drop in overall graphicon usage, particularly in kaomojis, in 2017.

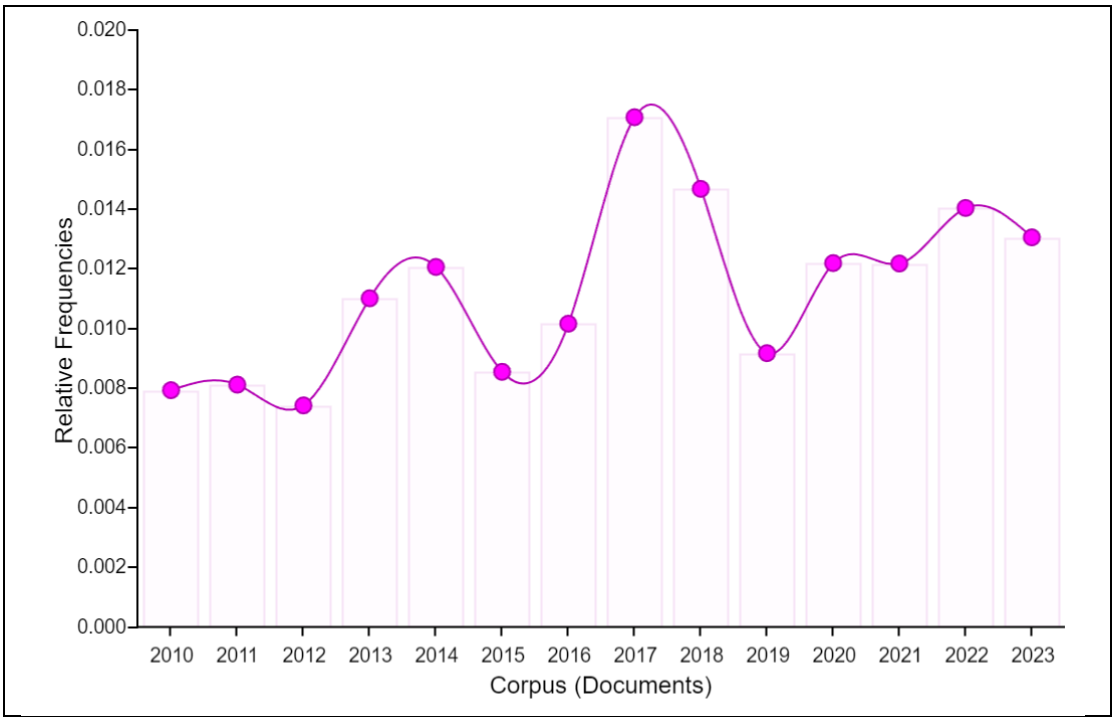


Figure 2. Frequencies of occurrence of 不 [BU] (normalized in relation to the total number of Chinese words)

A cooccurring factor that could also have contributed to the significant drop in kaomoji usage was the influx of new and non-ACG users in 2017 (as shown in Table 1), since the use of kaomojis is closely linked to ACG culture (Kaneyasu, 2022).

Another type of user discourse behaviour that plausibly impacted graphicon irregularities in our data is graphicon art. This involves using graphicons to create various shapes and designs, as illustrated in Figure 3. As emoticons gained in popularity in the 1990s, ASCII art emerged as a type of '*cyberplay*' (Danet, 2001) involving the use of the symbols from the ASCII set to craft images and designs in text-based messages (de Seta, 2018; Kozar, 1995). Graphicon art has evolved with the introduction of new graphicon forms, from ASCII symbols to emojis (Figure 3, left) and stickers (Figure 3, right). Designs composed of stickers were more popular than those with emojis in our corpus, a preference that may stem from stickers being larger and more colourful than emojis, making them a more appealing choice as graphic arts components.

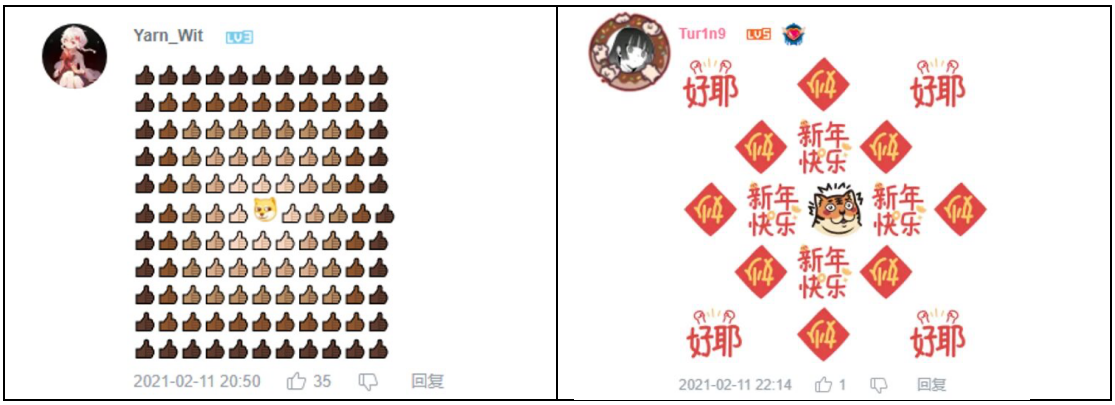


Figure 3. Examples of graphicon arts in messages from 2021

Graphicon arts gained immense popularity on Bilibili in 2021, with numerous replies featuring copy-pasted designs. This surge increased the frequency of graphicons, leading to a sharp rise in sticker tokens in 2021. However, its popularity was short-lived, resulting in a temporary spike in sticker usage in that year.

Technical factors: Graphicon availability

Beyond social factors, technical factors also significantly shaped the evolution of Bilibili graphicons. Graphicon availability stands out as a crucial factor in explaining their use. This refers to the presence and accessibility of graphicons on specific platforms, which in turn determines the range, variety, and ease of use of graphicons for users. This section focuses on two issues related to accessibility, graphicon design and the input interface.

Graphicon design influences graphicon usage, because visually appealing, easily recognizable, and contextually appropriate designs are more likely to be adopted and regularly used by users. This factor is especially important in the Chinese context, because users tend to prefer platform-specific graphicons that encode the community culture (de Seta, 2018; Zhang et al., 2022; Zhang et al., 2021).

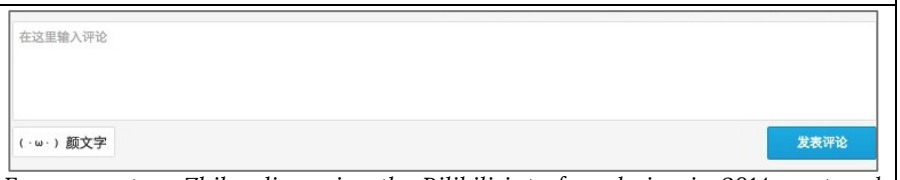
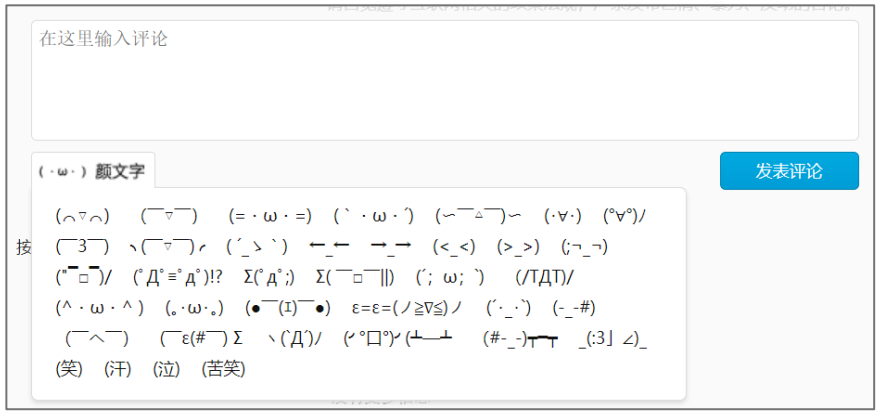
Our corpus has very low frequencies of emojis and stickers until 2020, which is unexpected given their widespread use on other social media platforms well before 2020. The significant increase in emojis and stickers after 2020 is primarily due to the introduction of platform-specific sets. Notably, Bilibili released a set of Yellow Face emojis in 2019 (see examples in Table 2), with facial representations that differ slightly from those found on other social media platforms like WeChat or Weibo (de Seta, 2018; Zhang et al., 2022). The Yellow Faces set also includes emojis for the New Year's celebration, such as the New Year Blessing in Table 2. Regarding stickers, Bilibili released several free sets that have become overwhelmingly popular among users. These include the TV set, which is an iconic symbol of Bilibili, and the Popular Words Series (PWS), which are graphic representations of selected popular expressions from comments or *danmu* (see Table 2). These platform-specific graphicons encode Chinese characters and the discourse practices of the platform, making them among the most frequently used in Bilibili (Zhang et al., 2022).

Category	Yellow faces		Stickers	
Name	Doge	New Year Blessing	PWS: wonderful	TV set: smile
Graphicon				

Table 2. Examples of platform-specific sets of emojis and stickers

It should be noted that there was a noticeable lag between the release of graphicons and their usage in comments. Emojis and stickers released in March 2019 did not see widespread use until 2020, as most comments on the gala show were posted shortly after the event in January. This explains the increase in the frequency of emojis and stickers from 2020 to 2023, driven by the release of platform-specific sets. This rise is especially noteworthy in light of a study on emoji usage during the COVID-19 outbreak on Chinese social media, which found a substantial decline in both the proportion of posts containing emojis and the ratio of users using emojis during that period (Liu et al., 2022).

Another technical factor influencing the availability of graphicons is the input interface, which refers to the features and functionalities that allow users to type and select graphicons in their comments for submission to be displayed on the platform. We expected that the inclusion of graphicons in the input interface would lead to an increase in their accessibility and further their usage.

Time	Screen shot
2010-2012	No kaomoji in the input interface for comments.
2013-2014	 *From a post on Zhihu discussing the Bilibili interface design in 2014, captured 07/20/2023 (https://www.zhihu.com/question/25116069)*
2015-2018	 *From the Wayback Machine, dated 04/24/2015, captured 07/20/2023.*

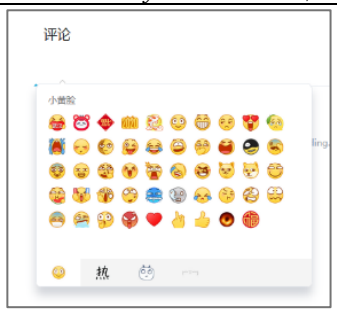
2019	 *From the Wayback Machine, dated 10/02/2019, captured 07/20/2023.*
2020-2023	 *From the Wayback Machine, dated 02/03/2020, captured 07/20/2023.*

Table 3. Input interface versions on the Bilibili website from 2010 to 2023

Several successive versions of the input interface for comments on Bilibili are presented in Table 3. At the early stage of Bilibili, no graphicons were available in the input interface. The input of kaomojis at that time required users to either manually type ASCII symbols or copy kaomojis from other sources. Kaomojis first appeared in the input interface in 2013 (see the interface of 2013-2014 in Table 3). The introduction of an auto-drop-down menu for kaomojis in 2015 (see the 2015-2018 input interface in Table 3) significantly improved input convenience, leading to a further increase in kaomoji use.

In 2019, the Yellow Faces set was introduced to the input interface, followed by an increase in emoji frequencies in 2020. The Popular Words Series and Bilibili TV series appeared in the 2020 interface, followed by an increase in sticker frequencies in 2021, 2022, and 2023. Also, in the 2020 interface, kaomojis were downplayed by using grey fonts instead of black, as in previous versions. It is also worth highlighting that the input interface did not include Unicode emojis or non-platform-specific stickers, which could be a possible reason for their usage frequencies remaining extremely low over the course of 14 years. This suggests that the (lack of) availability of a graphicon category in the input interface greatly affects its use. In support of this, we examined the top 10 kaomojis and found that they were mostly from the recommended list in the 2015-2018 interface, whereas the top emojis and stickers were from the recommended lists in the 2020 interface. It should be noted that the web interface is different from the mobile interface, which Bilibili released in February 2012. According to the mobile interface in 2023, users who made comments could either use graphicons recommended by the Bilibili interface or mobile input methods. Unfortunately, we were not able to retrieve the interface data from mobile versions.

Discussion

Based on a longitudinal corpus of comments from Bilibili, we first mapped the trends of the frequencies of kaomojis, emojis, and stickers. We then explored how these trends aligned with or diverged from the predicted rise-and-fall pattern of graphicons by Konrad et al. (2020). We investigated the history of Bilibili and uncovered both social and technical factors that plausibly influenced the evolution of graphicons.

Among the social factors, serious and negative situations in 2017 caused a marked decrease in the frequency of kaomojis in user comments (emojis and stickers had not yet become widely used

on Bilibili). Previous studies using qualitative data have shown that people tend to use more emoticons in positive contexts than in negative ones (Ahn et al., 2011) and that emojis are not likely to be used in negative criticism statements (Chang, 2016). The statistics from our corpus offer the first quantitative confirmation of this tendency. While it is widely recognised that graphicons are commonly used to add a positive and playful tone to messages (e.g., Konrad et al., 2020), understanding of their meaning potential in negative contexts remains quite limited. This factor highlights the need for further exploration of graphicons in negative contexts and for developing graphicon categories to express negative meanings.

Graphicon arts represent another form of user discourse whereby users craft elaborate visual displays by blending a combination of kaomojis, emojis, and stickers, causing a notable surge in sticker usage in 2021. There has been a trend toward larger and more complex visual designs as graphicons evolved from kaomojis to emojis and then to stickers. Meanwhile, there is a growing integration of graphicons, both their design and usage, into internet meme culture. Although it is widely acknowledged that internet memes are a major source for sticker creation (e.g., Ge, 2020; Ma, 2016), our findings indicate that graphicons are also intricately intertwined with the meme culture through graphicon arts. The copy-pasted graphicon arts are frequently used in messages as memes to execute various types of speech acts such as confirm and congratulate, consistent with the concept of '*memes as speech acts*' (Grundlingh, 2018). However, graphicon arts were only popular on Bilibili in 2021, and the reasons for their decline in 2022 remain unclear. To assess the durability of the graphicon art trend, further observation with more extensive longitudinal data is necessary.

For technical factors, we proposed that the design of graphicons had a significant impact on graphicon usage on Bilibili. The most popular graphicon types were those platform-specific sets that are deeply imbued with community practices and culture, first kaomojis and then Yellow Faces and Popular Word Series. Bilibili has highly sticky user groups and community engagement through the interactivity of the platform (Gao, 2021; Sun et al., 2023; Tian, 2021). Given the sharp increase in the frequency of platform-specific graphicon sets during a period of rapid influx of new users, we propose that these graphicon sets are strategic tools employed by the Bilibili platform to boost user engagement and cultivate a sense of community belonging.

Another technical factor that had a major impact on graphicon usage on Bilibili is the availability of graphicon categories in the input interface. We noted a rise in the frequency of each category (kaomojis, emojis, and stickers) after it was featured in the comment input interface. While we were able to track the availability of the web version's input interface using archived data, we could not be certain whether the extremely low usage of Unicode emojis and non-platform-specific stickers was due to their non-appearance in the input interface. However, there is precedent for assuming that it was. In their comparative study of websites/apps for restaurant recommendations, Chik and Vásquez (2017) found that many OpenRice reviewers included emojis in their reviews, while Yelp reviewers did not, because OpenRice provided users with the option to use emojis, whereas Yelp did not.

Conclusion

To the best of our knowledge, this is the first empirical case study to explore the factors driving graphicon evolution based on actual longitudinal data. Our longitudinal analysis uncovered both social factors, such as user discourse behaviour and graphicon arts, and technical factors, including graphicon design and input interfaces, that plausibly played a role in shaping graphicon evolution on Bilibili. Findings from the case study should be validated with other topics and platforms, however, as our analysis was limited to the Bilibili channel for the Chinese New Year show.

From a methodological perspective, building on our digital archaeological investigation of the factors influencing graphicon use, we expanded the socio-technical approach into a historically informed socio-technical approach for studying graphicon evolution. This method uncovered insights and connections that might otherwise have never been made previously, emphasising the

value of a contextually and historically enriched approach. Its quantitative aspect allows the identification of longitudinal patterns and irregularities in the data, while its qualitative aspect enables greater depth through consideration of the events underlying the data. In the present study, the historical aspect of this approach focused on understanding the temporal context in which graphicons have emerged, evolved, and declined, recognising their development as deeply intertwined with the broader social context and technological advancements on Bilibili. However, we are aware that the historical factors discussed in this article are not exhaustive. For instance, it is important to consider how specific hardware and mobile operating systems might influence the use of graphicons. Nonetheless, the historically informed socio-technical approach offers a feasible framework for future studies of graphicon evolution, as well as of other digital phenomena. It encourages researchers to consider historical and contextual factors for more comprehensive analyses. For platform designers and developers, our findings highlight the importance of both user behaviour and technical design in shaping digital communication tools. This understanding can lead to more user-centred and culturally responsive platform designs. The generalizability of the findings from Bilibili to other platforms remains to be explored; other Chinese social media platforms such as Sina Weibo and WeChat have their own distinctive cultures of use, including as regards graphicons. Such explorations can benefit from the historically informed socio-technical approach, which sheds light on the evolution of communication tools and digital communication, as well as broader trends in digital culture.

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