Unpacking Micro Data Videos: Key Elements and Design Practices in Minute-Long Data Videos for Mobile Usage

SAMAR SALLAM, University of British Columbia (Okanagan), Canada
YUMIKO SAKAMOTO, University of British Columbia (Okanagan), Canada
ANURADHA HERATH, University of British Columbia (Okanagan), Canada
JULIA PETRIE, University of British Columbia (Okanagan), Canada
MARIANA BRUSSONI, University of British Columbia, Canada
JOHN JACOB, University of British Columbia, Canada
POURANG IRANI, University of British Columbia (Okanagan), Canada

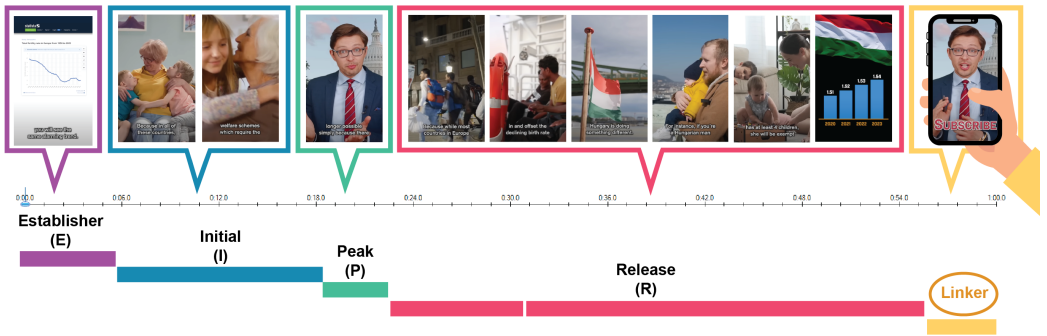

Fig. 1. A sample micro Data Video (mDV) [58] from Study 1, annotated with its narrative composition based on Cohn's commonly adopted narrative categories [14], along with a 'Linker' element. Despite being under a minute long, the video contains a full narrative arc structure with an *Establisher* segment, two *Initial* units, one *Peak*, and multiple *Release* Units. Additionally, the video ends with a *Linker* prompting viewers to subscribe to the channel for more similar videos. The *Linker* allows the video designer to provide the audience access to more information while keeping the video brief. It was found that the *Linker* is often strategically used to direct viewers' attention to certain content whether the goal is to provide more information, collect more views/subscriptions, or advertise for a certain product/service.

Authors' Contact Information: Samar Sallam, Department of Computer Science, University of British Columbia (Okanagan), Kelowna, British Columbia, Canada, sallams@student.ubc.ca; Yumiko Sakamoto, Department of Computer Science, University of British Columbia (Okanagan), Kelowna, British Columbia, Canada, yumiko.sakamoto@ubc.ca; Anuradha Herath, Department of Computer Science, University of British Columbia (Okanagan), Kelowna, British Columbia, Canada, caherath@student.ubc.ca; Julia Petrie, University of British Columbia (Okanagan), Kelowna, British Columbia, Canada, julia2@student.ubc.ca; Mariana Brussoni, Pediatrics, University of British Columbia, Vancouver, British Columbia, Canada, mariana.brussoni@ubc.ca; John Jacob, Medicine, University of British Columbia, Vancouver, British Columbia, Canada, john.jacob@ubc.ca; Pourang Irani, Department of Computer Science, University of British Columbia (Okanagan), Kelowna, British Columbia, Canada, pourang.irani@ubc.ca.

ACM 2573-0142/2025/9-ARTMHCI036
https://doi.org/10.1145/3743722

Micro Data Videos (mDVs) are up to one-minute data-driven vertical video clips for mobile devices. Widely adopted on social media platforms, mDVs hold significant potential for disseminating information. Despite their growing prevalence, little is known about their components and how they are designed. Thus, two studies were conducted. Study 1 analyzed 40 mDVs and revealed their narrative components. Study 2 examined, through design sessions with design experts, how such components are assembled to craft storyboards for mDVs. The diverse narrative styles of mDVs render them flexible and suitable for multiple topics and purposes. Further, many include a "Linker" directing viewers to external online resources. Participants approached their design in a structural yet iterative manner with emphasis on setting up a "hook" in the opening seconds to capture attention. We summarize and share common design practices used in creating mDVs, an increasingly important medium in data storytelling.

CCS Concepts: • **Human-centered computing** → **Visualization systems and tools**; **Information visualization**; **Empirical studies in visualization**; **Mobile devices**.

Additional Key Words and Phrases: Narrative visualization, data storytelling, mobile data video, short video, qualitative analysis, video design

ACM Reference Format:
Samar Sallam, Yumiko Sakamoto, Anuradha Herath, Julia Petrie, Mariana Brussoni, John Jacob, and Pourang Irani. 2025. Unpacking Micro Data Videos: Key Elements and Design Practices in Minute-Long Data Videos for Mobile Usage. *Proc. ACM Hum.-Comput. Interact.* 9, 5, Article MHCI036 (September 2025), 33 pages. https://doi.org/10.1145/3743722

1 Introduction

With the increasing prominence of platforms such as TikTok, YouTube Shorts, and Instagram Reels, vertical micro videos—typically lasting less than one minute—are reshaping user preferences, shifting demand away from longer formats [37]. This shift could be intertwined with users' decreasing capacity to focus on and engage with mobile content (48 seconds for the average person [33]), changes in video viewing devices from computers to smartphones, and changes in the viewing situation. People increasingly consuming content on mobile devices *while* commuting, cooking, cleaning, or in any other multitasking scenarios, the vertical orientation and brevity of these videos are particularly well-suited for mobile viewing, further accelerating their growing popularity. While the pervasive influence of such short videos raises concerns about attention spans and well-being of the viewers [32, 40, 68], this very pervasiveness can hold promising potential in situations requiring mass communication. For instance, during the COVID-19 pandemic, short videos enabled health agencies to promptly disseminate crucial health information reaching billions of individuals globally [6, 23, 71]. Mobile phones are widely adopted, and short videos are highly suitable when swiftly conveying bite-sized messages is necessary (e.g., emergency health alerts or educational snippets) [20, 29, 72].

Micro Data Videos (mDVs)—short vertical videos that tell data-based stories—have emerged and gained eminent popularity as a medium, especially for educational and informational purposes [30, 31, 44]. Compared to traditional media (e.g., news articles), videos provide a more engaging way to convey data insights efficiently [25, 28]. While common Data Videos (DVs) that are lengthier (on average, six minutes [26, 42]) and designed in landscape orientation, have attracted considerable research attention (e.g., [2, 9, 13, 55, 71]), mDVs have not been studied in depth yet. mDVs are much shorter, averaging up to one minute, and are typically viewed in a different context (e.g., on mobile devices and on the go). These differences suggest that the design and structure of DVs may not directly apply to mDVs. Moreover, unlike DVs, mDVs compete within an endless content stream where user engagement hinges on immediate attention capture. These fundamental differences underscore the need for research to understand the characteristics of mDVs as a genre of narrative

visualization. Such knowledge is essential to guide the design of mDVs and as a stepping stone to future research aiming at facilitating mDV design for effective data-based communication.

We aim to understand and define mDVs as a unique form of brief vertical videos designed to convey data-driven stories. We address three research questions: **RQ1**: What are the narrative characteristics (i.e., narrative structures and key features) of mDVs? **RQ2**: What are the visual and auditory techniques incorporated in mDVs?; and **RQ3**: How do experts approach the design process of mDVs? Two exploratory studies were conducted to answer these questions. In Study 1, we analyzed 40 publicly available mDVs from reputable YouTube channels, examining their narrative characteristics as well as key visual and auditory techniques utilized in mDVs. Interestingly, despite mDVs' brevity, their narratives largely follow the classical narrative arc [21] or Freytag's Pyramid structure [21] often used in films and also observed in DVs [2, 42, 70]. We identified the "Linker" as a component of mDVs that enriches content while preserving brevity. We discuss various data visualization and attention-grabbing techniques observed. Study 2 explored the processes and strategies designers employ in storyboarding mDVs, as well as the structures and components of their designed mDVs. Fifteen professional designers worked in groups to produce seven storyboards, five of which followed the classical narrative arc [21]. The 'Linker' component emerged as a prominent feature. Designers started the design process by identifying key narrative elements (e.g., hook, introduction, tension, ending) before selecting content. They also emphasized the importance of grabbing viewers' attention as soon as the video starts and sought to balance the right amount of content, with links to additional resources (i.e., Linker) for those interested.

This work contributes empirical insights into the narrative, visual, and auditory characteristics of mDVs, as well as the design strategies employed by expert creators. Through two exploratory studies, we (1) provide a systematic analysis of publicly available mDVs, revealing their prevalent narrative structures, key design elements, and the role of "Linkers" in maintaining brevity while enriching content; (2) uncover how expert designers approach mDV storyboarding, highlighting their emphasis on attention-grabbing techniques, structured storytelling, and balancing content density with supplementary links; and (3) offer design recommendations that can inform the creation of effective, engaging, and accessible mDVs. Our findings lay the groundwork for future research in optimizing mDV design for mobile-first communication and educational contexts.

2 Background and Related Work

2.1 Mobile Short Videos

The growing popularity of social video platforms, such as YouTube Shorts, Instagram Reels, and TikTok has fueled the rise of short videos. These videos are typically designed in a vertical format to cater to mobile device users. Short videos along with their hosting platforms are increasing in popularity (TikTok with 2 billion users [57] and YouTube 2.7 billion users [8]), and have attracted research attention recently [11, 52]. Short videos are referred to by various terms, including *Instant videos* [12], *Short videos*, *Video shorts*, *Bite-sized videos*, and *Micro-videos* [37]. Their duration typically ranges from five to a maximum of 90 s, dictated by platform constraints: Instagram Reels (up to 90 s), Instagram Story (60 s), Snapchat (60 s), Triller (60 s), and YouTube Shorts (60 s). Nie et al. [37] describe micro-videos as a form of "user-generated content." Unlike longer videos, micro-videos are often captured by lay users on mobile devices to record moments of their daily lives for sharing on social media [37]. YouTube Shorts, in contrast, are described as *micro-content* of up to a minute, that is searchable using hashtags in the title and descriptions [12]. Similarly, Data-GIFs are ultra-short animations (often under 15 s) of data visualizations that loop automatically [50]. Amid this quickly evolving landscape, professionally produced, vertically oriented short videos aimed at conveying data insights through visualizations have emerged. Sharing properties of DVs defined by Amini et

al. [2], with length and orientation limitations, we refer to them as *micro Data Videos (mDVs)*. Unlike user-generated short videos or trend-based social media content, mDVs represent a purposeful, data-driven form of short video communication. Their potential for engaging mobile audiences and disseminating complex information warrants special attention and close exploration.

While researchers are gradually shifting their attention to short videos, the focus has largely been on examining the applications on which these videos are created and hosted [19], the social interactions surrounding viral videos [36, 51], and the factors influencing viewer engagement and video popularity [64, 69]. The popularity of YouTube shorts has been linked to shorter titles and descriptions, as well as the number of emoticons and hashtags in the title, description, and viewers' comments [12]. Schellewald et al., [43] explored TikTok's communicative forms, categorizing its videos into six genres; comedic, documentary, communal, interactive, explanatory, and meta based on the video format and the type of content they convey. Comedic videos typically feature humorous commentary on general topics in a raw, unedited style, while explanatory videos present tutorials or life hacks, either in an unnarrated raw format or with music and speech annotations. While explanatory videos share similarities with mDVs in their intent to convey informative content, they do not necessarily incorporate data-driven insights—a defining characteristic of mDVs. Furthermore, existing research offers limited insights into the structure, components, and design processes of mDVs. In particular, there is a lack of studies examining their narrative structures or defining constituents, which sets mDVs apart as a compact and distinct genre of data storytelling within the broader field of narrative visualizations.

2.2 mDVs: An Operational Definition

To guide our exploration, *we operationally define mDVs as vertically-oriented, short videos with a duration of one minute or less that present data-driven facts through visualizations.* The vertical format optimizes compatibility with mobile devices and social media platforms. The duration limit is based on the constraints of the major platforms that promote such materials, such as YouTube Shorts, the most popular platform for short video content in general, and data-based videos in particular. We view mDVs as an evolution of traditional DVs, tailored to a fast-paced, mobile-first lifestyle characterized by multitasking and limited attention spans. As such, they retain the core characteristics of DVs—such as combining narrative and data visualization—while adapting to modern consumption patterns. This evolution raises questions about whether existing research on DVs applies to mDVs given their significantly shorter length and mobile consumption.

2.3 DVs as a form of Narrative Visualization

Narrative visualizations combine storytelling techniques with data visualization to convey information effectively[17]. DVs, a well-studied genre of narrative visualization, use visual, auditory, and textual elements to deliver engaging, data-driven stories [2, 9, 45]. DVs have gained popularity and have attracted significant attention in research [2, 9, 13, 55] and practice as a convenient and effective means to deliver information [25, 28]. Further, they have been used to influence people's perception effectively [13, 41, 42] in areas including education [26], journalism [22, 66, 67], science [1, 54], and health communication [5]. Similar to traditional videos, creating DVs is challenging as they weave several elements (i.e., visual, acoustic, and textual) to convey a cohesive and easy-to-follow narrative [37].

Narrative characteristics of DVs: Storytelling plays a central role in DVs and, by extension, mDVs. Efforts to analyze narrative approaches in DVs have taken different directions, focusing on key narrative characteristics.

Narrative structure: from a cinematic point of view, a narrative structure represents the order or arrangement of events within a story to convey a certain message [2, 9]. Storytelling often follows

widely used narrative structures in cinematography and literature, such as Freytag's Pyramid [21], the Hero's Journey, and the Three-Act Structure. Those structures assume a story that starts with an *introduction* or *exposition*, then a rise in action until the *Peak* or *climax*. Thereafter, the events take a descending direction in terms of intensity until a *resolution* is reached. Amini et al. [2] examined the narrative structures of DVs from this cinematic perspective and using Cohn's Narrative categories, namely *Establisher (E)*, *Initial* (I), *Peak (P)*, and *Release (R)* [14] to label different segments of the narrative. The authors observed narrative structures in DVs (e.g., EI+ pattern with no *P* aims to tell factual stories; E+I+P pattern raises tension with no *R* or resolution, and E+I+PR+ tells a 'well-balanced' story). The most commonly observed was the E+I+PR+ pattern which mirrors Freytag's pyramid structure and the Three Act which is also known as the common narrative arc [14]. Similarly, Yang et al.[70] confirmed that DVs commonly follow Freytag's pyramid structure [21]. Sallam et al. [42] have shown that a 'well balanced' narrative structure that follows the traditional narrative arc [14] is effective when the DV aims to influence the viewers' perception, highlighting the potential of DVs in attitude and perception modification. However, these findings are derived from DVs, which are, on average, six times longer than mDVs.

Narrative Attributes: Cao et al. [9], developed a taxonomy that describes narrative attributes of DVs such as the Ending Type, Story Strand, Order of Events, and Interactivity; drawing insights on common practices.

Visual and Auditory Techniques: Studies have also spanned different visual and auditory techniques utilized in DVs such as commonly utilized forms for data visualization [2], animation and techniques to guide viewers' attention [2, 48], as well as the common transition styles [55]. Utilizing animations and visual representations of data has proven useful in enhancing viewers' engagement and understanding of the data insights [3]. Such comprehensive knowledge about DVs has been pivotal in guiding the design of DVs and informing the development of DV authoring tools [4, 46, 47, 63, 65].

While extensive research has explored the structure, components, and design practices of traditional DVs, this knowledge may not directly translate to mDVs. The fundamental differences in duration and format introduce unique constraints and opportunities that likely influence the narrative structure, visual composition, and overall design strategies of mDVs.

3 Study 1: Analysis of existing mDVs

To understand the capacity and the limitations of mDVs, we conducted a qualitative content analysis with a corpus of 40 YouTube Shorts from reputable channels and with high number of views (minimum of 491K subscribers; see Table 3 in Appendix). Study 1 aims to answer RQ1: What are the narrative characteristics of mDVs?; and RQ2: What are the visual and auditory techniques incorporated in mDVs?

3.1 Methodology

3.1.1 Video Selection Process. We explored three of the most popular short video platforms; YouTube Shorts, Instagram Reels, and Tiktok. For YouTube, following previous studies (e.g., [2, 9, 42]), we navigated video Shorts with a high number of views and posted on popular and reputable informational channels such as Vox [59], Be Smart [7], and The Infographics Show [49][1]. We further followed YouTube's suggestions for related videos, enabling us to expand our dataset to include content from a diverse range of creators. Interestingly, identifying data-based videos on TikTok and Instagram was challenging. Keyword searches using terms such as 'data facts,' 'informational video,' and 'statistical facts' yielded very limited results. Instead of data-based communication, most

[1]Note all of these channels have more than 5M subscribers at the time of writing.

videos on these platforms were casual and user-generated (shot with the users' cellphone camera), focusing on personal moments, trends, and entertainment [37]. The initial video collection (N = 59) was screened by three researchers independently based on our operational definition of mDVs. The researchers unanimously agreed to remove the videos on TikTok. This left us with 40 mDVs; covering a wide range of topics (political, n = 9; scientific, n = 8; historic, n = 8; general knowledge, n = 6; socio-economic, n = 6; and sports, n = 3) and hosting channels (see Table 3 in the Appendix).

3.1.2 Video Analysis.

Narrative-related characteristics of mDVs. Based on previous works on DVs [2, 9], we examined the narrative characteristics of mDVs in terms of two main constructs: 1) narrative structures observed in mDVs; and 2) narrative-related attributes of mDVs.

To analyze the narrative structures employed in mDVs, we adopted Cohn's visual narrative structure framework [14], which classifies the narrative elements into four categories based on the role they play in the narrative, and which can be used as building blocks for narrative crafting:

- **Establisher (E):** establishes the scene by introducing the topic.
- **Initial (I):** initiates the action and sets it in motion.
- **Peak (P):** where the most important events and the highest tension occurs.
- **Release (R):** "the aftermath of the peak," [14] where conclusions are drawn.

These categories provide a common terminology across visual narrative genres and are used in similar DV analysis. For instance, Amini et al. [2] provides a structured lens for analyzing mDVs. Following their work, we split the videos into informationally-distinct temporal segments and assigned each to the matching narrative category (see Figure 1). We used regular expressions to label and combine emerging patterns where {Category+} signifies one or more occurrences of a narrative category, and {Category*} denotes zero or more occurrences.

Narrative attributes of mDVs. We examined the collected mDVs in terms of five attributes: three inspired by Cao et al., [9], namely: 1) ending type (open/closed), 2) story strand (single/multi storylines), and 3) order of events (linear/non-linear). We further examined 4) the narration method (audio narrated only/ narrated and captioned), and 5) the narrator's presence in the video (visible/invisible).

The lead researcher developed an initial codebook based on prior research and iterative brainstorming sessions among three HCI researchers. Additional codes were inductively added during the analysis to capture emergent features unique to mDVs. Two researchers independently coded the videos, resolving discrepancies through discussion. To ensure coding reliability, the process included iterative discussions after coding two, three, and five videos. If a consensus was not reached, a third HCI researcher was consulted. NVivo software [38] was used for coding and data analysis.

3.2 Study 1 Findings

3.2.1 Narrative Characteristics of mDVs. We organize our findings in terms of our two main constructs: 1) Narrative Structures, and 2) Narrative Attributes.

1- Narrative Structures in mDVs: We observed various combinations of Cohn's narrative categories (E,I,P,R), creating different narrative structure patterns (see Figure 2). The analysis showed two dominant patterns utilized in mDVs (75% of the videos). The first is the "E+I+P+R+" pattern (32.5%) along with its two variations "E+I+PI+R+" (7.5%) and "EI+P+RI+R*" (5%) shown in the top bar of Figure 2, which some researchers have described as a *'well-balanced'* pattern in telling stories [2, 42]. Despite their brevity, 45% of sample mDVs could tell their stories following the common narrative arc or Freytag's Pyramid structure [2, 21, 70]. Videos following this pattern

have a well-introduced topic in the *Establisher*, followed by multiple *Initial* units leading to one or more *Peaks* or a climax where the tension rises, and ending with one or multiple *Release* units where conclusions are drawn. The second commonly observed pattern "E+I+R+" (30%) includes no peak resulting in no tension, hence we describe it as 'No Tension' pattern. mDVs following this pattern provide information, or details on a certain topic followed by a conclusion, a summary or a call to action at the end, with no intense or conflicting events. Additionally, 12.5 % of our mDV collection followed a structure which does not include *Peak* nor *Release* units "E+I+". Those videos directly introduced a topic or claim followed by supporting data and facts in the form of a "*chain of facts*" format, commonly observed in DVs [9]. While we initially anticipated most mDVs to follow this pattern due to their limited length, our data shows that the structure of mDVs can be more complex than a mere chain of facts. Furthermore, we observed three videos (7.5%) raising tension through a peak with no resolution or Release"E+I+P+I*"; leaving the viewers in a state of uncertainty or with open questions. We refer to such videos as "*Tension Builders*".

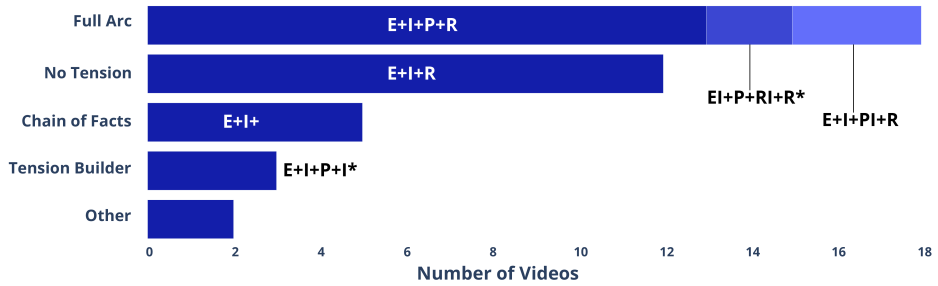

Fig. 2. Study 1: Frequencies of narrative structure patterns observed in 40 YouTube Shorts coded based on Cohn's narrative categories [14]. The majority of the coded mDVs followed the full arc structure (18 videos). The second most popular structure is one that utilized no peak units.

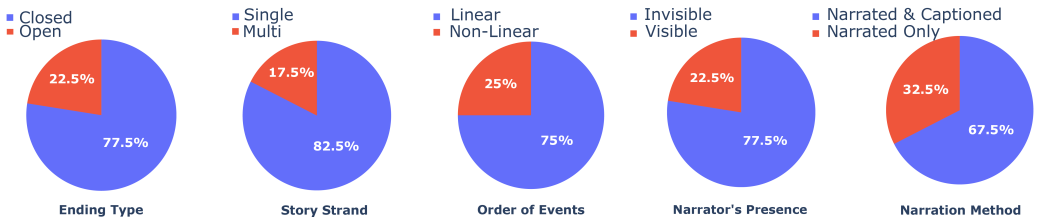

Fig. 3. The distribution of five key narrative attributes in the 40 analyzed mDVs.

2- Narrative Attributes. Our data showed that the majority of mDVs (77.5%) managed to conclude their stories via a closed ending (see Figure 3). The majority of the analyzed videos (82.5%) had a single story strand focusing on one topic or idea, a choice likely influenced by the time constraint. Unlike typical short videos on platforms such as TikTok and Instagram, the presence of a visible narrator was relatively uncommon (22.5%). When narrators did appear, they were featured in dedicated scenes within their own environment, without augmentation or overlay with video content. In these cases, the video alternated between the presenter and data-driven or thematic visuals. Only one video (Video 13 in Table 3, see Appendix) featured the presenter continuously in the lower portion of the screen while a chart was displayed above, a layout potentially influenced

by the portrait orientation of mDVs, which limits horizontal space and constrains the simultaneous display of both the narrator and video visuals. mDVs commonly enhance their narration with captions, observed in 67.5% of the analyzed videos. Check Figure 3 for a summary of the results.

3.2.2 Visual and Auditory Techniques. We examined *data visualization types, attention cue types, transition styles, video styles, and audio attributes.*

1- Data Visualization Types. Despite their brevity (55 s on average), mDVs presented large amounts of information using data visualizations (e.g., bar charts, pie charts, pictographs, etc.), occupying 35% of the total video duration on average–ranging from one to seven visualizations, with an average of four visualizations per video. We observed a total of 217 data visualizations across the 40 mDVs; spanning 12 different chart types, with maps and pictographs contributing 74.4% of all visualizations (38.7% and 35.6%, respectively) as seen in Figure 10 in the Appendix. We attribute the frequent use of pictographs to their effectiveness in simplifying data, making it more relatable through visual cues, and conveying complex information at a glance—a crucial feature given the time constraints of mDVs.

2- Attention Cue Types. Attention Cues are the visual and auditory techniques used to keep the viewers engaged or direct their attention to certain elements of the video [2]. The majority of the recorded attention cues (73%) fall under four types: *highlighting* (19.9%), *zooming* (18.6%), *animation* (17.4%), and *sound effects* (17.2%); with almost equal distribution (Figure 10 in the Appendix). While *Gradual text* is frequently used in DVs according to Amini et al. [2], it is not as commonly used in mDVs (8%), which could be attributed mDV's brevity, limiting the use of time-consuming visual effects.

3- Transition Styles. Transitions are the techniques used to switch from one scene to another [9], or more specifically between two "informationally-distinct" [56] scenes. While we have coded various transition effects such as zoom, wipe, dissolve, fade, etc., we grouped those into two larger categories; 1) *hard cuts:*complete update from one frame to the other with no visual connection between the two frames [55]; and 2) *gradual transition*: smooth changes that visually link scenes using effects such as fading or merging. The majority (65%) of the reported transitions fall under the hard cuts category. Once again, this design choice could also be attributed to the time restriction of mDVs; video creators were interested in utilizing relatively time-efficient techniques.

4- Video Styles. As shown in Figure 4, videos were categorized by style. Fully Animated videos—entirely digitally rendered—comprised 40% of the sample. Whiteboard Animation is a subset of the prior and made up 5% of the examined content; it involves a pre-recorded animation with a storyteller's hand and voice-over added post-production. Live Scribbles made up an additional 5%, and while similar to whiteboard animations, they include live sketching and often live discussion, which delivers more organic content. Lastly, 50% of the selected videos were Mixed Format and included combinations of the video styles discussed previously.

5- Audio Effects. We further examined the use of background music and sound effects in mDVs. Out of the 40 analyzed videos 18 videos included background music and 21 videos utilized sound effects.

3.2.3 The Linker (L). Some segments were repeatedly identified towards the end of seven mDVs (17.5%), with content that did not fit in any of the four narrative categories (i.e., E, I, P, R). While this content existed at the end of the video, it was not there as a conclusion or *Release*, neither was it an *Initial* because it was not part of the action initiation. Furthermore, it did not fit as a *Peak* as it did not aim to build tension. We have considered coding this sequence to be an *Establisher*

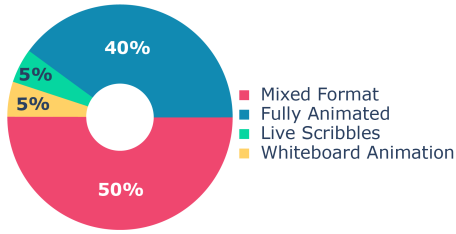

Fig. 4. Distribution of video styles observed in the analyzed videos

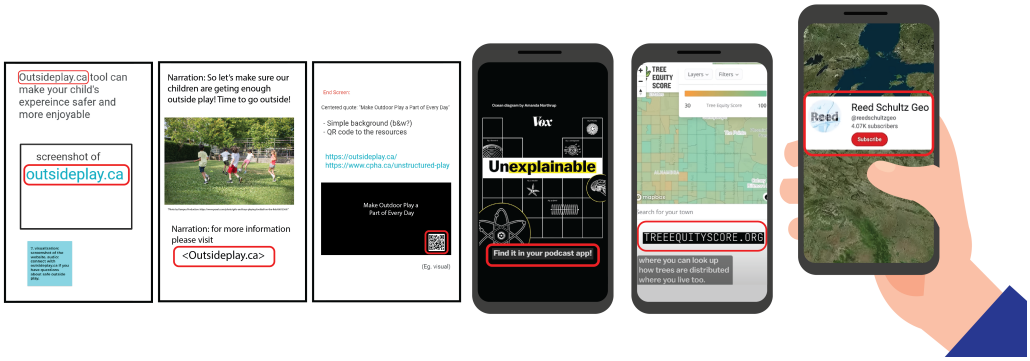

Fig. 5. Examples of Linkers identified in both studies. The three images on the right display Linkers from Study 1, sourced from [24, 60, 62], and showcasing a call to check a podcast channel (cross-platform traffic), visit a website (resource sharing), and subscribe to a channel (retention and channel growth) (from left to right). The three images on the left show sample Linkers from the storyboards developed by participants in Study 2, in the form of a website home page, website URL, and QR code linking to a website; all aim at resource sharing.

as it covered a different topic. However, it did not fit as an introduction; rather, it was an abrupt jump to new content aimed at directing viewers to external sources. More specifically, this segment sometimes includes an abrupt shift to a related but different topic, a request to press a subscribe button or visit a website for further information as shown in Figure 5. To further explore this new segment, we conducted a detailed analysis of the content of Linkers in the seven videos. Using open coding and guided by relevant literature [10, 15, 18, 27, 39], two researchers described the linker segments in terms of seven factors (see Table 5 in the Appendix for the final codebook): 1- *Content Type:* describing what the linker conveys (i.e., direct call or prompt to subscribe or visit a website, or just additional content or resources); 2- *Goal/Aim:* the purpose of the video whether to attract traffic and promote for the channel or to provide additional information by sharing more resources, or direct viewers to another platform (cross-platform); 3- *Placement:* where the linker appears in the video; whether overlaying the video content or having its dedicated screen; 4- *Visual Representation:* how the link is displayed (e.g., text, icons, thumbnail/preview of a webpage or platform, animated visuals); 5- *Auditory Support:* whether it is accompanied by audio narration; 6- *Engagement Mechanism:* how the viewer is expected to engage with the linker (e.g., clickable link within the video, QR code, link within the video platform context (e.g., channel or description box), non-embedded link); 7- *Content Relevance:* the relevance of the linker to the topic and content of the video; whether it is related to the video content or related to the hosting channel. Two researchers (one was part of factor generation and one not) independently coded the linker

segments based on those factors, then discussed and resolved disagreements (see Table 1 for the final coding). While the majority of the analyzed linkers' content was not directly related to the video but rather to its hosting channel (i.e., contextual linker), two out of the seven Linker instances included links to resources related to the video content, aiming to share further information. While the Linker emerged repeatedly throughout our coding, it notably does not fit into any of the story structure categories which are expected to affect the narrative flow, hence Linker was treated as an independent video component.

Table 1. Detailed description of the Linker segments observed in seven of the analyzed YouTube Shorts (rows 1-7), and the generated storyboards (rows 8-13). Please note that the video ID matches with that of Table 3 in the Appendix

Video ID/ Session ID	Functions and Goals					Visual Characteristics						Sound		Linking Method and Contents					
	Content Type		Goal/Aim			Placement		Visual Representation				Auditory Support		Engagement Mechanism				Relevance of Content	
	Call to Action (CTA)	Resource Links	Retention and Channel Growth	Knowledge/ Resource Sharing	Cross-Platform Traffic	Overlay	Dedicated Screen	Text-based	Iconography	Thumbnails/Previews	Animated Elements	yes	no	Clickable Links	QR Code	Contextual Anchored Prompts	Non-embeded	Content-Related Linker	Contextual EngagementLinker
4		x			x		x			x		x					x	x	x
14		x		x	x		x			x		x					x	x	
22	x		x			x			x		x	x				x			x
25	x		x				x		x	x	x	x				x			x
28	x		x			x		x			x		x			x			x
33	x		x			x			x	x	x	x				x			x
35	x		x			x				x	x	x				x			x
S1		x		x	x		x			x		x					x	x	
S3	x			x		x				x		x					x	x	
S4	x	x		x			x	x					x	x				x	
S5		x		x	x		x	x				x					x	x	
S6		x		x		x			x				x		x			x	
S7		x		x			x			x		x					x	x	

3.3 Insights at the Narrative Block Level

We further analyze mDVs at the narrative category level, reporting the duration proportion of each category relative to the total video length, a high-level summary of data visualization density and attention cues, and the types of content presented within each category.

1. Narrative Categories Distribution: On average, more than half of the time (i.e., 60%) was spent on the Initial, followed by the Release (19%). Despite being an essential element in all analyzed videos, the Establisher consumed a very brief portion of the video time (9%), implying that *designers of mDVs choose to briefly introduce the topic and jump directly to the main body where they discuss facts and claims* (see Figure 11 in the Appendix).

2. Distribution of Data Visualizations and Attention Cues within the Narrative Categories: More time was spent on *visualizations* during the Initial (32%), Peak (35%), and Release (31%) than in Establisher (22%), as seen in Figure 6. These three categories occupied the largest proportions identified in the overall video, implying the density and amount of information provided in those segments. The figure further highlights that *mDVs heavily utilize attention cues.*

3. Content Types within the Narrative Categories: We examined the content types across narrative elements in mDVs. As shown in Figure 6, new facts were introduced at all stages. Consistent with prior findings on DVs [2], mDVs commonly opened with a question (30%). However, mDVs featured less repetition and offered fewer details or examples to support key points, marking a notable

difference from their longer counterparts. As expected, tension peaked at the Climax or Peak while the takeaway message was typically delivered in the Release segment.

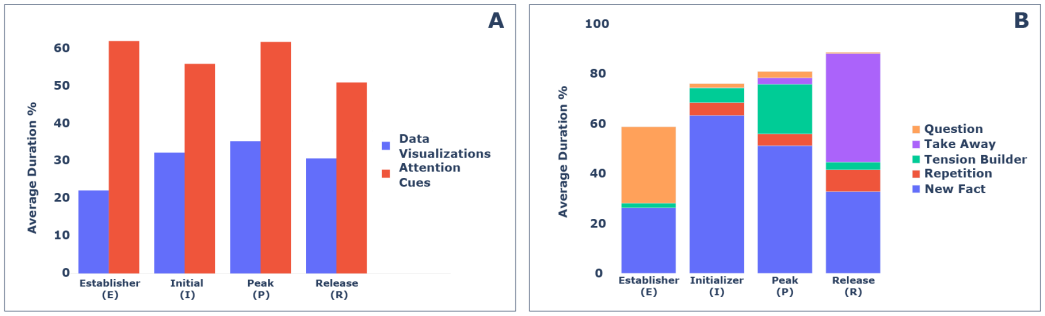

Fig. 6. Study 1: (A) The proportion of average duration spent on data visualizations and attention cues within each narrative category. The heavy utilization of Attention Cues reflect designers' high effort to retain viewers' attention. (B) Average percentages of the occurrences of different types of content within each narrative category. *Note: The two figures have different scales and are not put side by side for any comparisons or inferences.*

3.4 Study 1 Summary

Our analysis revealed that mDVs, despite their brevity, contain clear and diverse narrative structures: The majority of mDVs followed the full arc that is commonly seen in DVs and cinematography. We further report a commonly observed element, *Linker*, appearing at the end of the video and aiming to engage viewers with content external to the video. The analyzed mDVs contained a large number of data visualizations and were packed with visual and auditory techniques to attract and engage viewers. We believe the design choices of mDVs are driven by *their limited duration, and their viewing condition within a stream of other video feeds, necessitating that they instantly capture and retain viewers' attention via simple and visual data charts augmented with attractive but time-sensitive effects* (see Figure 9). Now, we turn to observe how experts put these contents and techniques together to design mDVs.

4 Study 2: Analysis of mDV Storyboarding

After learning the narrative structures and the techniques applied in mDVs, the central goal of Study 2 was to observe *how expert designers approach the design of mDVs*. A series of workshops were conducted, aiming at observing and understanding how experts design mDVs, represented through storyboards. The results present designers' choices in terms of the structures of their stories as well as the visual and auditory techniques they selected. We also describe the processes and activities involved in their storyboarding.

4.1 Methodology

Individuals with expertise in related fields were recruited for Study 2: Groups of either two or three individuals worked together to develop a mDV storyboard on the topic of children's outdoor play. This theme was chosen based on three reasons; it was well supported by date, relevant to all, and has clear social implications. Central information and data facts were provided so participants could focus on the design process of an mDV.

4.2 Participants

Fifteen participants (six reported as female and nine male) were recruited through various online channels, including local university programs in media and creative studies, social media groups, and subreddits focused on data visualization, animation, and storytelling, as well as HCI and data visualization communities. To be eligible for this study, participants were expected to have formal training and/or professional expertise in one or more areas related to DV design (e.g., storytelling, script writing, data visualization, video editing, and 3D animation): Six people were enrolled in bachelor of media studies; four in their final year, two PhD holders specializing in data visualization, one participant with a masters degree in communication and media studies, six participants reported professional experience in at least one area from screenplay writing, storytelling, and film and documentary, and animation design. Participants received (anonymized currency) $32 e-gift cards as compensation, in compliance with the study ethics approval.

4.3 Study Material

To ensure participants had adequate information about outdoor play, we prepared an information sheet (Figure 12 in the Appendix) which included general information about outdoor play, its benefits and risks, and a list of nine statistical data facts (e.g., statistics on risk factors and benefits associated with outdoor play). The information sheet also provided links to additional material/resources (e.g., relevant publications). [2] No specific instructions (e.g., use it as a *Linker*) were given regarding additional materials/resources, allowing us to observe how the designers naturally incorporate such information into their storyboards.

4.4 Procedure

Seven Zoom sessions (six with two participants and one session with three participants; all agreed to be video recorded) were conducted by the lead researcher. At the start of each session (which lasted about 3 hrs), participants' consent was collected and the instructions were provided. Each session consisted of three phases; 1) the survey, 2) the design, and 3) the semi-structured interview.

In the *survey phase* participants first completed a brief demographic survey (age, gender, education level, video design-related experience levels). Next, the researcher provided an explanation of the concept of mDVs. Participants then viewed six sample mDVs from YouTube Shorts (in random order) to facilitate their understanding of mDVs. Each video had a unique style, varying narrative structures, and covered diverse topics (e.g., sports, political, scientific). [3]

In the *design phase*, the researcher first introduced the task to the group, providing a written task description that was reviewed together. Participants had access to a shared Google Jamboard to collaborate on and were asked to create a storyboard for one mDV on the topic of children's outdoor play, targeting parents and/or teachers. They were provided with the data facts sheet described in 4.3. Designers were asked to incorporate at least three data visualizations [4] into their storyboard, using data from the provided sheet. They were informed that their storyboard would be converted into a video and were encouraged to include all necessary details–using drawings or annotations–for the video creation, such as sound effects, background music, animation, visual effects, and transitions. They had 90 mins to complete their storyboard. Once finished, the researcher conducted a *semi-structured interview*.

[2]The content of the information sheet was adjusted based on the feedback from two pilot sessions with five HCI researchers.
[3]Those videos are 4, 12,14, 15, 19 in Table 3 from the video pool analyzed in Study 1 in addition to [61].
[4]While Study 1 results suggest that four data visualizations are typical, we set the minimum at three to ensure participants focused not only on embedding visualizations but also on narrative and other video elements

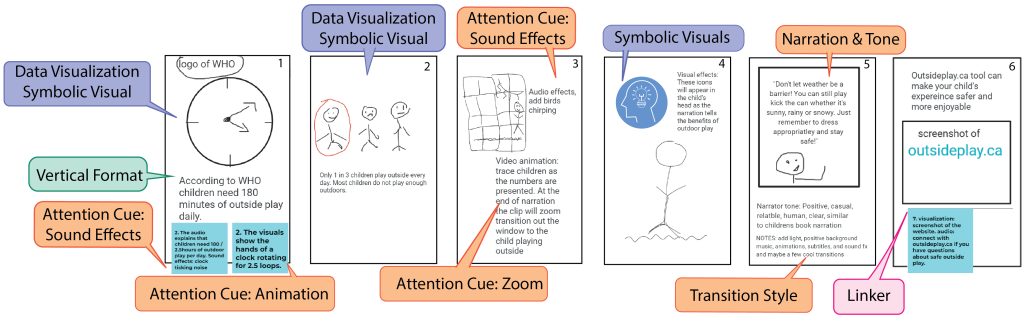

Fig. 7. Screenshots of storyboard frames conveying a variety of mDV elements (e.g., data visualizations and attention-grabbing techniques). The storyboards heavily utilized symbolic visuals to facilitate understanding and complement the audio narration. Linker segment appeared in the storyboards. *Note: portrayed frames belong to different storyboards and are not displayed in a temporal order.*

4.4.1 Storyboards and Sessions Analysis. We obtained seven digital storyboards and session recordings. To identify common narrative patterns and components, we coded the storyboards based on narrative structures, data visualization types, and attention cues, using the code-set from Study 1, while remaining open to new codes. Two researchers independently coded all storyboards, resolving disagreements through discussion until a full agreement was reached. A third researcher was consulted for unresolved cases. The analysis of recorded sessions followed these steps: First, the lead researcher developed an initial code-set based on activities observed in the sessions. Each code/activity was defined, and they were then grouped under four categories, inspired by a previous study [2], namely: 1) Read and understand the data; 2) Select data and corresponding visualization; 3) Craft the narrative; and 4) Engage viewers. The initial code-set underwent several rounds of revision with another HCI researcher to ensure clarity. Each recorded session was then coded individually by three researchers including the lead researcher. Discussion meetings were conducted to resolve any conflicts and update the coding schema with any new emerging codes (coders were encouraged to add new codes if necessary). The code book evolved with each coding iteration (see Table 4 in the Appendix).

4.5 Study 2 Findings

We collected seven unique digital storyboards (Figure 7). Here, we present our findings related to; 1) the structures of the stories portrayed in the collected storyboards; 2) the content of the stories; as well as, 3) description and analysis of the storyboarding process reflecting how experts put together different elements to design mDVs. It is worth mentioning that one group fully relied on GPT to generate their storyline. Since these participants did not engage in the narrative crafting activities we are interested in (e.g., to read and understand the data, design a narrative, etc.), their design session was excluded from the storyboarding process analysis (i.e., $n = 6$)[5].

4.5.1 Narrative structures: Five out of the seven storyboards (71.4%) portrayed stories that follow the common narrative arc. They began with an introduction to the topic or problem, followed by additional details, and then introduced a surprising, negative or controversial fact, such as the risks associated with outdoor play. This was followed by supporting facts and arguments aimed at resolving the tension, and concluded with an outro, often in the form of a call to action, as

[5]Data from the AI generated storyboard was considered for narrative structure and content analysis, only the storyboarding process was disregarded

described by many participants. The remaining two storyboards told stories with no *Peak* or tension focusing on communicating information and facts related to the topic. Altogether, findings around the narrative structures in the storyboards were parallel to those found in mDVs used in Study 1.

4.5.2 ***The Linker (L).*** Linker was a highly common component in the generated storyboards: Six out of the seven (85.7%) storyboards included a *Linker*. These Linkers were analyzed with the same analytic approach used in Study 1 (see Table 1). While the goal of all observed Linkers was to share knowledge and resources by directing the viewers to external resources, three linking styles were observed (Figure 5); 1) Showing a screenshot of the website's home page (*preview*) while narrating the URL (*narrated*:n = 3); 2) Displaying the website's URL (*text-based*) and narrating it (*narrated*:n = 2); and 3) Displaying a QR code on the screen (*Iconography*:n = 1).

4.5.3 mDV Content-Related Attributes.

Data visualization types: A total of 21 data visualizations were created across all the storyboards [6], covering five visualization types (Pie, pictograph, bar, infographic, map) (Figure 13 in Appendix) with the majority of data facts (90.5%) represented using three simple chart types; pie chart (42.9%), pictograph (28.6%), and bar chart (19%).

Attention cues: Designers utilized five techniques to capture the viewers' attention across the seven storyboards (Figure 13 in Appendix). Animation (40%), Sound effect (29%), and Zoom (9%) were the most commonly used attention cues. We acknowledge that storyboards can fall short in conveying attention cues compared to actual videos.

The use of symbolic visuals: One common strategy observed in the storyboards was the use of *symbolic visuals*, which refers to using illustrations, symbols, visual cues, or live images of an object or idea described in the video [9] (e.g., a clock to represent the time kids spend outdoors, a pictograph with two sad stick figures representing kids who do not play outdoors while a happy figure for the child who plays outdoors, see Figure 7). Symbolic visuals were also employed in non-data-driven contexts to complement the spoken narrative. For example, icons were displayed alongside narration emphasizing that outdoor play enhances children's concentration, memory, social and emotional learning, and mental health (see frames 1,2, and 4 in Figure 7).

4.5.4 Analysis of the Storyboarding Process. We describe the storyboarding processes and activities undertaken by the participants and organize those activities under four overarching groups listed in 4.4.1 and described in 4. We divided the recording of the storyboarding process into three equal temporal segments 1) Beginning, 2) Middle, and 3) End, and analyzed the kinds and frequencies of activities taking place in each of the segments (Figure 8). In general, the storyboarding process was creative and hence, *iterative rather than linear*.

1. Reading and understanding data and facts. This step occupied 10% of entire storyboarding time on average. This activity included exploring the provided data to gain an understanding of the topic, reading the task description, or checking the information in search of content to support a certain idea. Participants often searched for content for the hook or the opening scene of the video. As shown in Figure 8, reading the data mainly took place at the *beginning* of the storyboarding activity (19%) compared to *middle* and *end* phases (6%, 4% respectively).

2. Data and facts selection. Participants went through numerous decision-making steps to select and filter out information and data facts. While this goes hand-in-hand with the *read and*

[6]One group failed to follow the three data visualization instructions. However, a different group generated four data visualizations.

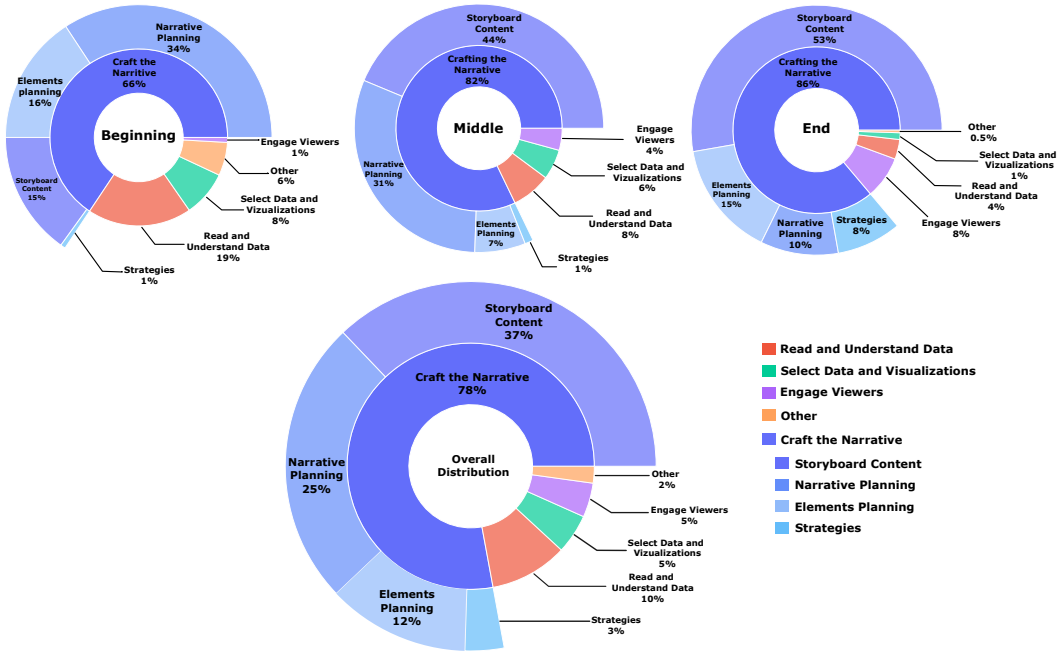

Fig. 8. Top row: Three equally divided temporal segments of the storyboarding process: Beginning, Middle, and End, reflecting the types and frequencies of activities in each of the segments across all sessions. Bottom row: The large figure shows the overall activity distribution across the coded sessions.

understand data activity, activities in this category always included decisions about retaining specific facts or information as opposed to just learning about the available facts. Activities in this category were commonly observed in the *beginning* (8%) and *middle* (6%) of the storyboarding process, compared to the final phase of the storyboard design (1%) Figure 8.

3. Crafting the narrative. Includes four sub-activities: three planning-related activities (3.1–3.3 in table 4 in the Appendix) and the fourth is implementation-focused (3.4 in the same table). As seen in Figure 8, these are the predominant set of activities in all three stages (*beginning* (66%), *middle* (82%) & *end* (86%), with emphasis on planning activities in the first stage (80% planning and 20% implementations) and almost a balance between planning and implementation in the middle stage (46% planning & 54% implementations). Towards the end, the focus shifted to implementation (40% planning & 60% implementations).

3.1 *High-level narrative planning*: covers activities aimed at shaping the core structure and intent of the video such as setting the target audience, discussing the overall goal or takeaway message, and outlining the overall storyline (see Table 4 in the Appendix for the full list of activities). These activities were heavily involved in the *beginning* and *middle* phases (34% and 31% respectively), compared to the *end* stage (10%), as the design ideas were more clear, and the focus was shifted more towards implementation rather than planning (Figure 8).

3.2 *Discussions surrounding narrative elements:* includes discussing key narrative elements such as the hook, the introduction, ending, linking to external material, the call to action, and the video title. As Figure 8 illustrates, during the *beginning* phase, participants discussed four video elements; the *hook*, the *linker*, the video *title*, and the *introduction*. Discussing the hook was the most dominant activity (72% of the total time spent discussing story elements), with five out of the six groups pinpointing the importance of starting with a strong hook. One group discussed linking to external

resources (i.e., linker) at that stage. In the middle phase of the design sessions, the focus shifted to the Linker and video *ending*. Toward the end of the sessions, participants brainstormed ideas for the video *title*.

3.3 *Discussing strategies for video content*: includes designers brainstorming the *visual style* or form of the video (e.g., animated vs. live footage), the overall visual style, strategies related to using *data facts* such as the optimal number and how to distribute data facts. One group discussed the importance of having *subtitles*. Decisions about the *narrator's tone* was also brought forward by one participant, stating that the narrator's tone should be "positive, not stressing or alarming" [P09]. Using the right *pace* was also discussed "the pacing to be not too fast, but also keep it rolling" [P09]. While some strategies like the use of data facts was introduced at early stages of the design, the majority were discussed towards the end after the main storyline was decided upon.

3.4 *Storyboard content execution*: Storyboard implementation tasks including discussing and adding audio narration and visuals, as well as reviewing and revising the narrative. Designers discussed, sketched, and looked up specific visual elements like icons, pictures or charts and also explained in writing what the narration would be. As seen in Figure 8, these activities were included in all storyboarding stages. However, they were predominant in the *middle* and *end* (44%, 53% of the overall time spent *crafting the narrative*, respectively), compared to only 15% in the *beginning* phase.

4. ***Engaging the viewers.*** This includes activities related to discussing and/or adding visual or auditory elements and effects to make the video more appealing, engaging, and easy to follow such as *animation and visual effects*, *background music*, and *sound effects* to retain the viewers' attention [2]. We observed two approaches for this: 1) inclusion of animations, visual effects, and sound effects was brought up throughout brainstorming and sketching the actual content; 2) some designers finished the entire storyboard and then went over it to add such elements.

4.5.5 Insights from Semi-Structured Interviews.

Informational content in mDVs: Designers argued that mDVs can convey a good message as long as they focus on one central idea "*It's good to tell a message, but I think you have to be specific about that message*" [P10]. This participant further criticized a sample mDVs they watched, which contained numerous pieces of data/information ("*I kind of got lost in it, because, even though they had one message. Really hard to follow*)."

Feedback on the Linker: Participants who included a Linker highlighted the Linker's utility in providing access to additional information beyond the video's time constraints. One participant noted, "*We have to choose one core message and maybe 3 data points right? But there's obviously more to it, and more information, or even just resources for people*" [p10]. Others saw it as a way to engage interested viewers: "*if you're definitely more interested than the average viewer, you know where to get more information*" [P7], while some framed it as a call to action: "*something for them to do at the end of the video*" [p15] making the goal of the video "*not just raise their awareness, but actually suggest them a way, a better approach*" [P12] to solve the problem. Participants emphasized that the Linker prevented information overload while offering an alternative path for deeper exploration: "a *2-way thing like we're not bogging down the video with these bits of information and we are letting them get another avenue to get access to more in-depth guides and information*" [P7]. Overall, they viewed the Linker as an effective way to balance conciseness with accessibility to further resources.

4.5.6 Study 2 Summary.

Parallel to Study 1, the generated stories relied on simple and highly visual chart types, and utilized time efficient effects to engage the viewers. We observed a *significant focus on symbolic visuals in representing data and contextual information.* This choice was deliberately made

to facilitate understanding and engage viewers via a glanceable content. Through the observations, interviews with designers, and the analysis of the storyboarding process (see Figure 8), we learned that designers spent most of their time trying to figure out the storyline/story structure. While they did not specifically utilize Establisher, Initial, Peak, and Release as terminology, they approached the design in a structural manner; *breaking the story into main narrative phases or elements, and then fitting content within those elements.* For example, the *hook* or attention grabber was described as the determinant of whether viewers would keep watching the video or just scroll to another video. Hence, they carefully picked the content of the hook to be *catchy, surprising, and relevant.* Participants also discussed the *Introduction* as an important stage where they get to introduce the topic to the viewers. In the majority of the sessions (n = 5), and parallel to the *peak*, designers chose to include negative, shocking or disturbing facts about outdoor play (e.g., risks associated with outdoor play were mentioned in three storyboards). The video *ending* or '*outro*', was also an important stage that the designers discussed and carefully planned the suitable content for. Designers who included negative or disturbing content, made sure to resolve or lessen the tension by providing reassuring facts (e.g., facts to prove that outside play is safer than we think), and providing solutions or suggestions to make outside play possible. Most storyboards ended with a call to action. The content designers picked for the outro fits with the *Release* category.

5 Discussion

We sought the answers to three research questions; **RQ1**: What are the narrative characteristics of mDVs? **RQ2**: What are the visual and auditory techniques used in mDVs?; and **RQ3**: How do experts approach the design process of mDVs?

5.1 Narrative characteristics of mDVs (RQ1)

We learned that mDVs can be decomposed to commonly used building blocks, Cohn's narrative categories (E,I,P,R). These blocks can then be placed within commonly accepted cinematic story structures such as narrative arc or Freytag's Pyramid to convey a variety of stories (e.g., problem solution, tension builder, factual stories). We speculate that this could point toward the potential of mDVs for influencing attitudes and perceptions given their capacity to introduce a problem along with solutions or suggestions, parallel to DVs. Indeed, Sallam et al. [42] effectively influenced viewers' perceptions by providing the solutions/suggestions to a presented issue in a DV. Given how well-adopted mDVs are in our society, future exploration of mDVs' capacity for such impact will be fruitful.

5.2 Visual and Auditory Techniques in mDVS (RQ2)

Our collected mDV corpus identified a range of data visualizations (e.g., bar, pie, pictograph, maps) and attention-grabbing techniques (e.g., zoom, highlight, animation). Understandably, the goal of visualizations heavily focused on time-effective communication (e.g., the use of pictographs to convey ideas and data together) with less emphasis on time-inefficient effects (e.g., gradual appearance; Figure 10 in the Appendix). Additionally, attention-grabbing techniques were heavily used throughout the videos and storyboards: retaining the viewers' attention throughout mDVs appears to be important, presumably due to the platform of the videos whereby the viewers can readily move onto another video at the moment they disengage; see Figure 9. Altogether, mDVs *have the capacity for all these effects* to convey data facts. Designers, however, need to carefully choose their data visualizations and visual effects by prioritizing simple, engaging, and easily comprehensible data visualization while minimizing the use of time-intensive effects.

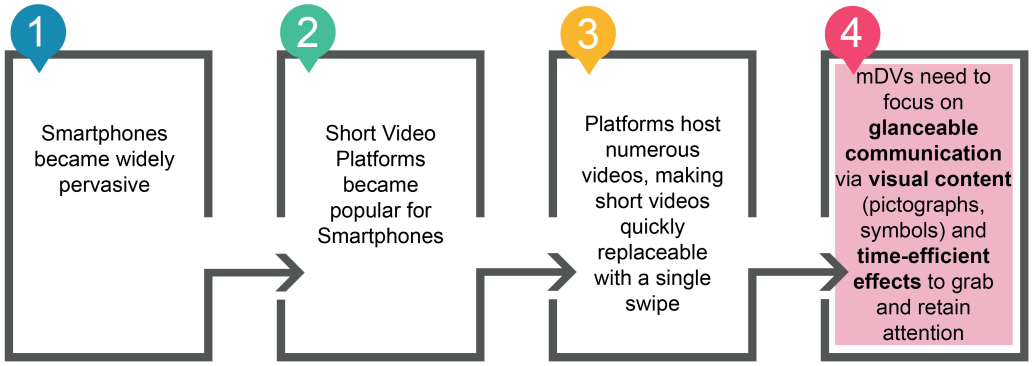

Fig. 9. A series of factors influencing and reshaping video consumption and guiding video design. The widespread of smartphones (1) that fueled the creation and popularity of short video platforms (2). These platforms host numerous short videos in the form of continuous feed (3). Consequently, mDVs are required to be *glanceable* and highly engaging in order to stand the competition.

5.3 Finding and Implications from mDV Design Process (RQ3)

We learned that the design process is structured, yet creative and iterative. As Figure 8 shows, participants iterated between activities throughout the design session stages (i.e., beginning, middle, and end). However, they approached the narrative creation by breaking it down into main narrative elements or building blocks (e.g., *hook, introduction, linker, and ending*). They then planned, discussed, and picked the suitable content for each. This indicates the potential to leverage our findings regarding Cohn's narrative categories as building blocks for mDV narratives by incorporating [E,I,P,R] into narrative templates that reflect commonly observed structural patterns, providing a systematic approach for mDV design. We further observed that designers' choices and decisions were mainly driven by the limited video length as well as its mobile nature, as shown in Figure 9.

5.4 Linker

We repeatedly identified a type of content, *Linker*, which guides the viewers to external content/website. It is worth mentioning that while only a few of the mDVs used in Study 1 contained the Linker, six out of the seven storyboards in Study 2 contained a Linker. Furthermore, the functions and goals of the Linker varied remarkably between the analyzed YouTube Shorts in Study 1 and the storyboards in Study 2: The majority of Linkers found in Study 1 were in the form of a call to subscribe to the channel, aiming at channel growth, while Linkers in Study 2 were in the form of resource links aiming at sharing knowledge and resources (Table 1). We speculate this could be because mDVs collected for Study 1 were all taken from popular channels which produce numerous mDVs. Thus, their primary goal might have been to keep the viewers engaged in videos they produced *within their channel*. In contrast, the mDV's objective in Study 2 was to promote children's outdoor play based on given information and facts that included a couple of links to useful resources. This might have increased the suitability of adding a link to useful resources and information they could not fit in their videos. Hence, the variability in the reason for including a Linker and the function of the Linker was minimized in Study 2, which might have resulted in the high frequency of Linker use and similar goals of the Linker.

Depending on the video's purpose or the creators' intent, the Linker can serve various roles, such as marketing (e.g., encouraging subscriptions or directing traffic) or providing additional resources beyond the video's duration. We even anticipate that *in some cases, the video itself acts as a teaser,*

and the main goal is to guide viewers to external content like websites, articles, or tools. However, the extent to which viewers engage with different Linker styles and whether they achieve their intended purpose remains unclear, warranting further investigation.

5.5 Design Considerations Influenced by mDVs' Length and Mobile Nature

The findings from both studies confirm that *the constrained length of mDVs, their vertical orientation, and the competitive viewing environment—characterized by a continuous stream of brief videos—are key factors shaping designers' decisions in mDV creation, see Figure 9.* Designers approached mDV design with the understanding that these videos are usually consumed on the go, necessitating conciseness, clarity, and, most importantly, the ability to capture and sustain viewers' attention; otherwise, viewers are likely to scroll to the next video. These considerations influenced various design choices across multiple aspects. Interestingly, we noticed that the design considerations discussed by the designers and reflected in their storyboards in Study 2, as well as those employed in the YouTube Shorts analyzed in Study 1, align nicely with design principles and theories commonly followed in HCI research; such as the Cognitive Load Theory [53] and the Multimedia Learning Principles [35]. Designers mainly aimed to reduce the cognitive load by wisely selecting the right amount and type of information in order not to overwhelm viewers (i.e., intrinsic load) and carefully choosing highly visual, yet common and simple visualization types, supplementing narration with symbols and icons, and avoiding cluttered scenes (i.e., extraneous load). Below, we summarize the key takeaways and touch on relevant design principles:

- **The hook:** The opening scene is a critical determinant of whether viewers continue watching or swipe away. Special attention should be paid to its visual and narrative elements to ensure effective audience engagement.
- **The right amount and type of information:** mDVs should focus on delivering surface-level information centered around a single idea and using one storyline (i.e., a single strand), to introduce viewers to the subject. For those seeking additional details, mDVs can incorporate a Linker to direct viewers to further resources.
- **Visual strategies to save time and boost comprehension and engagement:** When strategically used, symbols and icons can supplement spoken narrative and represent both data and contextual information (Multimedia & Modality Principles [35]). They can ease the cognitive load and make abstract concepts more intuitive, hence optimizing the videos' limited duration. Visual effects like zooming and animation are important to keep viewers engaged and direct their attention to specific content (Signaling Principle [35]). Designers should avoid time-intensive effects (e.g., gradual appearance). Augmenting the audio narration with captions helps reinforce key points, and aids in comprehension, particularly when videos are viewed without sound. Given the short duration of mDVs, captions can play a crucial role in ensuring that viewers quickly grasp the presented content without relying solely on auditory information.
- **Optimize narrator presence for vertical orientation constraints**: Although the presence of a visible narrator is not commonly employed—consistent with the Image Principle [34]—when it is utilized, it is preferable to present the narrator in discrete segments rather than maintaining a continuous on-screen presence to avoid obstruction and cluttering. If a narrator must appear alongside visual content, using a split-screen layout with the narrator on one side (e.g., the lower portion of the screen) can help balance visual focus.

While DVs and mDVs share many similarities, *they differ significantly due to variations in length, orientation, and viewing context.* Table 2 summarizes our contribution by comparing our key

Table 2. Comparison of mDV vs. DV. Information on mDVs are based on the results of our two studies, and that on DVs is based on previous work as well as as our observations and common knowledge.
Note: blue cells denote areas of differences, yellow cells highlight similarities, while red cells highlight areas that are not fully reported.

	mDV	DV
Duration	Up to 60 seconds	Unrestricted (6 minutes on average [26, 42])
Orientation	Vertical	Mostly Horizontal [2, 9, 42, 70]
Viewing Context	Mobile, fast-scrolling environments	Typically desktop/ laptop, focused attention
Level of Details	Surface-level, like a 'paper abstract'*	Can have more details
Platform Access	Social media (e.g., Shorts, TikTok, Instagram)	YouTube, websites (e.g., educational, health, news)
Access & Playback	Viewer-initiated or appears in algorithm-driven feeds; Autoplay as part of a stream	Viewer-initiated; Actively searched or selected
Focus & Scope	Focused on a single key message*	Not reported
Cognitive Load	Low, optimized for quick consumption*	Moderate, designed for deeper engagement
External Links	Common*	Not reported
Narrative Structures	Can be described in terms of Cohn's narrative categories [14] Can convey various story structures: Narrative Arc, Freytag's Pyramid, Problem Solution - E+I+P+I*R+ Tension Builder - E+I+P+I Chain of Facts - E+I+	Can be described in terms of Cohn's narrative categories [2, 14] Can convey various story structures: Narrative Arc, Freytag's Pyramid, Problem Solution - E+I+PI*R+ [2] Tension Builder - E+I+P+ [2] Factual - EI+ [2]
Data Visualizations	Simple types (e.g., map, pictograph, bar), with high **emphasis on pictographs***	Simple types (e.g., bar, pictograph, map) [2]
Attention Cues	**Highlighting, Zoom, Animation, and Sound Effect are most common, time-intensive effects (e.g., Gradual text) are less common***	Cover a variety of attention cues with no restrictions: Animation, Gradual text, Highlighting [2]
Design Process	Structred and Iterative	Iterative (whether structured or not is not reported)

* **Can be linked to brevity**

findings on mDVs with prior research on DVs, drawing on results from both of our studies, general observations, and existing literature.

5.6 Responsible Communication Beyond the Metrics

Given that mDVs are primarily distributed on social media platforms—where success and quality are often measured by metrics such as views, shares, and likes—it is important not to lose sight of their potential and capability to inform and educate the public through truthful and responsible communication. While our research, along with similar efforts, aims to enable and guide the creation of powerful and impactful mDVs, the potential for misuse remains a significant concern. The same techniques that enhance engagement can also be exploited to spread misinformation or manipulate viewer perception. Although addressing these issues is beyond the scope of our current work, we believe this domain urgently requires frameworks and safeguards to mitigate the societal harm that can result from the misuse of such fast-paced, emotionally charged, and highly persuasive video content.

6 Limitations and Future Work

In Study 1, we selected mDVs based on view count, informational accuracy, and channel popularity—criteria commonly associated with video quality [2, 9, 16, 42, 70]. However, these indicators do not guarantee adherence to best practices in video design and they fail to capture viewers' experience. Moreover, by focusing on professional and reputable channels, we may have reduced the diversity of our sample, overlooking user-generated content that is prevalent on short-form video platforms. We acknowledge this as a limitation, as user-generated mDVs may exhibit different design styles, engagement strategies, and narrative structures. Additionally, our focus on YouTube Shorts limits the generalizability of the findings to other platforms like TikTok or Instagram, which have distinct content cultures and user engagement patterns. Future studies should include a broader range of platforms and creator types to better capture the diversity of mDV design practices across social media. Furthermore, since the videos were collected from social media platforms that commonly prioritize viewer engagement for subscriber increase, their design and content may reflect *entertainment and/or marketing-driven goals* rather than a commitment to *data communication*. This raises important question of whether the strategies observed truly enhance

viewers' comprehension or simply attract attention. Future work exploring this distinction more systematically by investigating what it means for an mDV to be effective—whether in terms of enhancing comprehension and recall, sparking curiosity for deeper engagement, or delivering accessible insights to a broad audience, will be fruitful. Such work would help move beyond popularity metrics to more nuanced evaluations of communicative success. Finally, we provided only one objective and the same set of data facts to our designer participants in Study 2. This might have affected the variability in the styles, structures and elements of the designed mDVs. There is a great potential for future work to examine whether the nature of the data being presented influences the narrative choices, and whether there is a link between the communicative goal of the video (e.g., educational vs. persuasive videos) and the optimal structure to be followed. Nonetheless, we present our exploration of mDV elements as a stepping stone for further understanding of this data storytelling type.

7 Conclusion

While mDVs are becoming increasingly popular, only little is known about their unique features and design process. Such knowledge is essential to unveil the capacity and limitations of mDVs. Our research aimed at taking one step forward towards a comprehensive knowledge base informing and guiding the design of effective mDVs. To reach our goal, we first decomposed and analyzed 40 mDVs to understand their narratives and unique features. Then, we observed expert storytellers and video designers as they created storyboards for mDVs. Our findings highlight the ability of mDVs to support diverse storytelling styles while relying heavily on visual content and time-efficient effects. Designers' choices are strongly influenced by the brevity and mobile-first nature of mDVs. Our studies show that existing story structures and building blocks can be adopted for mDV development. Finally, we conclude that designers' awareness of mDV's brevity, unique user context, and intended device (i.e., mobile phone) will help guide them through the mDV design process. We distill our findings into key takeaways and design considerations to support future mDV creation. As a next step, we aim to apply these insights in the design of new mDVs and evaluate their effectiveness in engaging and informing viewers. As mDVs continue to shape how data is consumed in mobile-first contexts, we urge designers, content creators, and researchers to consider not only how to make these videos popular or highly shareable, but also how to make them ethically responsible and socially effective. Our proposed design practices can be powerful tools—but like any tool, they can be misused. Future work should explore safeguards against such misuse and develop frameworks that support both engagement and cognitive value, ensuring that mDVs serve not just the interests of creators, but also the informational needs of society.

Acknowledgments

This research was supported by Mitacs through the Accelerate program. We gratefully acknowledge their funding and support. We also thank our partner organization, Provincial Health Services, for their collaboration and valuable contributions throughout the research. Special thanks to Charles-Olivier Dufresne-Camaro for his insightful feedback, which significantly enhanced the clarity and quality of this manuscript. We also extend our gratitude to the members of the OVI Lab for their ongoing support, feedback, and thoughtful discussions throughout the development of this work.

References

[1] Joachim Allgaier. 2019. Science and environmental communication on YouTube: Strategically distorted communications in online videos on climate change and climate engineering. *Frontiers in communication* 4 (2019), 36.

[2] Fereshteh Amini, Nathalie Henry Riche, Bongshin Lee, Christophe Hurter, and Pourang Irani. 2015. Understanding data videos: Looking at narrative visualization through the cinematography lens. In *Proceedings of the 33rd Annual*

ACM conference on human factors in computing systems. 1459–1468.
[3] Fereshteh Amini, Nathalie Henry Riche, Bongshin Lee, Jason Leboe-McGowan, and Pourang Irani. 2018. Hooked on data videos: assessing the effect of animation and pictographs on viewer engagement. In *Proceedings of the 2018 International Conference on Advanced Visual Interfaces*. 1–9.
[4] Fereshteh Amini, Nathalie Henry Riche, Bongshin Lee, Andres Monroy-Hernandez, and Pourang Irani. 2016. Authoring data-driven videos with dataclips. *IEEE transactions on visualization and computer graphics* 23, 1 (2016), 501–510.
[5] Reynold Andika, Chien T Kao, Christopher Williams, Young J Lee, Hassan Al-Battah, and Richard Alweis. 2021. YouTube as a source of information on the COVID-19 pandemic. *Journal of community hospital internal medicine perspectives* 11, 1 (2021), 39–41.
[6] Corey H Basch, Grace C Hillyer, Emily A Zagnit, and Charles E Basch. 2020. YouTube coverage of COVID-19 vaccine development: implications for awareness and uptake. *Human vaccines & immunotherapeutics* 16, 11 (2020), 2582–2585.
[7] BeSmart. 2022. Be Smart YouShorts. https://www.youtube.com/@besmart [Online; accessed 10-April-2023].
[8] GMI Blogger. 2024. Youtube Statistics 2024 (Demographics, Users by Country & More). https://www.globalmediainsight.com/blog/youtube-users-statistics/ [Online; accessed 12-April-2024].
[9] Ruochen Cao, Subrata Dey, Andrew Cunningham, James Walsh, Ross T Smith, Joanne E Zucco, and Bruce H Thomas. 2020. Examining the use of narrative constructs in data videos. *Visual Informatics* 4, 1 (2020), 8–22.
[10] Tser-Yieth Chen, Tsai-Lien Yeh, and Chin-I Chang. 2020. How different advertising formats and calls to action on videos affect advertising recognition and consequent behaviours. *The Service industries journal* 40, 5-6 (2020), 358–379.
[11] Xu Cheng, Jiangchuan Liu, and Cameron Dale. 2013. Understanding the Characteristics of Internet Short Video Sharing: A YouTube-Based Measurement Study. *IEEE Transactions on Multimedia* 15, 5 (2013), 1184–1194. https://doi.org/10.1109/TMM.2013.2265531
[12] Yanyan Chi and Eunil Park. 2022. Counterattacking long videos: exploring the characteristics of popular instant videos and roles of producers and viewers. *Library Hi Tech* ahead-of-print (2022).
[13] Eun Kyoung Choe, Yumiko Sakamoto, Yanis Fatmi, Bongshin Lee, Christophe Hurter, Ashkan Haghshenas, and Pourang Irani. 2019. Persuasive data videos: Investigating persuasive self-tracking feedback with augmented data videos. In *AMIA Annual Symposium Proceedings*, Vol. 2019. American Medical Informatics Association, 295.
[14] Neil Cohn. 2013. Visual narrative structure. *Cognitive science* 37, 3 (2013), 413–452.
[15] Jessica R Collier, Johanna Dunaway, and Natalie Jomini Stroud. 2021. Pathways to deeper news engagement: Factors influencing click behaviors on news sites. *Journal of Computer-Mediated Communication* 26, 5 (2021), 265–283.
[16] Brandy Drozd, Emily Couvillon, Andrea Suarez, et al. 2018. Medical YouTube videos and methods of evaluation: literature review. *JMIR medical education* 4, 1 (2018), e8527.
[17] Cameron Edmond and Tomasz Bednarz. 2021. Three trajectories for narrative visualisation. *Visual Informatics* 5, 2 (2021), 26–40.
[18] Teng-Kai Fan and Chia-Hui Chang. 2010. Sentiment-oriented contextual advertising. *Knowledge and information systems* 23 (2010), 321–344.
[19] Yu-Liang Feng, Chun-Chin Chen, and Shu-Ming Wu. 2019. Evaluation of charm factors of short video user experience using FAHP–A case study of Tik Tok App. In *IOP conference series: Materials science and engineering*, Vol. 688. IOP Publishing, 055068.
[20] Angel Fiallos, Carlos Fiallos, and Stalin Figueroa. 2021. Tiktok and Education: Discovering Knowledge through Learning Videos. In *2021 Eighth International Conference on eDemocracy & eGovernment (ICEDEG)*. 172–176. https://doi.org/10.1109/ICEDEG52154.2021.9530988
[21] Gustav Freytag. 1895. *Technique of the drama: An exposition of dramatic composition and art*. S. Griggs.
[22] L Galan, J Osserman, T Parker, and M Taylor. 2019. How young people consume news and the implications for mainstream media. Flamingo and Reuters Institute.
[23] Hao Gao, Hao Yin, Li Peng, and Han Wang. 2022. Effectiveness of social video platforms in promoting COVID-19 vaccination among youth: a content-specific analysis of COVID-19 vaccination topic videos on Bilibili. *Risk Management and Healthcare Policy* (2022), 1621–1639.
[24] Reed Schultz Geo. 2024. I never knew that Canada bordered another country. https://www.youtube.com/watch?v=SgXrItdmko0 [Online, Accessed 10-April-2024].
[25] Nahum Gershon and Ward Page. 2001. What storytelling can do for information visualization. *Commun. ACM* 44, 8 (2001), 31–37.
[26] Philip J Guo, Juho Kim, and Rob Rubin. 2014. How video production affects student engagement: An empirical study of MOOC videos. In *Proceedings of the first ACM conference on Learning@ scale conference*. 41–50.
[27] Shan Hao, Zezhong Wang, Benjamin Bach, and Larissa Pschetz. 2024. Design Patterns for Data-Driven News Articles. In *Proceedings of the CHI Conference on Human Factors in Computing Systems*. 1–16.
[28] Leslie J Hinyard and Matthew W Kreuter. 2007. Using narrative communication as a tool for health behavior change: a conceptual, theoretical, and empirical overview. *Health education & behavior* 34, 5 (2007), 777–792.

[29] Xiaofeng Zhou Jiaoju Ge, Yuepeng Sui and Guoxin Li. 2021. Effect of short video ads on sales through social media: the role of advertisement content generators. *International Journal of Advertising* 40, 6 (2021), 870–896. https://doi.org/10.1080/02650487.2020.1848986 arXiv:https://doi.org/10.1080/02650487.2020.1848986

[30] Andreas Krämer and Sandra Böhrs. 2018. *The Use of Explainer Videos as a Learning Tool: An Internal and External View*. Springer International Publishing, Cham, 189–202. https://doi.org/10.1007/978-3-319-62776-2_15

[31] Christoph Kulgemeyer and Cord H Peters. 2016. Exploring the explaining quality of physics online explanatory videos. *European Journal of Physics* 37, 6 (2016), 065705.

[32] Mingli Liu, Aixia Zhuang, Jill M. Norvilitis, and Tian Xiao. 2024. Usage patterns of short videos and social media among adolescents and psychological health: A latent profile analysis. *Computers in Human Behavior* 151 (2024), 108007. https://doi.org/10.1016/j.chb.2023.108007

[33] Gloria Mark. 2023. *Attention span: A groundbreaking way to restore balance, happiness and productivity*. Harlequin.

[34] Richard E Mayer. 2005. Principles of multimedia learning based on social cues: Personalization, voice, and image principles. *The Cambridge handbook of multimedia learning* (2005), 201–212.

[35] Richard E Mayer. 2013. Ten research-based principles of multimedia learning. In *Web-based learning*. Routledge, 371–390.

[36] Emily A Mendelson. 2023. Sensemaking and public intimacy on TikTok: How viral videos influence interpersonal relationships offline. *New Media & Society* 0, 0 (2023), 14614448231163231. https://doi.org/10.1177/14614448231163231 arXiv:https://doi.org/10.1177/14614448231163231

[37] Liqiang Nie, Meng Liu, and Xuemeng Song. 2019. Multimodal learning toward micro-video understanding. *Synthesis Lectures on Image, Video, and Multimedia Processing* 9, 4 (2019), 1–186.

[38] NVivo. 2023. NVivo Help — help-nv.qsrinternational.com. https://help-nv.qsrinternational.com/14/win/Content/welcome.htm [Accessed 12-08-2024].

[39] Itziar Oltra, Carmen Camarero, and Rebeca San Jose Cabezudo. 2022. Inspire me, please! The effect of calls to action and visual executions on customer inspiration in Instagram communications. *International Journal of Advertising* 41, 7 (2022), 1209–1234.

[40] James A Roberts and Meredith E David. 2023. Instagram and TikTok flow states and their association with psychological well-being. *Cyberpsychology, Behavior, and Social Networking* 26, 2 (2023), 80–89.

[41] Yumiko Sakamoto, Samar Sallam, Aaron Salo, Jason Leboe-McGowan, and Pourang Irani. 2022. Persuasive Data Storytelling with a Data Video during Covid-19 Infodemic: Affective Pathway to Influence the Users' Perception about Contact Tracing Apps in less than 6 Minutes. In *2022 IEEE 15th Pacific Visualization Symposium (PacificVis)*. IEEE, 176–180.

[42] Samar Sallam, Yumiko Sakamoto, Jason Leboe-McGowan, Celine Latulipe, and Pourang Irani. 2022. Towards Design Guidelines for Effective Health-Related Data Videos: An Empirical Investigation of Affect, Personality, and Video Content. In *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*. 1–22.

[43] Andreas Schellewald. 2021. Communicative forms on TikTok: Perspectives from digital ethnography. *International Journal of Communication* 15 (2021), 21.

[44] Anna Schorn. 2022. Online explainer videos: Features, benefits, and effects. *Frontiers in Communication* 7 (2022), 1034199.

[45] Edward Segel and Jeffrey Heer. 2010. Narrative visualization: Telling stories with data. *IEEE transactions on visualization and computer graphics* 16, 6 (2010), 1139–1148.

[46] Danqing Shi, Fuling Sun, Xinyue Xu, Xingyu Lan, David Gotz, and Nan Cao. 2021. Autoclips: An automatic approach to video generation from data facts. In *Computer Graphics Forum*, Vol. 40. Wiley Online Library, 495–505.

[47] Danqing Shi, Xinyue Xu, Fuling Sun, Yang Shi, and Nan Cao. 2020. Calliope: Automatic visual data story generation from a spreadsheet. *IEEE Transactions on Visualization and Computer Graphics* 27, 2 (2020), 453–463.

[48] Yang Shi, Xingyu Lan, Jingwen Li, Zhaorui Li, and Nan Cao. 2021. Communicating with motion: A design space for animated visual narratives in data videos. In *Proceedings of the 2021 CHI conference on human factors in computing systems*. 1–13.

[49] The Infographics Show. 2020. The Infographics Show Shorts. https://www.youtube.com/@TheInfographicsShow. [Online; accessed 10-April-2023].

[50] Xinhuan Shu, Aoyu Wu, Junxiu Tang, Benjamin Bach, Yingcai Wu, and Huamin Qu. 2020. What makes a data-GIF understandable? *IEEE Transactions on Visualization and Computer Graphics* 27, 2 (2020), 1492–1502.

[51] Tao Deng Shu-Chuan Chu and Juan Mundel. 2024. The impact of personalization on viral behavior intentions on TikTok: The role of perceived creativity, authenticity, and need for uniqueness. *Journal of Marketing Communications* 30, 1 (2024), 1–20. https://doi.org/10.1080/13527266.2022.2098364 arXiv:https://doi.org/10.1080/13527266.2022.2098364

[52] Aliaksandra Shutsko. 2020. User-Generated Short Video Content in Social Media. A Case Study of TikTok. In *Social Computing and Social Media. Participation, User Experience, Consumer Experience, and Applications of Social Computing*, Gabriele Meiselwitz (Ed.). Springer International Publishing, Cham, 108–125.

[53] John Sweller and Paul Chandler. 1991. Evidence for cognitive load theory. *Cognition and instruction* 8, 4 (1991), 351–362.
[54] Sean Tackett, Kyle Slinn, Tanner Marshall, Shiv Gaglani, Vincent Waldman, and Rishi Desai. 2018. Medical education videos for the world: an analysis of viewing patterns for a YouTube channel. *Academic medicine* 93, 8 (2018), 1150–1156.
[55] Junxiu Tang, Lingyun Yu, Tan Tang, Xinhuan Shu, Lu Ying, Yuhua Zhou, Peiran Ren, and Yingcai Wu. 2020. Narrative transitions in data videos. In *2020 IEEE Visualization Conference (VIS)*. IEEE, 151–155.
[56] Tan Tang, Junxiu Tang, Jiayi Hong, Lingyun Yu, Peiran Ren, and Yingcai Wu. 2020. Design guidelines for augmenting short-form videos using animated data visualizations. *Journal of Visualization* 23 (2020), 707–720.
[57] tiktok Newsroom. 2021. Thanks a billion! https://newsroom.tiktok.com/en-us/1-billion-people-on-tiktok [Online; accessed 10-April-2023].
[58] Secret to More Babies. 2024. Secret to More Babies. https://www.youtube.com/watch?v=5SQiRVFozT8 [Online, Accessed 10-April-2023].
[59] Vox. 2022. Vox Youtube Shorts. https://www.youtube.com/@Vox/shorts [Online; accessed 10-April-2023].
[60] Vox. 2022. Why trees matter in a warming world. https://www.youtube.com/watch?v=ACstD5GCfQY [Online, Accessed 10-April-2023].
[61] Vox. 2023. America's car crash epidemic. https://www.youtube.com/shorts/3dlZUlqda18 [Online, Accessed 10-April-2024].
[62] Vox. 2023. The largest animal migration on Earth. https://www.youtube.com/watch?v=RlWDsKrBqmE [Online, Accessed 10-April-2023].
[63] Qianwen Wang, Zhen Li, Siwei Fu, Weiwei Cui, and Huamin Qu. 2018. Narvis: Authoring narrative slideshows for introducing data visualization designs. *IEEE transactions on visualization and computer graphics* 25, 1 (2018), 779–788.
[64] Yunwen Wang. 2020. Humor and camera view on mobile short-form video apps influence user experience and technology-adoption intent, an example of TikTok (DouYin). *Computers in Human Behavior* 110 (2020), 106373. https://doi.org/10.1016/j.chb.2020.106373
[65] Yun Wang, Yi Gao, Ray Huang, Weiwei Cui, Haidong Zhang, and Dongmei Zhang. 2021. Animated presentation of static infographics with infomotion. In *Computer Graphics Forum*, Vol. 40. Wiley Online Library, 507–518.
[66] Wibke Weber. 2020. Exploring narrativity in data visualization in journalism. *Data visualization in society* (2020), 295–311.
[67] Wibke Weber, Martin Engebretsen, and Helen Kennedy. 2018. Data stories: Rethinking journalistic storytelling in the context of data journalism. *Studies in communication sciences* 2018, 1 (2018), 191–206.
[68] Yiling Wu, Xiaonan Wang, Skylar Hong, Min Hong, Meng Pei, and Yanjie Su. 2021. The relationship between social short-form videos and youth's well-being: It depends on usage types and content categories. *Psychology of Popular Media* 10, 4 (2021), 467–477. https://doi.org/10.1037/ppm0000292
[69] Carla A. Santos Xin Du, Toni Liechty and Jeongeun Park. 2022. 'I want to record and share my wonderful journey': Chinese Millennials' production and sharing of short-form travel videos on TikTok or Douyin. *Current Issues in Tourism* 25, 21 (2022), 3412–3424. https://doi.org/10.1080/13683500.2020.1810212 arXiv:https://doi.org/10.1080/13683500.2020.1810212
[70] Leni Yang, Xian Xu, XingYu Lan, Ziyan Liu, Shunan Guo, Yang Shi, Huamin Qu, and Nan Cao. 2021. A design space for applying the freytag's pyramid structure to data stories. *IEEE Transactions on Visualization and Computer Graphics* 28, 1 (2021), 922–932.
[71] Qian Yang, Zhihua Wu, Ying Xie, Xiaohua Xiao, Jinnan Wu, Tian Sang, Kejun Zhang, Haidong Song, Xifeng Wu, and Xin Xu. 2021. The impact of health education videos on general public's mental health and behavior during COVID-19. *Global health research and policy* 6 (2021), 1–11.
[72] Jie Zhao and Jianfei Wang. 2020. Health Advertising on Short-Video Social Media: A Study on User Attitudes Based on the Extended Technology Acceptance Model. *International Journal of Environmental Research and Public Health* 17, 5 (2020). https://doi.org/10.3390/ijerph17051501

Appendix

A Additional Content Related to Study 1

A.1 Final list of Videos

Table 3. A list of 40 YouTube shorts analyzed in study 1, *Note: video 26 is no longer available on YouTube.*

ID	Title	Link	Length	Channel	View Count
1	This is why Daylight Saving Time needs to GO	http://youtu.be/-H9zm0Tdpco	0:57	Be Smart	629,000
2	How far is a second?	http://youtu.be/1rL4k9Rjbuc	0:56	Be Smart	4,800,000
3	The US House Speaker drama, explained	http://youtu.be/oxgsOxc3_Q8	1:00	Vox	333,000
4	The largest animal migration on Earth	http://youtu.be/RlWDsKrBqmE	0:56	Vox	2,000,000
5	So where's that student debt relief?	http://youtu.be/4uXJHO-5tLs	0:59	Vox	253,000
6	How the Merchant of Death got his nickname	http://youtu.be/t6jm8m5PEZE	0:57	Vox	713,000
7	Why blackface is still part of Dutch holidays	http://youtu.be/TDA4HbuEcxM	0:58	Vox	5,300,000
8	The fusion breakthrough, explained in 60 seconds	http://youtu.be/7qnapmKaeDY	0:56	Vox	257,000
9	The 2026 World Cup has a huge math problem	http://youtu.be/-nHLjWXIcXs	0:59	Vox	4,000,000
10	Every 2022 World Cup penalty shootout, tracked	http://youtu.be/RcPDE7OhbNw	1:00	Vox	180,000
11	Why Moroccan football fans dress up as lions	https://youtu.be/jAr9d1yBxow	0:55	Vox	124,000
12	4 keys to Morocco's success in the World Cup	https://youtu.be/VcyjP9-1gR8	0:55	Vox	439,000
13	Why population pyramids aren't always pyramid-shaped	https://youtu.be/paEoh6yxvv0	0:52	Vox	2,100,000
14	Why trees matter in a warming world	https://youtu.be/ACstD5GCfQY	0:59	Vox	1,300,000
15	How did turkeys get so big	https://youtu.be/XvgI0uCZAFE	0:50	Vox	156,000
16	Disney's Bob CEO drama, in one chart	https://youtu.be/RcJKtSIkdeQ	0:42	Vox	335,000
17	The chart that explains the 2022 US election	https://youtu.be/zFSHSwV6zCY	0:59	Vox	4,000,000
18	The surprising reason we call each other "guys"	https://youtu.be/eUvBuD5MjrQ	0:52	Vox	1,100,000
19	Military Comparison - Iran vs Saudi Arabia	https://youtu.be/HMWlPL45sgg	0:59	The Infographics Show	84,000
20	Why American and European Trucks Are So Different	https://youtu.be/bZqDQrvSTlk	0:57	The Infographics Show	2,100,000
21	What If the Pacific Ocean Disappeared	https://youtu.be/V1Sh52PGPrU	0:59	The Infographics Show	74,000
22	All of the top three countries blew my mind	https://youtu.be/_yDi1YgyVN4	0:52	Reed Schultz Geo	7,600,000
23	US vs China: Military Bases - How Do They Compare?	https://youtu.be/N53NuZC8lRg	0:56	The Infographics Show	605,000
24	How North Korea Defends Its Border	https://youtu.be/bEawjck5Zt0	0:56	The Infographics Show	224,000
25	I never knew that Canada bordered another country	https://youtu.be/SgXrItdmko0	0:49	Reed Schultz Geo	8,100,000
26	The Most Massive Organism To Ever Live	https://youtu.be/wfShixEZdkM	0:56	Think Grow Successful	4,500
27	The Weirdest Island on Earth!	https://youtu.be/Jv_oWG4U1Hg	0:58	The Curious Pod	N/A

Table 3. A list of 40 YouTube shorts analyzed in study 1, *Note: video 26 is no longer available on YouTube.*

ID	Title	Link	Length	Channel	View Count
28	Secret to More Babies	http://youtu.be/5SQiRVFozT8	0:59	Facts Matter with Roman Balmakov	914,000
29	The Difference Between Strategic and Tactical Nuclear Bombs	https://youtu.be/gAOLzJaojt8	0:58	The Infographics Show	150,000
30	What Happens to Plastic in the Ocean?	http://youtu.be/fE6TbXCJ8q4	0:54	Neo	28,000,000
31	What Borders Would Look Like AFTER WW3	https://youtu.be/-ilUHLfMSbA	0:58	The Infographics Show	4,000,000
32	The Most Inaccessible Place In The World	https://youtu.be/Pn0CpRnrE0Q	0:54	Think Grow Successful	9,000,000
33	Who will be the first person to claim this land?	https://youtu.be/soZhSWkrtTU	0:52	Reed Schultz Geo	3,600,000
34	Earth's Secret 8th Continent (EXPLAINED)	http://youtu.be/pvfzsETlEjM	0:26	Zack D. Films	14,600,000
35	Why Does Russia own this Old Piece of German Land?	https://youtu.be/7VrRDGyueXI	0:51	Reed Schultz Geo	5,800,000
36	I never knew this about Western Sahara	https://youtu.be/7Wt5HIGgQPY	0:55	Reed Schultz Geo	6,700,000
37	The history of the "cure chair"	http://youtu.be/Mcetu_75Dak	0:59	Vox	478,000
38	How Long is a Trip to Mars?	https://youtu.be/ogffasPum14	0:59	Good to Know	24,000,000
39	The British Tank That's Never Been Defeated	http://youtu.be/7cOpugyCF7E	0:54	The Infographics Show	330,000
40	Why China still uses spy balloons	http://youtu.be/WA7OjYIdpzI	0:59	Vox	976,000

A.2 Distribution of Data Visualizations and Attention Ques Observed in the coded 40 Videos

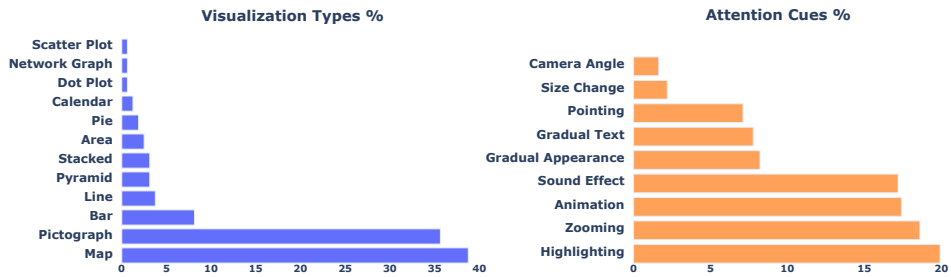

Fig. 10. Study 1: Percentage of coded visualization types (Left), and attention cue types (Right). Maps, pictographs, and bar charts are the most commonly used data visualization types. We attribute the higher use of maps to the nature of four videos that are published by a channel focusing on educational videos on geography. Attention Cues that required more time like camera angle, size change, and gradual appearance were less frequent.

A.3 Distribution of the Narrative Categories and the Linker

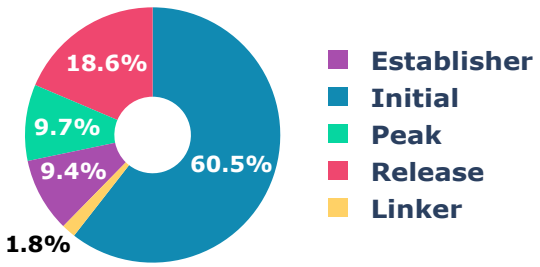

Fig. 11. Study 1: Proportion of average duration of narrative categories in addition to the newly observed element (Linker) to the total video duration. More than half of the video time (60%) is spent in the initiation phase or the Initial.

A.4 The Final Codebook

Table 4. The Final Codebook used to analyze the storyboarding process in Study 2.

1. Read and understand the data (Data/information familiarization activities)		**This is more like an exploration or preparation stage, in which participants (i.e., video designers) go through the provided information and material to gain an understanding on the topic or search for specific data/information to support the narrative**
1.1	Explore the provided data and information	go through the provided information and material to gain an understanding on the topic or identify potential facts to be included
1.2	Read data and information in search for a hook	Go through the provided material specifically to find ideas for a hook to grab viewers' attention
1.3	Read for supporting data or information	Go through the provided material in search for evidence to support a claim or idea or provide examples
1.4	Lookup additional data or information	using external resources to lookup or gain additional information (e.g., using ChatGpt, or browsing the internet). This includes browsing the provided links for more information
2. Select data/information and corresponding visualization from the given sheet (Information and data selection activities)		**Decisions to select or discard specific pieces of information or data facts as well as decisions and discussions on the data visualization type to be used. While this is closely coupled with the "Read and Interpret Data" activity, activities in this category always include decisions about specific facts whether to include or discard them and/or how to visualize them while the aim of "Read and Interpret" is just to explore and gain knowledge about the topic and the available facts.**
2.1	Select data and/or visualizations	Select specific data fact(s) of interest (could be in the data facts sheet, looked up, or made up) and make the choice to include them in the storyboard . This is different from the initial data exploration stage as the aim of this activity is a selection of specific data fact(s) vs exploring all fact list. This also includes choosing and deciding visualization types for a selected data facts.
2.2	Select information	Select a specific piece of information of interest and make the choice to include them in the storyboard and discuss ideas on their corresponding visuals
2.3	Avoid certain facts or information	Decisions to specifically avoid using certain facts or data (e.g., avoid using negative information like risks)
3. Craft the Narrative		**Activities related to coming up with the overall storyline via putting together and arranging the content. This includes but not limited to 1) selecting the overall theme 2) createing a meaningful transition between scenes 3) deciding on the hook or the opening scene as well as the ending 4) discussing strategies for data fact usage or different elements of the video**
3.1	High level narrative planning	
	3.1.1 Discuss/decide the message framing (positive vs. negative)	Discussions around the general framing of the video message whether positive or negative (e.g., deciding to avoid negative information, disturbing visualizations)
	3.1.2 Discuss the take-away, goal or main message	Discussions regarding the take-away message. This is when participants engage in discussions related to what they want this video to convey or what should the viewers get or learn by the end of the video. This usually happens in the planning phase or when they are selecting what information to include.
	3.1.3 Set the target audience	Discussions related to selecting the target audience
	3.1.4 Discuss/identify tailoring strategies to target audience	Discuss/identify strategies to tailor the video content to target audience
	3.1.5 Plan the overall storyline/narrative	Brainstorm, plan or outline the overall story flow or narrative
	3.1.6 Discuss/identify the general or logical flow of the narrative	Working on or planning the flow of the video storyline. This includes discussing the logical transition or connections between scenes (e.g., adding scenes; adjusting the visuals; or narrative transition; or even transition effects to maintain a logical connection and flow)
3.2	Actvities surrounding story elements	Activities related to discussing and identifying potential content for different video elements (e.g., the hook, peak, introduction, ending, call to action, title, linker, etc.) These set of activities include times when participants planning how to approach different narative components
	3.2.1 Discuss/identify the hook or content for starting scene	Discussions and/or brainstorming ideas around starting the video with a hook or attention grabber
	3.2.2 Discuss the introduction	Discussions surrounding the inclusion of an introduction to the topic
	3.2.3 Discuss/Identify content for the peak	Discussions around having a peak or tension raising content and/or brainstorming and discussing ideas and potential content for the story peak
	3.2.4 Discuss/add linker	Discussions and/or addition of a link to external resources
	3.2.5 Discuss/add call to action	Discussions around having some sort of call to action related content
	3.2.6 Brainstorm ideas for video title	Brainstorm and discuss ideas for the title of the video
	3.2.7 Discus the video ending	Brainstorm and discuss ideas for the ending scene or the end of the video
3.3	Discussions of strategies and styles to use for different video elements	Development of strategies as well as discussions on different video aspects based on participants' own experiences and views
	3.31 Narrator's style and tone	Discussions around the narrator (e.g., tone of voice and style such as the use of human voice vs. robotic voice; positive/ and calm tone vs. alarming)
	3.3.2 Subtitles	Discussions around the use and role of subtitles
	3.3.3 Video pacing	Discussions around the recommended pace of the video in terms of the speed and flow of the information
	3.3.4 Data facts and visualizations Style	Discussions around tips on data facts (numerical) such as the frequency of data facts as well as how they should be styled. This also includes discussions about the overall visual style to use in the video

3.4	Work on the storyboard content	Activities related to translating the narrative ideas into actual content to be added to the storyboard (writing and/or drawing) or revising existing content
	3.4.1 Discuss and add audio narration	Discussing and adding what the video narration or spoken words should be at a specific scene and writing it down on the storyboard
	3.4.2 Discuss and add visuals or descritption of the visuals	Discussions around specific scene visuals as well as implementing or actually drawing them on the storyboard. This includes data visualizations as well as drawings and sketches. This activity includes importing any images/ graphs or visual content to the storyboard
	3.4.3 Consult the outline to move on with the content	Get back and consult the outline while working on filling in the storyboard content to see what should come next
	3.4.4 Review/ Revise the generated narrative	This usually takes place when few scenes or frames are already created or when the storyboard is entirely done. Participants go back and check the generated content thus far and sometimes make modifications
4. Engage Viewers		**Discussions and design techniques related to engaging viewers (not about the story content per se); such as the addition of animation, sound effects, BG music or various visual/auditorial effects.**
4.1	Discuss and/or add animations-visual effects	Activities related to discussing and/or adding various animations and visual styles
4.2	Discuss and/or add BG music	Activities related to discussing and/or adding background music as well as discussions
4.3	Discuss and/or add sound effects	Activities related to discussing and/or adding sound effects

B Additional Content Related to Study 2

B.1 Information Sheet Used in the Study

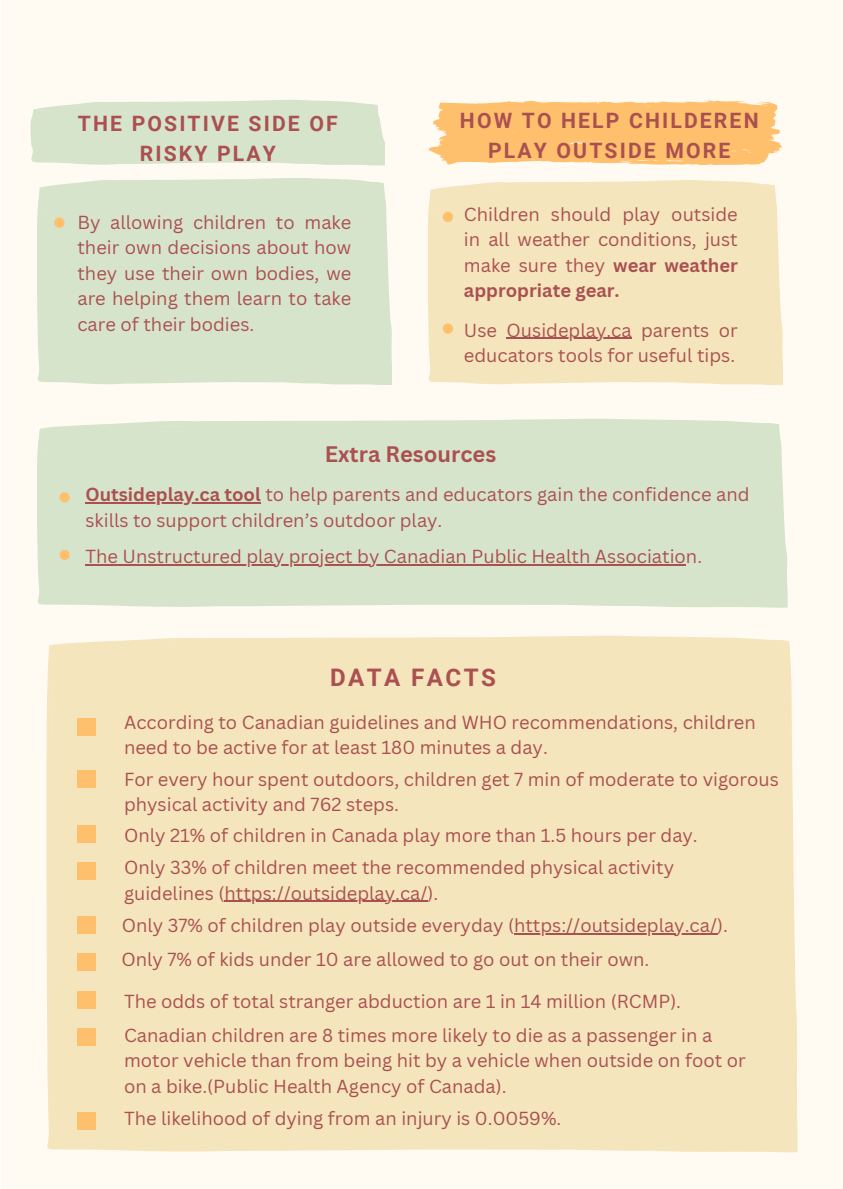

Fig. 12. Information sheet provided to participants at the start of the mDV design session in Study 2

B.2 Final Codebook for the ”Linker” Analysis

Table 5. The final outcome of the analysis of the ”linker”

A. Functions and Goals		
A.1. Content Type		**Defines what the linker conveys**
A.1.1	Call-to-Action (CTA)	Direct instructions (e.g., ”Subscribe,” ”Follow us”)
A.1.2	Resource Links	Additional content related to the video
A.2. Goals or Aims		**The purpose of the linker**
A.2.1	Retention and Channel Growth	Keep viewers in the ecosystem
A.2.2	Knowledge or Resource Sharing	Provide additional value or learning through a third party
A.2.3	Cross-Platform Traffic	Direct viewers to other platforms affiliated with them
B. Visual Characteristics		
B.1. Placement		**Where the linker appears**
B.1.1	Overlay	On-screen during the video’s final moments
B.1.2	Dedicated End Screen	Specific section for linkers (e.g., last 5–10 seconds)
B.2. Visual Representation		**How the linker is displayed**
B.2.1	Text-Based	Static or dynamic text overlays
B.2.2	Iconography	Buttons, logos, or icons
B.2.3	Thumbnails/Previews	Links with visuals from other content
B.2.4	Animated Elements	Moving or eye-catching visuals
C. Audio Support		
C.1. Presence of Narration		**Presence of audio narration accompanying the visual link/icon (e.g., ”subscribe to our channel” or ”check out this website for more information”)**
C.1.1	Present	
C.1.2	Absent	
D. Methods of Engagment and Relavance		
D.1. Engagement Mechanism		**How viewers interact with the linker**
D.1.1	Clickable Links	Embedded links within the video
D.1.2	QR Codes	Scannable codes for external access
D.1.3	Contextual Anchored Prompts	Visual cues pointing to platform elements (e.g., arrows toward the subscribe button below)
D.2. Relevance of Content		**The relationship between the linker’s content and the video’s core content**
D.2.1	Directly Relevant	Tightly connected to the video’s topic, narrative, or purpose (e.g., A tutorial video linking to supplementary materials or a related lesson)
D.2.2	Contextually Related	Related to the creator or channel (e.g., Suggesting a playlist of similar videos or a general ”Subscribe for more.”)

B.3 Data Visualization Type and Attention Cue Distribution

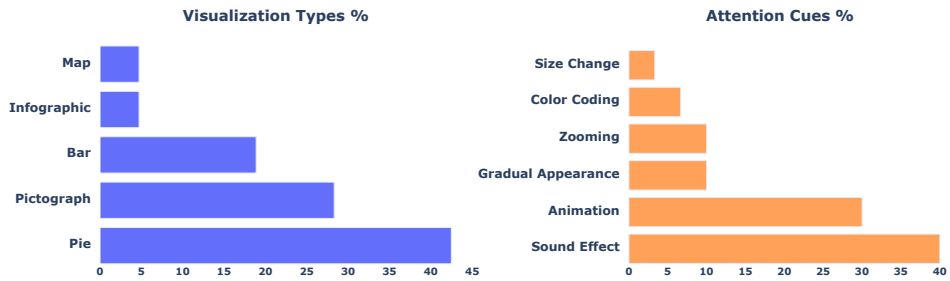

Fig. 13. Study 2: Distribution of data visualization types (left) and attention cue types (right) in the generated storyboards.