# FeelTheNews: Augmenting Affective Perceptions of News Videos with Thermal and Vibrotactile Stimulation


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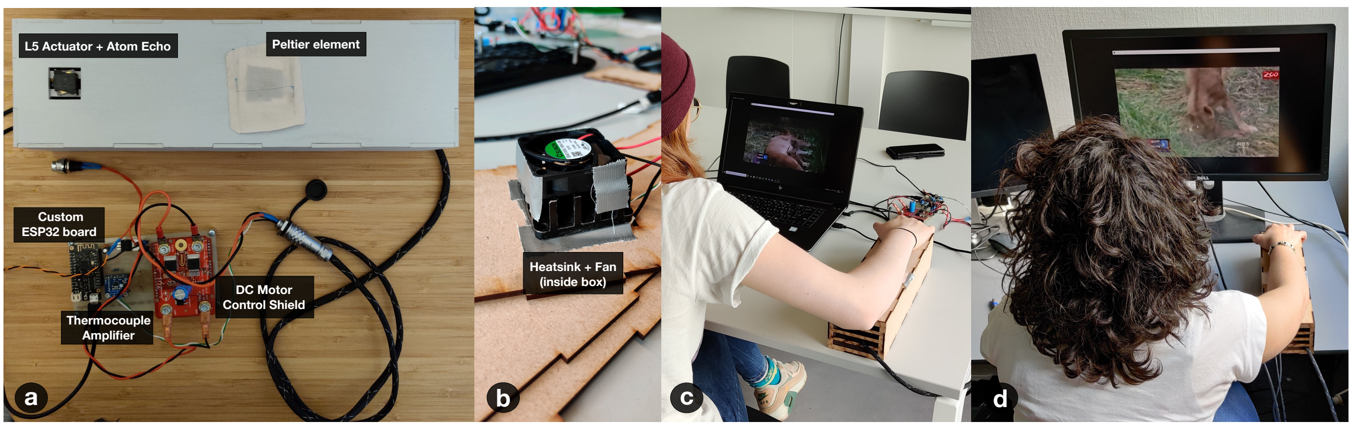


**Figure 1: (a, b) FeelTheNews hardware components. (c, d) Pilot participants experiencing the FeelTheNews prototype.**


## ABSTRACT

Emotion plays a key role in the emerging wave of immersive, multi-sensory audience news engagement experiences. Since emotions can be triggered by somatosensory feedback, in this work we explore how augmenting news video watching with haptics can influence affective perceptions of news. Using a mixed-methods approach, we design and evaluate FeelTheNews, a prototype that combines vibrotactile and thermal stimulation (Matching, 70Hz/20° C, 200Hz/40° C) during news video watching. In a within-subjects study (N=20), we investigate the effects of haptic stimulation and video valence on perceived valence, emotion intensity, comfort, and overall haptic experiences. Findings showed: (a) news valence and emotion intensity ratings were not affected by haptics, (b) no stimulation was more comfortable than including stimulation, (c) attention and engagement with the news can override haptic sensations, and (d) users' perceived agency over their reactions is critical to avoid distrust. We contribute cautionary insights for haptic augmentation of the news watching experience.



## CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**; *Haptic devices.*

## KEYWORDS

news, haptics, emotion, thermal, vibrotactile, journalism

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## 1 INTRODUCTION

What happens if we enable people to "feel" the news, not just "hear or read" the news? We are entering a technological wave where the news user experience is transforming through the emergence and adoption of immersive, interactive, and multi-sensory experiences [19, 39, 49]. This straddles multiple facets of journalism, including storytelling, empathy, the reality-virtuality divide, and new



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forms of interactivity [48], where it is now accepted that quality journalistic reporting and editing has emotion at its core [8]. In this emotion space, digital platforms and social media can enable new affordances when engaging with the news [38, 41, 55], beyond user engagement and affective interactions with internet videos [7]. Given this key role for emotion, it is essential to highlight that emotions can be triggered by somatosensory feedback, where such feedback spans tactile perception and thermoception (cf., embodied emotion theories [37]). Both modalities of thermal and vibrotactile stimulation indeed have a rich history in Human-Computer Interaction (HCI), with links to emotion perception and processing. Thermal sensation is a fundamental part of sensory and perceptual experience [31], where thermal stimulation has association with human emotion [15, 16, 44, 52, 58]. Similarly with haptic (touch) stimulation, where several studies have shown associations with emotion and affective ratings [32, 33, 43, 47], and has the capacity to promote empathy [27]. Given the foregoing, this work explores how augmenting news consumption experiences with haptics can influence our affective perceptions of news, and potentially enhance empathic reactions.

In this work, we adopt an exploratory, mixed-methods approach to better understand whether haptic displays, specifically thermal and vibrotactile stimulation, influence our affective perception of news videos. We ask: **(RQ)** What are the effects of combined vibrotactile and thermal stimulation on affective perception augmentation of news videos? In a within-subjects experiment (N=20), we investigate the effect of haptic stimulation (None vs. Matching vs. 70Hz/20°C vs. 200Hz/40°C) and video valence (Positive, Neutral, Negative) on perceived valence, emotion intensity, stimulation comfort, and overall haptic experiences during news video watching. We contribute insights and design considerations for haptic augmentation of news watching experiences across thermal and vibrotactile modalities.

# 2 RELATED WORK

## 2.1 Emerging immersive and multi-sensory journalistic media experiences

Incorporating novel media technology, such as haptics, into news consumption and delivery is at its infancy. Trattner et al. [53] highlight that tomorrow's media experiences will increasingly combine smart sensors with artificial intelligence and personal devices to increase engagement and collaboration with the news, where it is paramount to consider what makes for accurate, impartial and transparent journalistic endeavors [1]. Similarly, Pavlik [39] discusses the news user experience, which will be redefined by the emergence and adoption of immersive, interactive, and multi-sensory experiences. Indeed, this current new wave of immersive technologies will straddle several aspects of journalism, including storytelling, empathy, the reality-virtuality continuum, along with novel forms of interactivity [48]. Furthermore, Järvelä et al. [24] investigated how immediate media experience predicts future news reading, and found that news sections were differentiated by self-reported emotional responses, among other factors (e.g., relevance to the user and interestingness). Lastly, Bakker et al. [6], in studying affective responses to political rhetoric, showed that affective responses lead to opinion change, independent of self-reported emotions. These works underscore the importance of emotion, and how new forms of journalism can influence such affective responses to the news. Although haptic vibration stimulation has shown to be promising in enhancing short scenery clips [34] and for animation and movie videos [14], to our knowledge there is no work to date that investigated haptic experience with news videos. To this end, we draw on Samide et al.'s [46] database of news videos, which contain continuous valence ratings.

## 2.2 Haptic stimulation and emotion perception

Within thermal stimulation research, prior work has shown that warm temperatures are generally described as comfortable and pleasant [28] and promoting social proximity [23], while cold temperatures are often perceived as uncomfortable [50]. Similarly, research has shown that warmth is associated with positive feelings and coldness with negative feelings when low to moderate changes in temperature are applied [16, 58]. Specifically, Salminen et al. found that a 6°C change in temperature (especially when warm) was rated as unpleasant, arousing, and dominant, while a 4°C increase was still rated as arousing and dominant but pleasant [45]. With respect to vibrotactile feedback, Yoo et al. [61] found that constant vibration frequency on the hand can affect valence ratings, with high frequencies of 200-300Hz resulting in higher valence ratings and lower frequencies of 60Hz resulting in lower valence ratings. Wilson and Brewster [56] found the opposite effect when testing vibration in isolation, with no correlations to valence ratings when adding thermal stimuli. Furthermore, Macdonald et al. [32] found that emotionally resonant vibrations were generally perceived as positive, partly due to vibration familiarity. Lastly, Seifi and MacLean [47] found that on-hand vibrations with smooth and rhythmic patterns were perceived as positive, while rough and strong vibrations were perceived as more negative (alarming). Lastly, Yoo et al. [60] combined vibrations with thermal stimuli, using two vibration frequencies: 70Hz and 200Hz vibrations. They found that 200Hz vibrations were perceived as having higher valence than the lower 70Hz frequency vibrations, when combined with thermal stimuli across 20°C, 30°C, and 40°C. Furthermore, Jones and Singhal [26] have found that warming the skin influences the ability to identify vibration patterns. Given our aim of eliciting haptic sensations (thermal and vibrotactile) in relation to news video watching, we draw on Yoo et al. [60]'s parameters to elicit ratings across low and high valence.

# 3 METHODOLOGY

## 3.1 News video dataset

We select news videos from Samide et al.'s [46] database of news videos, which aimed to study the dynamics of emotion and memory. Importantly, videos in this dataset were continuously annotated for valence on a 9-point Likert-scale (1-"extremely unpleasant" to 9-"extremely pleasant"), which closely relates to the common Self-Assessment Manikin (SAM) [9] scale. In their annotation setup, the dynamic valence slider started at a random scale position in each trial, where participants adjusted the slider as quickly as possible to reflect their ongoing impression of the video. Slider position was sampled every 100ms, with later analysis downsampled to a rating every 500 ms, for obtaining a mean valence rating across participants for each video. Videos were gathered from a television news archive[1] using a range of negative and positive keywords, where each video was rated by 50 participants. Videos were manually filtered to remove any with low resolution, any containing an event similar to other videos, and any with highly familiar, international news stories. All selected videos contained some visual footage of the event. Videos were trimmed to be between 20 and 52 s in duration, where videos were 640 pixels in width, and 360-480 pixels in height. From this database, we selected 12 videos: four with low mean valence ratings, four with moderate (neutral) mean valence ratings, and four with high mean valence ratings. The videos were additionally selected to address similar topics, with arousal ratings that are as similar as possible. These videos are shown in Supplementary Material A.

## 3.2 Hardware and software

*3.2.1 System description.* We used Peltier elements (TEC1-12706 thermoelectric modules) as primary thermal actuators, as they are capable of providing fast changes in temperature for generating cool or warm stimuli, as in previous research [16, 21, 40]. Following prior work [16], we forego the PID controller when the Peltier element reaches a setpoint, and instead apply a constant maximum output value to drive the element until it reaches the target temperature. This ensured a Rate of Change of 1° C/s. Since this higher output value means a higher current is needed, we use a DC motor driver. To avoid the increased heat generated due to resistance, we use only 7.5V. System components include a custom ESP32 microcontroller, a 3.3V regulator, Adafruit 1-Wire Thermocouple Amplifier (MAX31850K)[2], a K-type thermocouple, Infineon DC Motor Control Shield BTN8982TA[3], and a Peltier element attached to a heat sink and cooling fan, which connects to a laptop through a Serial (RS-232) to USB cable with 115200 baud rate. For vibrotactile feedback, we used a Lofelt L5 Actuator[4] wired to an M5STACK Atom Echo[5] smart speaker. Vibration stimuli were connected to the Atom Echo via Bluetooth, where mp3 files were sent directly from the laptop running a Processing script, which controlled stimuli presentation order. The hardware was placed beneath an MDF box, where only the vibration and thermal stimulation can be felt (see Fig. 1 a,b).

## 3.3 Stimuli design

Haptic perception with thermal and vibrotactile stimulation can have varying sensitivities depending on the site of body stimulation. Furthermore, there are considerations of the influence of fabrics, spatial separation of modalities, ergonomics of video watching, and acceptability of social touching on the body [51]. To this end, we draw on Zeagler's [62] functional and technical considerations for on-body wearables, and prior work [32, 40, 56], where we apply vibrotactile stimulation to the palm and thermal stimulation to the forearm (Figure 1(c,d)). For creating the stimuli, we drew on prior work to create three types of stimulations: (1) Matching (2) 70Hz/20°C (3) 200Hz/40°C.

*3.3.1 Matching.* Given the continuous valence ratings (sampled every 100ms) for news videos [46], we tested direct mappings between ratings and actuation parameters. For thermal, we based this on previous work on isolated thermal stimuli that found (with exception of [60]) that warm temperatures correspond to higher valence ratings and cold temperatures to negative valence [44, 45, 57], and that vibrations people resonate with are perceived as positive [32]. For positive videos, we mapped valence ratings to warm stimuli (40° C), and to cold temperatures (20° C) for negative videos. For vibrotactile stimulation, we directly map the video audio to vibrations (0.3 amplitude) using Audacity.

*3.3.2 Thermal-Vibration stimuli.* As mentioned (cf., Sec 2.2), Yoo et al. [60] combined vibrations with thermal stimuli, where they used two vibration frequencies: (a) 70-Hz vibrations, which are largely mediated by the rapidly adapting channel and provide low-frequency, fluttering sensations [11]. (b) 200-Hz vibrations, which were representative of smooth tactile stimuli mediated through the Pacinian corpuscle channel [18]. They found that 200Hz vibrations were perceived as having higher valence than the lower 70Hz frequency vibrations, when combined with thermal stimuli across 20°C, 30°C, and 40°C. Given this, we test two combinations of vibration (with 0.3 amplitude) and thermal stimuli: 70Hz/20°C (negative) and 200Hz/40°C (positive). While affective associations for thermal stimuli have high variance across prior works, values of 20°C and 40°C were deemed suitable in our own tests, especially considering that the fabric layer above the Peltier element would maintain comfort [22].

## 3.4 Study design and procedure

Our experiment is a 4 (Stimulation: None vs. Matching vs. 70Hz/20°C vs. 200Hz/40°C) x 3 (Video Valence: Positive vs. Neutral vs. Negative) within-subjects design, tested in a controlled, indoor environment (Figure 1(c,d)). This resulted in 12 conditions, which were counterbalanced using a Latin Square design. We measured: (a) Perceived valence (cf., [46]) on a 9-point Likert-scale (1-"extremely unpleasant" to 9-"extremely pleasant") (b) Perceived emotion intensity (arousal) on a 9-point Likert-scale (1-"not at all intense" to 9-"extremely intense") (c) Perceived stimulation comfort on a 9-point Likert-scale (1-"not at all comfortable" to 9-"extremely comfortable") (d) News video familiarity (e) Comfort Rating Scale (CRS) [29, 30] to assess overall perceived comfort of FeelTheNews (Cronbach's $\alpha$=0.6) (f) Room and skin temperature before the session begun (g) consensually audio-recorded semi-structured interview asking participants about their experiences with haptic augmentation of news videos (see Supplementary Material A). Our study followed strict guidelines (with approval) from two institutes' ethics and data protection committee, including COVID-19 regulations.

Our study procedure is shown in Fig. 2, where study duration was ~60 min. Participants first read the instructions, filled in their demographics, signed the consent form, and were explained the procedure. They were guided to place their arm on the MDF box,

[1]https://archive.org/details/tv
[2]https://learn.adafruit.com/adafruit-1-wire-thermocouple-amplifier-max31850k/wiring-and-test
[3]https://www.infineon.com/cms/en/product/evaluation-boards/dc-motorcontr_btn8982/
[4]https://e2e.ti.com/cfs-file/__key/communityserver-discussions-components-files/6/Lofelt-L5-Actuator-Datasheet.pdf
[5]https://github.com/m5stack/ATOM-ECHO

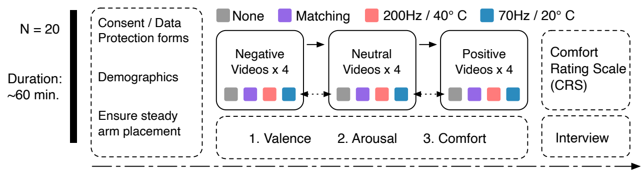



**Figure 2: Study procedure.**

ensuring their palm was on the vibration actuator and forearm on the Peltier element. Afterward, they clicked play to start the video on each trial. Video audio was kept at a constant volume so the (minimal) noise from the vibration actuator and DC motor were inaudible. After each trial, they answered questions on their perceived valence, intensity, comfort, and video familiarity. Answering questions took >10 seconds (cf., delays between 10 sec [57] to two minutes [22]) to avoid thermal adaptation [25]). Lastly, participants filled in the CRS form, underwent a semi-structured interview, and were rewarded with a €10 voucher for participating.

## 3.5 Participants

20 participants (11m, 9f) aged 22-69 (Md=26, IQR=6.75) were recruited based on apriori power and effect size[6]. Several were students, recruited from different institutes. Average room temperature was 23.14°C (SD=1), and average skin temperature was 30.4°C (SD=1.34). Seven participants reported sometimes watching the news, six reported several times per week, three reported daily, three never, and one watched once per week. Lastly, most had never seen or heard of the story (80%), a few found the story familiar but had not seen this footage (18%), and the remainder saw the exact footage.

# 4 RESULTS

## 4.1 Perceived emotion and comfort ratings

We analyzed the combined effects of Stimulation and Video Valence on participants' valence, intensity, and comfort ratings, by fitting a full linear mixed-effects model on each dataset. Since our data distribution for each was not normal, we applied the aligned rank transform prior to fitting [59]. Post-hoc contrast tests were performed using ART-C [17].

*4.1.1 Perceived valence.* Valence ratings for each stimulation condition across video valence (negative, neutral, positive) are shown as boxplots in Fig. 3. Analysis of deviance model showed significance for Video Valence ($F_{1,2} = 178.37, p < .001$), but not for Haptic Stimulation ($F_{1,3} = 0.017, p = 0.99$) nor interaction effects ($F_{1,6} = 0.54, p = 0.78$). Post-hoc contrasts details provided in Supplementary Material B.

*4.1.2 Perceived emotion intensity.* Emotion intensity ratings for each stimulation condition across video valence (negative, neutral, positive) are shown as boxplots in Fig. 4(a-c). Analysis of deviance model showed significance for Video Valence ($F_{1,2} = 115.76, p < .001$), but not for Haptic Stimulation ($F_{1,3} = 0.94, p = 0.42$) nor interaction effects ($F_{1,6} = 0.44, p = 0.85$). Post-hoc contrasts details provided in Supplementary Material B.

*4.1.3 Perceived comfort.* Since our focus here is on stimulation comfort, we analyze per stimulation condition only, and not video valence. Comfort ratings across each condition are shown as boxplots in Fig. 4(d). Analysis of deviance model showed significance for Haptic Stimulation ($F_{1,3} = 5.13, p < .05$). Post-hoc contrasts revealed significant differences only for None-Matching, None-200Hz/40°C, and None-70Hz/20°C. Details provided in Supplementary Material B.

*4.1.4 Comfort Rating Scale (CRS).* For each CRS subscale [29, 30], the lower the score, the more it contributes to overall subjective comfort. Results for each factor are: Emotion (Md=2, IQR=2.5), Attachment (Md=15.5, IQR=10.5), Harm (Md=5.5, IQR=8.25), Perceived Change (Md=13.5, IQR=7.25), Movement (Md=14, IQR=6.5), Anxiety (Md=4.5, IQR=6.5).

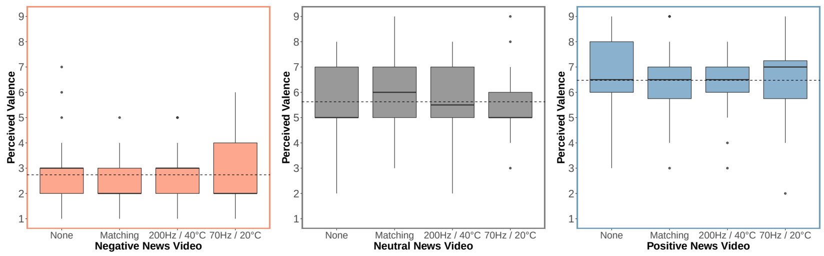
## 4.2 Interviews

We analyzed the data with inductive thematic analysis [10, 12]. First we coded it according to evoked topics. Then within each topic we analyzed emerging themes. Participants are labeled P1-P20.

*4.2.1 Awareness of thermal and vibrotactile stimuli.* Participant's experience of both thermal and vibrotactile stimuli were highly context- and person-dependent. For instance, "when you see something shocking you also physically react to it, maybe you already get a bit hotter" (P6), meaning that heat by the system may not be felt as hot enough due to one's body temperature changing. Some participants did not notice changes, e.g., "I didn't really notice the vibration. I noticed the temperature..." (P16) versus "I didn't feel the temperature much. The vibration I felt" (P15). This could be due to individual sensitivity variations, but another reason can be people's level of immersion or concentration while watching. P5 states "I was completely busy watching the video. [So] I did not feel the heat or the cold. I felt the vibrations sometimes but it did not bother me". This heightened attention may have reduced their peripheral attention to the stimulation. However even if not cognitively noticeable, participants could still experience visceral reactions: "I did not notice the thermal thing as much, so I did not feel it to be very comfortable or uncomfortable in that sense. When I felt the cold I was a bit annoyed because I thought "this induces some kind of feeling in me"" (P10). Therefore, some people may not be aware of changes in vibration or heat, but they may also **not want to be aware** of changes in modality. This suggests that becoming aware of and integrating newly added sensations should be an **active choice**.

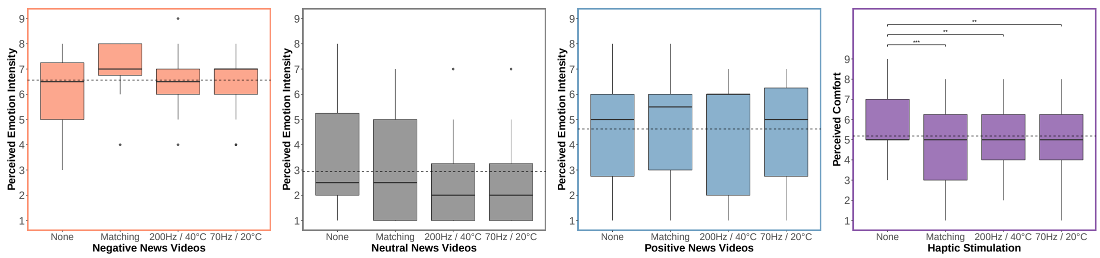
*4.2.2 Responsibly targeting emotion stimulation.* Interpersonal variation is expected when it comes to what exactly consists of targeted emotions via thermal and vibrotactile stimuli, for whom and why. "Some people say that they have a hard time connecting to their emotions. [...] I can imagine it being really useful for someone to get a really full experience" (P16). If some people are emotionally "numb", finding new ways to feel, such as with thermal and vibrotactile stimuli, can be a driver. People can be trained to map temperature or tactile feedback to be interlinked with emotions: "It

[6] For effect size f=0.25 under $\alpha = 0.05$ and power (1-$\beta$) = 0.95, with 12 repeated measurements within factors, we need 18 participants.




(a) Valence x Negative news video (b) Valence x Neutral news video (c) Valence x Positive news video

**Figure 3**




(a) Intensity x Negative news video (b) Intensity x Neutral news video (c) Intensity x Positive news video (d) Trial-wise perceived comfort

**Figure 4**

needs to have a link with my emotions to augment the message" (P17). This requires further study to assess negative impacts of stimulation: "...can be negative because it can impact how people feel without teaching them how to feel. So if they after a while associate, e.g., heat with sadness and if they feel something hot then feel sad about it and that's not what we want" (P17). Hence, associations between stimuli need to be mindfully trained. While some people may want to feel more emotions, individuals and technology developers should **responsibly consider the consequences of how bodies can be habituated** to associate certain stimuli with specific thinking or feeling, which becomes paramount when considering emerging news production practices.

#### *4.2.3 News intensity and perceived control.*

Some participants found the artificial sensations to be off-putting or inappropriate with emotionally intense news: "It's a very serious matter. So it is very weird if the device got warm. It made me feel very uncomfortable...it already is . . . .high anxiety. . . [It is ]very difficult for a human brain to grasp that somewhere else people died?" (P18). "When there was bad news, it felt uncomfortable to have the vibration and the cold. News was already sad and intense enough" (P4). "The high frequency vibration for the terrorism videos was a lot sometimes, they added a lot to the intensity. It really heightened the feeling of 'oh my god something is wrong" (P1). Indeed, the already familiar modality of sound might be more than enough: "With the news you already feel uncomfortable watching bad things happening, you don't want to feel too many bad things." (P17). When people are overwhelmed by negative news, they might want to be desensitized or calmed down, not further triggered. An important point P6 makes is that while many want to be informed and even appreciate emotional intensity, the level of personal *control* over one's reactions is key: "I want to keep up with the world, but if there are videos of people being beheaded, like Gaza, I want to know but I want a way for it to not affect me. So I can imagine something like this being helpful to neutralize it. I like emotional intensity. I don't want it to be out of my control. That's what happens with news" (P16). Here, additional modalities are said to have the potential to *neutralize* or *tone down* the news for the viewer to remain in control. Others were hesitant about modalities due to others' (news agency) control over their reactions, "I have a feeling a news agency can affect my emotions in ways that I do not really like. I felt quite tense when I felt the device moving (vibrations) or the device being cold. I feel like it will be used for ads...I don't feel I need the extra layer of interaction with the video" (P10). Emotionally intense news is already difficult to digest, which can relate to people's desired level of control: "Sometimes when I feel the heat, I feel like it is too hot. So, I think the vibrations makes me feel more safe. I would like to set scales myself, maybe sometimes I want to have very cold or very hot" (P3). If thermal or vibrotactile interaction can be **controlled by the user**, it can help neutralize an intense news story or add meaning in a personalizable way. However, if news agencies or media have more control over the modalities, people might be weary of being **"emotionally hijacked"** (i.e., losing their sense of agency), and therefore **distrust new modalities**.

# 5 DISCUSSION AND CONCLUSION

## 5.1 Limitations

We did not test thermal and vibrotactile feedback in isolation, and instead focused on the holistic haptic experience. We preset actuation not accounting for individual sensitivities (e.g., desensitization [3, 42], or letting participants set the level of intensity beforehand) and personalized preferences (cf., [54]). Lastly, FeelTheNews would require updates given medium scores on movement-related scales of CRS. Despite these limitations, FeelTheNews provided insights into augmenting news video watching experiences with haptics.

## 5.2 Towards haptic augmentation of news video watching

Our work contributed the FeelTheNews prototype, along with insights on how vibrotactile and thermal stimulation of news videos impacted participants' affective perceptions. This resulted in key observations: First, in contrast to prior works on haptic augmentation of media (e.g., [2, 16, 36, 52]), we found that news valence and emotion intensity ratings were not statistically affected by haptic stimulation. However, from our interview responses (cf., Sec 4.2.1), we find that this could be either due to increased immersion and attention to a news video, where the semantics of the videos may take precedence in overriding haptic sensations. Alternatively, this could have been due to active participant choice of suppressing such feedback, or due to variation across skin sensitivities. Second, we found that having no stimulation was more comfortable than the haptic stimulation conditions, which may have come as a result of hesitations toward intentional emotion targeting (cf., Sec 4.2.2), and how it may impinge on our perceived sense of agency (cf., Sec 4.2.3). Lastly, we found that haptic stimulation can inappropriately intensify the news experience, and in some cases neutralize the emotional impact of news stories. This resulted in participants feeling a loss of control and agency over their reactions, which can lead to distrust new modalities and news agencies. To this end, the adoption and acceptance of such augmentations may require so-called sensory transparency [35], to ensure responsible human-machine integration as we cross into the age of immersive and multi-sensory news media [19, 39].

## 5.3 Ethical considerations and cautionary next steps for affective haptics for news

Our FeelTheNews prototype brings to question users' sense of agency [13, 35] should they experience any signal of *"emotional hijacking"* (cf., Sec 4.2.3). Indeed, prior work in proxemic interactions have identified application scenarios that qualify as "dark patterns", where users are deliberately deceived through a particular interaction technology [20], which extends across interaction techniques and experiences (e.g., shape-changing interfaces [4]). We believe careful steps need to be taken here for understanding and minimizing adverse impacts of steering human emotion through haptic stimulation. This is of crucial importance to avoid emotion targeted disinformation [5] using haptics, which requires journalists to subsequently carefully reconsider their relationship with their public [19] during news delivery through emerging interactive and immersive media. Immediate next steps should consider creating custom haptics that cater to individuals' skin sensitivities (cf., [3]) and ensuring availability across hardware devices (e.g., VR headsets); the long-term vision necessitates addressing *"dark affective haptics"* in journalistic endeavors, which requires careful attention from HCI researchers, practitioners, and importantly, journalists, for the future of experiential news.

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