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Can muted video advertising be as effective as video advertising with sound?

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Abstract

Video ads are often muted when seen in social media on a smartphone. This research compared video ads across three Muting conditions: (1) normal (audio), (2) muted, and (3) muted with subtitles. The lab-study results showed that muted ads had lower free brand recall, cued brand recall, and brand recognition than normal ads and adding subtitles did not improve effectiveness on these measures. However, the free brand recall effects were significant only for ads seen in a news environment on a desktop computer. Ads seen in a social media environment on a mobile phone were less effective, measured by free brand recall, which is a difficult memory task. Muted ads were just as effective as normal ads and subtitled ads, in a mobile social media environment, on every measure except brand recognition, which is an easy memory task. These results suggest that muting makes little difference to the effectiveness of video ads seen in social media on smartphones. In the desktop news environment, muting reduced ad effectiveness, measured by free brand recall, but improved ad liking. The negative effect of muting on free brand recall was significant only for ads with high amounts of information (speech and audio branding) in their soundtracks, which was lost when the ad was muted. Two visual strategies (visual storytelling, and referencing shared understandings) counteracted the effects of muting on high audio information ads seen in a desktop news environment.

Keywords Video advertising; Brand Recall; Mobile; Social Media; Desktop Computer; Muted/Silent Advertising

Declarations

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Conflicts of interest/Competing interests

The authors declare the following: this research was funded by a consortium of companies that included Facebook and its competitors (e.g., Google, and television networks). This balance of interests means that this research was not influenced by any single company or industry group.

Availability of data and material

All data generated or analysed during this study are included in this published article and its supplementary information files.

Code availability

The code used for analysis of the data is also available for download as a supplementary file.

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Advertising M37

1 Introduction

The fastest growing categories of digital advertising are social media, online video, and mobile advertising (Dentsu Aegis 2020). On Facebook, 85% of video advertising is watched without sound, to avoid annoying others (Patel 2016), and usually on a mobile phone (Statista 2019). But little is known about the effectiveness of silent video advertisements (Campbell and Pearson 2019). In this study, we compare the effectiveness of video ads seen across three conditions: (1) normally (with sound), (2) muted (silent), and (3) muted with subtitles.

Advertising theory suggests that muting will reduce the effectiveness of video advertising, because sound enhances motivation, opportunity, and ability to process (Campbell and Pearson 2019; MacInnis et al. 1991). Dual-coding theory (Paivio 1986) explains how sound provides additional neural pathways for recall (Bryce and Yalch 1993, Leigh 1991). But Facebook provides examples of muted ads that use subtitles to compensate for the loss of sound (Facebook 2016a). More recently, Campbell and Pearson (2019) have identified four strategies, derived from advertising and screen media research, for creating successful muted video advertising. They analyzed a database of 3,484 online video ads, 88% of which had been seen without sound (e.g., on Facebook). They also identified 29 examples of ads discussed in articles as examples of ads that worked well without sound. Finally, they interviewed eight professionals who developed advertising that worked without sound. Potentially, the four techniques Campbell and Pearson (2019) identified improve video advertising to the point where ads are equally effective whether they are seen normally, with sound, or muted, without sound. We test these four strategies using traditional advertising effectiveness measures, such as brand recall and ad liking.

We also investigate a potential moderator of the effects of muting on advertising effectiveness (Campbell and Pearson 2019). Viewing muted ads on a mobile device versus a computer may be associated with differences in advertising processing (MacInnis et al. 1991). The mobile screen's smaller size (narrower visual angle) may diminish emotional impact and therefore ad effectiveness (Gall and Latoschik 2020; Raptis et al. 2013; Reeves et al. 1999). Alternatively, the intensely personal nature of touchscreens may enhance advertising on mobile phones (Brasel and Gips 2014a; Grewal et al. 2016). We compare the effectiveness of video advertising with and without sound when seen on a mobile device versus on a desktop computer. To increase the contrast between these two viewing environments, we also varied the context surrounding the ads. Communication and social media are the most popular mobile phone apps, used by 98% of adults in the United States (Statista 2019). Social media is also the most likely environment in which desktop users will encounter muted video ads. But people may process ads in a

news context with a different mindset compared with viewing ads in social media. For example, readers of online news may treat an ad as relevant to an article and part of an integrated whole (Wojdynski and Bang 2016), whereas social media users mostly see ads as irrelevant and avoid them (Kelly et al. 2010). If a news context heightens attention to ads, then the differences between normal ads (with sound) and muted ads may be more significant. For these reasons we compared the typical environment for seeing muted video ads, in social media on a mobile phone, with seeing muted video ads in news content on a desktop computer.

We use a laboratory experiment and test ads that have been identified as outstanding examples of silent video advertising (Campbell and Pearson 2019), although only one was actually silent, the rest had soundtracks containing up to four categories of audio information. With advertisers spending half of their budgets on digital advertising (Dentsu Aegis 2020), and more of that on video advertising in social media, this research provides some empirical guidance on how effective that spending might be.

2 Background

2.1 Impact of sound on advertisement effectiveness

Silent ads should be less effective than normal ads because visual-only (single-channel) content is less likely to be recognized or recalled than audiovisual (dual-channel) content (Lang 1995). Sound helps video advertising to get noticed and associated with the advertised brand (Campbell and Pearson 2019; Rossiter and Percy 2017). First, the soundtrack can bring distracted viewers' attention back to the screen (Bellman et al. 2010), or substitute for the ad's visual information with audio information (Bryce and Yalch 1993; Lang 1995). Second, dual-coding theory (Paivio 1986) suggests that adding sound to video advertising creates additional neural pathways for later recall (Bryce and Yalch 1993, Leigh 1991). Sound also conveys emotion that can change the meaning and effect of video advertising (Allan 2006; Fraser 2014; Hung 2001; Lantos and Cratton 2012; Oakes 2007; Scott 1990), which suggests that ads without sound will be less effective on measures of awareness (recall and recognition), but also on evaluative measures such as ad liking. All these arguments suggest that video advertising with sound is likely to be more effective than video advertising without sound, on both cognitive and evaluative measures of advertising effectiveness. Therefore, we propose the following:

H1: Audiovisual (normal) video advertising is more effective than visual-only (muted) advertising, when effectiveness is measured by (a) free brand recall, (b) cued brand recall, (c) brand recognition, and (d) ad liking.

The main purpose of advertising is to refresh, and occasionally build, memories of the advertised brand so that it comes to mind during purchase situations (Sharp 2010). We measure this brand awareness effect of muted video advertising using three cognitive measures of advertising effectiveness. In order of increasing demand for cognitive resources, these are (1) recognition, which measures memory encoding, (2) cued recall (using the brand's product category as the cue), which measures memory storage, and (3) free recall, which measures memory retrieval (Lang 2000). Another purpose of advertising is to change attitudes about the brand (Vakratsas and Ambler 1999). However, attitude toward the brand and brand purchase intention generally align with market share (Ehrenberg et al. 1990), and are difficult to shift with a single brief exposure, especially for established and trusted brands (Dens et al. 2018; Herbst et al. 2012), like the ones advertised in our test commercials. For this reason, we use attitude toward the ad (ad liking) as our evaluative measure of advertising effectiveness, as ad liking is sensitive to single exposures and potentially has downstream effects (which might require multiple exposures) on brand attitude and purchase intention (Brown and Stayman 1992).

2.2 Impact of subtitles on muted advertising effectiveness

Facebook (2016a) reported that 24% of the video ads in their news feed were understandable without sound, mainly because they used visual branding and subtitles. When branding is conveyed visually (Bryce and Yalch 1993), brand recall for muted television advertising can be equal to normal (with sound) television advertising (Bellman et al. 2010; Maher et al. 2006). These results suggest that adding visual branding and subtitles can increase muted advertising's effectiveness (Brasel and Gips 2014b). However, multiple resource theory (Wickens 2008) suggests that subtitles may go unread among competing visual stimuli. The ability to attract attention back to the screen is a key advantage of using sound (Lu et al. 2013), so the presence of subtitles may not attract attention to the ad. Even if subtitles are read, they cannot convey the effects of sound and music on attention and emotion (Rigg 1964; Shevy 2007). Therefore, we hypothesize that normal ads with sound will still be more effective than muted ads with subtitles:

H2: Audiovisual (normal) video advertising is more effective than visual-only (muted) advertising with added subtitles, when effectiveness is measured by (a) free brand recall, (b) cued brand recall, (c) brand recognition, and (d) ad liking.

2.3 Device and contextual environment effects

A limited amount of research has compared the effectiveness of video advertising across mobile phones and desktop computers. Advertising exposure time in social media content is much shorter on a mobile phone (1.7 *s*) than on a desktop computer (2.5 *s*) (Facebook 2016a). Online news sites on desktop computers provide long page-viewing times (e.g., 50 to 120 *s* in Danaher et al. [2006]), giving viewers more opportunity for advertising exposure. Mobile phones are less usable than desktop computers (Jastrzembski and Charness 2007; Raptis et al. 2013), so it may not be easy for many viewers to turn on ad-sound if they wanted to. Finally, the narrower visual angle of a mobile phone's small screen may diminish the emotional intensity of video content (Gall and Latoschik 2020; Reeves et al. 1999). The audio component may be less affected, especially if viewers are listening through headphones, but the soundtrack is unlikely to be a total replacement for the visual communication of the ad, just like radio ads perform worse than television ads (Edell and Keller 1989). This evidence leads us to expect that video advertising in general will be less effective in a mobile social media environment than in a desktop news environment. For this reason, the differences between normal advertising, which will be less effective in a low-effectiveness mobile-phone environment, and muted and subtitled advertising will diminish. Consequently, we propose two hypotheses, a main and an interaction effect of advertising environment on the effectiveness of muted video advertising:

H3: (a) Audiovisual (normal) video advertising and visual-only (muted) advertising will be more effective when seen in a desktop news environment versus a mobile social media environment. (b) The effect of advertising environment will interact with the effects of muting and subtitling, such that the differences between normal ads and muted ads, and between normal ads and subtitled ads, will be more significant when these ads are seen in a desktop news environment.

2.4 Effects of soundtrack information lost when video advertising is muted

The more an advertisement relies on audio information in its soundtrack, the more it may suffer when it is seen muted (Bryce and Yalch 1993, Campbell and Pearson 2019; Leigh 1991). An advertisement's soundtrack can include sound effects and dialog that help tell the story of the ad, and music that generates emotional responses. The

soundtrack can also include audio branding information, linking the advertisement to the advertised brand. Ads that rely less on audio information will repeat that audio information (e.g., branding), redundantly, using visual information (Lang 1995). At the extreme, a truly silent ad will convey its message using vision alone, so its performance should not be affected by muting.

Our first research question investigates the main effect of soundtrack information on ad effectiveness, and the potential interaction between soundtrack information and muting. We identified four categories of audio information in our test ads' soundtracks: (1) sound effects, (2) music, (3) speech, and (4) audio branding. The test ads varied in the number of categories of information in the soundtrack (Table 1). For example, the soundtracks of 5 Gum's "Skinny Dip" ad, and Hotel.com's "Piano" ad, provided additional emotional and conceptual information beyond what was conveyed visually. The heartbeat music in the 5 Gum "Skinny Dip" ad heightened the suspense of the ad's "will he or won't he" moment. Hearing how badly Hotel.com's Captain Obvious played the piano was worse than might be imagined. Geico's "Life's a Beach" and Wells Fargo's "Team Run" ads had speech and audio branding in their soundtracks, which conveyed information that was not redundantly present in the visuals. For this reason, these two ads may have benefitted the most from subtitling to compensate for losing this high level of soundtrack information when these ads were seen muted. We defined high audio information as the presence of speech or audio branding in the ad's soundtrack. Although some famous ads have used sound effects (e.g., McCain's "ping") or music (e.g., "Intel inside") as branding devices, research shows that, in general, sound effects and music tend to have generic associations, and so are less likely to be associated with a specific brand (Romaniuk 2018). Five of our nine test ads had high audio information, while the remaining four had either no audio information (Wendy's), or low audio information (just sound effects or music) (see Table 1). We ask the following research question:

> *RQ1:* Is the effect of muting, on the effectiveness of video advertisements, significantly worse for ads with high amounts of audio information in the soundtrack?

Insert Table 1 about here

2.5 Effects of different strategies for improving muted video advertising

Campbell and Pearson (2019) suggested four strategies for improving the effectiveness of silent video advertising. They identified the top 50 and bottom 50 silent ads in an agency's database, measuring performance by viewing

time. Coding of these ads, plus 29 silent ads identified in press articles, and interviews with eight advertising professionals, resulted in the final set of recommended strategies and tactics listed in Table 2.

Insert Table 2 about here

1. *Visual rather than verbal storytelling*. Without sound, filmmakers can only use visual storytelling. Visual imagery must convey all the emotion, and often the story needs simplifying. Table 2 lists the test ads we used in our experiment. Huggies's "Hug the Mess" advertisement, a cited example of visual storytelling, uses a child's point-of-view to focus "attention on the child's actions and gestures" (Campbell and Pearson 2019, p. 92). Volkswagen's "An Idea Destined to Fail" advertisement uses big emotional gestures, like an old silent movie (Campbell and Pearson 2019), such as a farmer jumping on the car to test its suspension.
2. *Reference to shared understandings*. Telling a story without sound is easier when the story is familiar. The Kleenex advertisement in Table 2 draws on memories of school days to tell the "tear-jerking story" of an elementary school custodian (Hall 2016). A.1. Steak Sauce's "New Friend Requests" advertisement plays with the modern phenomenon of relationship updates on Facebook (Campbell and Pearson 2019, p. 92).
3. *Increased visual intensity and energy*. Increasing the visual energy on screen can compensate for the absence of sound. The "Skinny Dip" advertisement for Wrigley's 5 chewing gum employs "handheld roving camerawork, split-second editing, and varied camera angles" (Campbell and Pearson 2019, p. 93). Hotel.com's "Piano" advertisement uses "a single, rapidly swooping shot that grabs attention" (Campbell and Pearson 2019, p. 93).
4. *Avoidance or tactical integration of subtitles*. Subtitles can be distracting, so they should either be avoided or used creatively to attract attention and convey emotion. Wendy's "4 for $4" advertisement "uses captions popping out from different locations to guide attention" (Campbell and Pearson, 2019, p. 93). This Wendy's ad was the only one of our test ads that was silent (our results are not substantially different when we analyze our data without this ad). Geico's "Life's a Beach" ad used subtitles "to make the ad understandable to people who viewed it on Facebook without sound" (Maheshwari and Benner 2016). Adding subtitles to the Facebook version of the Wells Fargo "Team Run" ad "resulted in a 3-point increase in advert recall" (Facebook 2016b).

Campbell and Pearson (2019) called for experiments to test and compare the effectiveness of their recommended strategies. We expected that the first three strategies, which use visuals to compensate for the lack of sound, will have a different pattern of results than the fourth strategy, which is aimed at improving the performance of subtitled ads. Campbell and Pearson (2019) propose that their four visual information strategies can compensate

for the loss of audio information when a video advertisement is seen muted. But some of Campbell and Pearson's (2019) four strategies may be better than others at compensating for the loss of audio information. Without prior evidence to base hypotheses on, we ask the following research question:

> *RQ2:* Is the pattern of results for normal ads versus muted and subtitled ads different across the four strategies proposed by Campbell and Pearson (2019)? The first three strategies, which compensate for the absence of sound, should be associated with fewer significant differences between normal ads and muted ads. The fourth strategy, which recommends that subtitles should be used creatively, should be associated with fewer significant differences between normal ads and subtitled ads. Are the results across the four strategies proposed by Campbell and Pearson (2019) different depending on the amount of lost information in the soundtrack?

3 Research method

3.1 Sample

The data were collected by MediaScience, a commercial audience laboratory, in accordance with procedures approved by the Murdoch University Human Research Ethics Committee (HREC 2011/157). Informed consent was obtained from all participants, and only the measures an individual had consented to were collected. All participants earned a $30 American Express gift card for their travel and time. To collect data efficiently, and to generalize the results, the lab sessions ran in identically equipped labs in two centrally located US cities, in Chicago, Illinois and Austin, Texas. A quota sampling approach ensured the sample of 147 participants was broadly representative of the US population (aged 22 to 72 years [M = 44.7, SD = 13.6], 52% [n = 77] female, 48% [n = 70] male).

3.2 Design and stimuli

The experiment used a 2 (environment) × 3 (muting) mixed within/between-participants design, and the data were analyzed using repeated-measures multivariate analysis of variance (MANOVA). Each participant was randomly assigned to one of two environment groups:

1. *Desktop News:* video display ads replaced real ads in the front page of a single edition of *The New York Times*, copied from the newspaper's website, and seen by our participants only on a desktop computer (n = 71 [48%]).
2. *Mobile Social Media:* video ads replaced real ads in a replicated social media app (Facebook), seen by our participants only on a smartphone (n = 76 [52%]).

It is important to note that each group saw the same 9 test advertisements; only the ad environment changed (news on a desktop vs. social media on a mobile phone). These 9 ads were seen in three different muting conditions:

1. *Normal:* (control condition) video ads play with sound.
2. *Muted:* video ads play without sound.
3. *Muted with Subtitles:* (subtitles condition) muted ads play with subtitles.

Table 1 lists the 9 test ads used in the experiment. All were for different brands and had been identified as outstanding examples of ads that perform well when muted. Two of the ads had a normal version, with soundtrack and no subtitles, from which the soundtrack could be removed to create the muted version, plus an official subtitled version (Geico, Hotels.com). For the other ads, appropriate subtitles (reproducing sound effects and speech) were created by the researchers and added to the muted version to create the subtitled version (5 Gum, A.1. Sauce, Huggies, Kleenex, Wells Fargo, VW). The Wendy's ad, which had no soundtrack, was identical in the normal and muted conditions, and in the subtitled condition, the subtitle "[no audio]" was added.

The 9 test ads were rotated across these three muting conditions so that each participant saw three different ads in each condition, to control for unique brand effects. Missing data (if present) were replaced by the participant's mean for all nine test ads, and then the average over the three ads seen in each muting condition was the participant's score for that condition.

To mask the purpose of the experiment and provide a realistic task and context, participants were told that the study was about the contextual content in which the test ads were shown: "In this study we are exploring how enjoyable it is to look at different types of content, with ads included." In the desktop news condition, participants saw the website content on a flat screen computer. The phone in the mobile social media condition was supplied by the lab (not the participant's personal phone) and was fixed to a stand to control visual angle (Bellman et al. 2009).

3.3 Measures

Immediately after viewing the content (news or social media), participants completed a distraction task. The task consisted of questions about the content (e.g., content liking, Coulter 1998), consistent with how the research was positioned, followed by the dependent measures.

Free brand recall Participants were asked, "Please list the names of the products and brands (e.g., Dove body wash) that you remember seeing ads for in today's session (guesses are encouraged)." Correct brand recall (misspellings allowed) was coded 1, otherwise 0.

Category-cued brand recall Participants were then shown a list of product categories "which may have been advertised" in the content they saw, and asked, "Do you remember the brands that were advertised for each category?" Correct cued recall (misspellings allowed) was coded 1, otherwise 0.

Ad recognition Participants were shown a list of 18 brand names, the nine test brands and their competitors, and asked "Can you identify brands that were advertised in the content you saw?" Correct brand recognition was coded 1, otherwise 0.

Ad liking Participants were shown three stills from each test ad, and asked "Which of the following statements best describes your feelings about this ad?" (1 = "I disliked it very much", 2 = "I disliked it", 3 = "I disliked it a little", 4 = "I liked it a little", 5 = "I liked it", 6 = "I liked it very much") (Bergkvist and Rossiter 2007).

To check random assignment, the questionnaire ended with measures of individual differences, including demographics (gender, age, education, occupation, income), brand familiarity (Woltman Elpers et al. 2003), prior exposure to the test ads (Crosby and Stephens 1987), category usage (Goldberg and Gorn 1987), and brand usage (Nenycz-Thiel et al. 2013; Vaughan et al. 2016). Usage ever (1/0) identified users of infrequently purchased brands. Heavy usage (purchase frequency > median for the brand in this experiment) identified users (1/0) of frequently purchased brands. There were no significant differences between the environment groups in demographics. A MANOVA, which controlled for multiple tests, revealed no significant multivariate effects of environment and muting on brand familiarity, prior exposure, category usage, or brand usage. These tests showed there was no need to include any covariates in the analysis.

For those participants who consented, we collected additional process measures during advertising exposure. To explore whether muting reduced annoyance with video advertising, facial expression was recorded with a high-definition video camera, and computer-coded for signs of negative emotion (anger, frustration, sadness) (McDuff et al. 2014). This facial expression measure was time-locked with the on-screen appearance of the test ads. Viewing time on screen for each test ad was measured in seconds.

3.4 Data Availability

All data generated or analyzed during this study are included in this published article and its supplementary information files (e.g., S1_data.csv).

4 Results

4.1 Hypothesis 1

Hypothesis 1 proposed that audiovisual (normal) video advertising is more effective than visual-only (muted) advertising. A 2 (Environment: mobile social media vs. desktop news) × 3 (Muting: normal, muted, subtitled) MANOVA, which controlled for multiple tests, simultaneously analyzed all the measures we used, including the four advertising effectiveness measures: free brand recall, cued brand recall, brand recognition, and ad liking (Table 3). This analysis revealed significant multivariate effects of muting, environment, and the two-way interaction between muting and environment. The multivariate effect of muting reflected three significant univariate effects (Table 4), on free brand recall, cued brand recall, and brand recognition. Planned contrasts showed that normal ads had higher levels of free brand recall than muted ads (M_{Normal} = 34%, SE = 3%, 95% CI [29%, 39%] vs. M_{Muted} = 24%, SE = 3%, 95% CI [19%, 29%], $F(1,135) = 12.13$, $p = .001$, $\eta p^2 = .08$), and also higher levels of cued brand recall (M_{Normal} = 55% SE = 3%, 95% CI [50%, 61%] vs. M_{Muted} = 49%, SE = 3%, 95% CI [43%, 55%], $F(1,135) = 5.08$, $p = .026$, $\eta p^2 = .04$), and brand recognition (M_{Normal} = 54% SE = 3%, 95% CI [48%, 59%] vs. M_{Muted} = 46%, SE = 3%, 95% CI [40%, 52%], $F(1,135) = 7.53$, $p = .007$, $\eta p^2 = .05$). These results provided support for H1a, b, and c, but not for H1d.

Insert Tables 3 and 4 about here

4.2 Hypothesis 2

Hypothesis 2 predicted that audiovisual (normal) video advertising is more effective than visual-only (muted) advertising with added subtitles. As was reported above, muting (normal, muted, subtitled) had a significant multivariate effect on free brand recall, cued brand recall, and brand recognition (Table 4). Planned contrasts showed that normal ads had higher levels of free brand recall than muted ads with subtitles (M_{Normal} = 34% SE = 3%, 95% CI [29%, 39%] vs. $M_{Subtitled}$ = 24%, SE = 3%, 95% CI [19%, 29%], $F(1,135) = 12.97$, $p < .001$, $\eta p^2 = .09$), and also higher levels of cued brand recall (M_{Normal} = 55% SE = 3%, 95% CI [50%, 61%] vs. $M_{Subtitled}$ = 46%, SE = 3%, 95% CI [40%, 52%], $F(1,135) = 9.03$, $p = .003$, $\eta p^2 = .06$), and brand recognition (M_{Normal} = 54% SE = 3%, 95% CI [48%, 59%] vs. $M_{Subtitled}$ = 44%, SE = 3%, 95% CI [38%, 50%], $F(1,135) = 9.52$, $p = .002$, $\eta p^2 = .07$). These results provided support for H2a, b, and c, but not for H2d.

4.3 Hypothesis 3

Hypothesis 3 proposed that: (a) audiovisual (normal) video advertising and visual-only (muted) advertising will be more effective when seen in a desktop news environment versus a mobile social media environment; and (b) the effect of advertising environment will interact with the effects of muting and muting with subtitles, such that the differences between normal ads and muted ads, and between normal ads and muted ads with subtitles, will be more significant when these ads are seen in a desktop news environment. As we reported above, the multivariate effect of environment was significant (Table 3). This overall effect reflected a significant difference between the two viewing environments in free recall ($M_{\text{Mobile Social Media}}$ = 23% SE = 3%, 95% CI [18%, 29%] vs. $M_{\text{Desktop News}}$ = 32%, SE = 3%, 95% CI [26%, 37%], $F(1,135) = 4.91$, $p = .028$, $\eta_p^2 = .04$; for other results see Table 5). This result provided partial support for H3a. However, as we reported above, there was a significant multivariate effect of the two-way interaction between muting and environment (Table 3), reflecting significant univariate effects on free brand recall and ad liking (Table 4). Consistent with H3b, the significant differences on these two variables between normal, muted, and muted ads with subtitles occurred in the desktop news environment, rather than in the mobile social media environment (Table 5). In the desktop news environment, normal ads (M_{Normal} = 43% SE = 4%, 95% CI [35%, 50%]) had significantly higher free brand recall than muted ads (M_{Muted} = 25%, SE = 4%, 95% CI [18%, 32%], $F(1,68) = 19.51$, $p < .001$, $\eta_p^2 = .22$) and muted ads with subtitles ($M_{\text{Subtitled}}$ = 29%, SE = 4%, 95% CI [22%, 36%], $F(1,68) = 10.52$, $p = .002$, $\eta_p^2 = .13$). But in that desktop news environment, muted ads (M_{Muted} = 4.49, SE = 0.09, 95% CI [4.31, 4.66]) had significantly higher ad liking than normal ads (M_{Normal} = 4.34, SE = 0.10, 95% CI [4.14, 4.54], $F(1,68) = 4.63$, $p = .035$, $\eta_p^2 = .06$) and muted ads with subtitles ($M_{\text{Subtitled}}$ = 4.36, SE = 0.09, 95% CI [4.18, 4.54], $F(1,68) = 6.90$, $p = .01$, $\eta_p^2 = .09$). The effect of the interaction between muting and environment was not significant for brand recognition (Table 3), but as tests of interaction effects "are notoriously low in power" (Hayes 2015, p. 15), we interpreted the different results across the two viewing environments as meaningful. In contrast to the results for free brand recall, the significant differences in brand recognition between normal, muted, and muted ads with subtitles occurred in the mobile social media environment, rather than in the desktop news environment. In the mobile social media environment, normal ads (M_{Normal} = 51% SE = 4%, 95% CI [43%, 59%]) had significantly higher brand recognition than muted ads (M_{Muted} = 42%, SE = 4%, 95% CI [33%, 50%], $F(1,67) = 5.42$, $p = .02$, $\eta_p^2 = .08$) and muted ads with subtitles ($M_{\text{Subtitled}}$ = 40%, SE = 4%, 95% CI [31%, 48%], $F(1,67) = 7.32$, $p = .01$, $\eta_p^2 = .10$).

Insert Table 5 about here

4.4 Research Question 1

Research Question 1 asked whether the effect of muting, on the effectiveness of video advertisements, was significantly worse for ads with high amounts of audio information in the soundtrack. We expected that ads with more information in the soundtrack would be less effective when the ad was muted.

We tested RQ1 using univariate analyses of free brand recall, cued brand recall, and brand recognition, the three advertising effects measures with significant MANOVA results (Table 4). We restructured our experimental data from one row per participant to nine rows per participant, one for each test brand. These panel data (S3_panel_data.csv) included one column for each dependent variable, and columns of potential independent variables: (a) Environment ([categorical] 1 = mobile social media, 2 = desktop news), (b) Muting ([categorical]: normal, muted, muted with subtitles), and (c) High Audio Information (= 1 [speech or audio branding present]) vs. Low Audio Information (= 0 [silent, or sound effects, or music present]). Because the dependent variables were now binary (0/1) variables, we used logistic regression for panel data, and hence the significance of the independent variables was tested by Wald χ^2 tests. We ran generalized linear mixed regression models in SPSS 26, specifying participant number as the subject variable, a binomial distribution, and a logit link function. These models revealed significant main effects of high audio information on free brand recall and brand recognition (Table 6).

Insert Table 6 about here

The main effect of high audio information had a different direction for free brand recall versus brand recognition. High audio information increased free brand recall (M_{Low} = 23% SE = 2%, 95% CI [19%, 27%] vs. M_{High} = 31%, SE = 3%, 95% CI [27%, 37%], $\chi^2(1) = 12.32$, $p < .001$), but reduced brand recognition (M_{Low} = 54% SE = 3%, 95% CI [49%, 59%] vs. M_{High} = 44%, SE = 3%, 95% CI [39%, 49%], $\chi^2(1) = 18.56$, $p < .001$). These main effects of high audio information averaged over significant main effects of muting, which may explain these differences in direction. Although the interaction between muting and high audio information was not significant for any of the three dependent variables (Table 6), the effect of muting was different for high versus low audio information ads (see Table 7).

Insert Table 7 about here

To test RQ2 (see below), we estimated separate regression models for ads with high versus low audio information. The effects of muting were significant only for ads with high audio information. First, normal ads were

more effective than muted ads, measured by free brand recall (M_{Normal} = 38% SE = 4%, 95% CI [31%, 46%] vs. M_{Muted} = 30%, SE = 3%, 95% CI [24%, 37%], $\chi^2(1) = 3.90$, $p = .048$) and brand recognition (M_{Normal} = 53% SE = 4%, 95% CI [46%, 60%] vs. M_{Muted} = 43%, SE = 4%, 95% CI [36%, 50%], $\chi^2(1) = 6.83$, $p = .01$). Second, subtitling did not replace the high level of audio information that was lost when these ads were seen muted. There were significant differences between normal ads and muted ads with subtitles, in free brand recall (M_{Normal} = 38% SE = 4%, 95% CI [31%, 46%] vs. $M_{Subtitled}$ = 27%, SE = 4%, 95% CI [20%, 34%], $\chi^2(1) = 6.94$, $p = .01$), cued brand recall (M_{Normal} = 58% SE = 4%, 95% CI [50%, 65%] vs. $M_{Subtitled}$ = 46%, SE = 4%, 95% CI [39%, 54%], $\chi^2(1) = 7.20$, $p = .01$), and brand recognition (M_{Normal} = 53% SE = 4%, 95% CI [46%, 60%] vs. $M_{Subtitled}$ = 40%, SE = 4%, 95% CI [33%, 48%], $\chi^2(1) = 10.06$, $p = .002$). Note that because muting had no significant effect on ads with low audio information, there were no significant differences between these ads when they were seen normally (with sound), muted, and muted with subtitles (e.g., free brand recall: M_{Normal} = 29% SE = 4%, 95% CI [23%, 37%], M_{Muted} = 19%, SE = 3%, 95% CI [14%, 27%], $M_{Subtitled}$ = 23%, SE = 3%, 95% CI [17%, 30%]). High audio information ads were still more likely to be recalled than low audio information ads, when both were seen muted, because their free brand recall confidence intervals did not overlap. But in answer to RQ1, these results suggest that the effect of muting, on the effectiveness of video advertisements, was significantly worse for ads with high amounts of audio information in the soundtrack. Low audio information ads were less likely to be recalled, but more likely to be recognized, whether they were seen muted or with sound.

4.5 Research Question 2

Research Question 2 asked whether the pattern of results for normal ads versus muted and subtitled ads is different across the four strategies proposed by Campbell and Pearson (2019). RQ2 further asked if the results across the four strategies proposed by Campbell and Pearson (2019) were different depending on the amount of information in the soundtrack that is lost when the ad is seen muted. We expected the first three strategies, which compensate for the absence of sound, to be associated with fewer significant differences between normal ads and muted ads, compared with the fourth strategy. Ads using the fourth strategy, which involves integration or avoidance of subtitles, should have had fewer significant differences between normal ads and muted ads with subtitles.

To answer RQ2, we ran separate mixed regression models for ads with high versus low audio information (defined above to answer RQ1). This was because a severe limitation of our selection of test ads was that all four of Campbell and Pearson's (2019) strategies did not apply across our high and low audio information ads. As shown in

Tables 1 and 2, strategy 1 (visual storytelling) applied only to high audio information ads (Huggies and VW), and strategy 3 (visual energy) applied only to low audio information ads (5 Gum and Hotels.com). Strategy 2 (reference to shared understandings) applied to an ad with high audio information (Kleenex) and an ad with low audio information (A.1.). Strategy 4 (subtitle avoidance or integration) also applied across ads with high audio information (Geico and Wells Fargo) and low audio information (Wendy's). Because subtitling is the main compensating visual strategy used by muted ads, strategy 4 was used as the default reference for comparisons between strategies. Only two dummy variables were needed for each of the separate regression models for the high and the low audio information groups of ads, as only three strategies were present in each group. The results of these models revealed significant main or interaction effects of strategy on all three dependent variables, except for free brand recall of low audio information ads (Table 7).

There was no main effect of strategy on free brand recall of high audio information ads, but there was a significant three-way interaction between muting, environment, and strategy (Table 7). As shown in Figure 1, the differences between normal ads, muted ads, and muted ads with subtitles varied depending on the viewing environment and the strategy used. Using strategy 1 (visual storytelling) or strategy 2 (reference to shared understandings), there were no significant differences between normal ads with sound, muted ads, and muted ads with subtitles, in both environments (desktop news and mobile social media). Strategy 4 (subtitle avoidance or integration) was associated with two significant differences. In the desktop news environment, normal ads were more effective than muted ads (M_{Normal} = 41% SE = 7%, 95% CI [28%, 56%] vs. M_{Muted} = 23%, SE = 6%, 95% CI [13%, 37%], $\chi^2(1) = 4.04$, $p = .045$). In the mobile social media environment, normal ads were more effective than muted ads with subtitles (M_{Normal} = 43% SE = 7%, 95% CI [30%, 57%] vs. $M_{Subtitled}$ = 16%, SE = 5%, 95% CI [8%, 29%], $\chi^2(1) = 9.74$, $p = .002$).

Insert Figure 1 about here

Strategy had its largest and most significant main effect on cued brand recall of low audio information ads. Ads using strategy 2 (reference to shared understandings) were more effective than ads using strategy 4 (subtitle avoidance or integration) (M_2 = 84%, SE = 3%, 95% CI [76%, 89%] vs. M_4 = 51%, SE = 4%, 95% CI [42%, 59%], $\chi^2(1) = 46.76$, $p < .001$). In addition, strategy 3 (visual energy) was less effective than strategy 4 (M_3 = 38%, SE = 3%, 95% CI [32%, 44%], $\chi^2(1) = 7.65$, $p = .01$). The most interesting results for cued brand recall, however, are those for ads with high audio information, because these were the ads that were significantly affected by muting.

Strategy 2 increased cued brand recall, compared with strategy 4, whether high audio information ads were seen normally, muted, or muted with subtitles (M_2 = 58%, SE = 4%, 95% CI [50%, 66%] vs. M_4 = 48%, SE = 3%, 95% CI [41%, 55%], $\chi^2(1) = 6.76$, $p = .01$).

The significant main effects of strategy on brand recognition were qualified by significant interactions with viewing environment (Table 7). For high audio information ads, strategy 2 was more effective than strategy 4 (M_2 = 55%, SE = 4%, 95% CI [46%, 63%] vs. M_4 = 38%, SE = 3%, 95% CI [33%, 44%], $\chi^2(1) = 14.50$, $p < .001$), but this main effect averaged over significant differences in the desktop news environment, and insignificant differences in the mobile social media environment. In the desktop news environment, strategy 1 was more effective than strategy 4 (M_1 = 51%, SE = 5%, 95% CI [41%, 61%] vs. M_4 = 35%, SE = 4%, 95% CI [28%, 43%], $\chi^2(1) = 11.14$, $p = .001$), but less effective than strategy 2 (vs. M_2 = 64%, SE = 6%, 95% CI [52%, 74%], $\chi^2(1) = 7.45$, $p = .01$). Consequently, strategy 2 was also more effective than strategy 4 ($\chi^2(1) = 25.70$, $p < .001$). For low audio information ads, strategy 2 was more effective than strategy 4 (M_2 = 68%, SE = 4%, 95% CI [60%, 76%] vs. M_4 = 54%, SE = 4%, 95% CI [46%, 62%], $\chi^2(1) = 8.98$, $p = .003$), but again this main effect averaged over results that differed across viewing environments. In the desktop news environment, strategy 2 was more effective than strategy 4 (M_2 = 79%, SE = 5%, 95% CI [68%, 87%] vs. M_4 = 50%, SE = 6%, 95% CI [38%, 61%], $\chi^2(1) = 21.08$, $p < .001$), and strategy 3 (vs. M_3 = 54%, SE = 5%, 95% CI [45%, 63%], $\chi^2(1) = 22.60$, $p < .001$). In the mobile social media environment, strategy 3 was less effective than strategy 2 (M_3 = 42%, SE = 4%, 95% CI [34%, 51%] vs. M_2 = 55%, SE = 6%, 95% CI [43%, 66%], $\chi^2(1) = 4.92$, $p = .03$) and strategy 4 (vs. M_4 = 58%, SE = 6%, 95% CI [46%, 69%], $\chi^2(1) = 6.30$, $p = .01$).

Answering RQ2, these results suggest that strategy 1 (visual storytelling) and strategy 2 (reference to shared understandings) lifted the effectiveness of muted ads, so there were no longer any significant differences in free brand recall between video ads seen with sound, muted, or muted with subtitles (Figure 1). But strategies 1 and 2 improved muted ad effectiveness only for high audio information ads. This was because muting significantly affected only ads that lost high levels of audio information (speech and audio branding) when seen muted. Strategy 2 also was associated with the highest level of cued brand recall of low audio information ads. This may have been due to the use of this visual strategy or something else memorable in the ad (for A.1.). Ads using strategy 4 (integration or avoidance of subtitles) did not have fewer significant differences between normal ads and muted ads with subtitles. Strategy 4 did not always lift the effectiveness of muted ads with subtitles to the level of normal ads with sound (e.g., the difference in free brand recall was significant in the social media environment). Our results for

strategy 1 (visual storytelling) were limited to ads with high audio information. Similarly, our results for strategy 3 (visual energy) were limited to ads with low audio information, but they suggest that strategy 3 is less effective than strategy 2 or strategy 4.

4.5 Exploring explanations

We explored whether our additional process measures, exposure time (log-transformed to normalize its distribution), and negative emotion (facial expression) could explain our results. The significant multivariate effect of environment, reported in Table 3, also reflected a significant univariate effect on viewing time (Table 4). Viewing times were significantly shorter in the mobile social media environment ($M_{\text{Mobile Social Media}}$ = 12.73 *s*, *SE* = 2.39, 95% CI [8.01, 17.46] vs. $M_{\text{Desktop News}}$ = 34.08 *s*, *SE* = 2.44, 95% CI [29.26, 38.91], $F(1,135) = 49.24$, $p < .001$, $\eta_p^2 = .27$). There was also a significant main effect of muting on viewing time (Table 4). The muting × environment interaction was not significant, but the pattern of results was different across the two environments. In the mobile social media environment, muted ads with subtitles ($M_{\text{Subtitled}}$ = 10.10 *s*, *SE* = 1.44, 95% CI [7.22, 12.98]) had significantly shorter viewing times than normal ads (M_{Normal} = 14.76 *s* *SE* = 2.16, 95% CI [10.46, 19.07], $F(1,67) = 11.66$, $p = .001$, $\eta_p^2 = .15$). There were no significant differences between viewing times in the desktop news environment (Table 5). There were no significant effects of environment or muting on negative emotion (Table 4).

5 Discussion

This research examined the effectiveness of online video advertising, when these ads are seen normally, with sound, versus muted or muted with subtitles. Additionally, we investigated whether the effects of muting or subtitling are affected by differences in the viewing environment: in social media on a mobile phone, versus in news on a desktop computer. Our results answer a call for empirical evidence about the effectiveness of silent video advertising (Campbell and Pearson 2019), as most video advertising is seen without sound in social media environments. The first contribution is the consistent evidence that muting reduces brand awareness measures of advertising effectiveness (free brand recall, cued brand recall, and brand recognition). These results can be explained by advertising and film theory (Campbell and Pearson 2019), which proposes that sound increases attention, memorability, and emotional response to video (Lang 1995; MacInnis et al. 1991; Paivio 1986). We included an evaluative measure, ad liking, to test whether hearing sound play automatically in video ads is good for memory but bad for attitudes (van Reijmersdal 2009). Ad liking showed this reactance effect (in a desktop news environment).

A second contribution is showing that adding subtitles does not compensate for the lack of sound in muted ads. Again, this result was implied by the many studies showing the difference sound and music can make to the effects of advertising (Allan 2006; Fraser 2014; Hung 2001; Lantos and Cratton 2012; Oakes 2007; Scott 1990). One of our ads, for Wendy's, was silent even when seen normally, so for this ad, adding subtitles added something to the ad, rather than substituting for sound. We identified the audio information categories (audio branding, sound effects, music, and speech) that were present in each ad's soundtrack, and classified our test ads as having either high or low audio information. Ads with high amounts of information in the soundtrack (speech or audio branding) performed worse when seen muted, on measures of free brand recall and brand recognition. The overall main effect of muting was due its significant effects on ads with high audio information. Muting had no effect on ads with low audio information. When we analyzed our data without including the Wendy's silent ad, we did not find any substantial differences in the results.

Third, we compared the effectiveness of muted video ads and normal video ads across two contrasting viewing environments, in social media on a mobile phone (the typical environment for seeing muted ads), versus in news on a desktop computer. The results were different depending on the memory measure used. Free recall is a hard memory task, requiring a large amount of cognitive resources during ad processing to create retrieval paths in memory (Lang 2000). In a desktop news environment, normal ads had higher free recall than muted ads and muted ads with subtitles, suggesting that sound provides additional memory retrieval paths in that environment (Paivio 1986). Brand recognition is an easy memory task, measuring memory encoding, which requires relatively few cognitive resources during ad processing (Lang 2000). Even muted ads were encoded well in a desktop news environment, so there were no differences in brand recognition in that environment between normal ads, muted ads, and muted ads with subtitles, consistent with more cognitive resources being deployed to process ads in a news context (Wojdynski and Bang 2016), versus a social media context (Kelly et al. 2010). But the onset of sound (e.g., voices) in a normally silent mobile social media viewing environment may have recruited additional cognitive resources for ad processing (Lang et al. 2015), and this would explain why normal ads with sound were recognized better than muted ads and muted ads with subtitles in that environment. However, consumers do not always appreciate being assaulted by video ads that play sound automatically. In the desktop news environment, normal ads with sound were more likely to be remembered, but muted ads were liked more than normal ads and subtitled ads. Social media is mostly consumed on a mobile phone, and in that environment most video ads are seen muted. In our

experiment, muted video ads were, except for brand recognition, just as effective as ads with sound in a mobile social media environment. This was because video advertising had lower effectiveness, measured by the hard memory task of free brand recall, in a mobile social media environment, compared with the same ads seen in a desktop news environment. This difference between our two environments reflects differences in visual angle, due to screen size (Gall and Latoschik 2020; Reeves et al. 1999), and viewing time (Facebook 2016a). The longer exposure times in the desktop news environment help explain the significant effect of hearing audio information on free brand recall when ads were seen in that environment (Goldstein et al. 2011). The differences between our two environments also reflect differences in advertising context (news vs. social media). Because device and context were confounded in our experiment, we cannot be certain whether one or both caused the significant two-way interactions between muting and environment that we found. We return to this issue in the implications and limitations sections below.

Finally, we explored whether some of the recommended strategies for improving the effectiveness of silent video advertising (Campbell and Pearson 2019) worked better than others or were specifically effective for muted ads, or muted ads with subtitles. We also investigated whether the effects of these strategies differed depending on the amount of information in the soundtrack that is lost when the ad is seen muted. The results suggested that Campbell and Pearson's (2019) strategy 1 (visual storytelling) and strategy 2 (reference to shared understandings) help to lift free brand recall of high audio information ads, so there were no significant differences when these ads were seen normally (with sound) versus muted, or muted with subtitles. Strategy 4 (subtitle integration or avoidance) did not always eliminate the significant differences in free brand recall between normal ads with sound and muted ads with subtitles. Our comparisons between strategies were severely limited by the sample of test ads we used, as strategy 1 was used only by high audio information ads, and strategy 3 (visual energy) was used only by low audio information ads. Nevertheless, these exploratory results, together with the results from our analysis of the effects of high versus low audio information, suggest that the best strategies for compensating for the loss of sound in online video advertising are reference to shared understandings, visual storytelling, or simply not relying on soundtrack information.

6 Implications

Spending on digital advertising has overtaken television advertising spending, and in 2020, more money was expected to be spent on mobile advertising than on television advertising (Dentsu Aegis 2020). But mobile screens, which are mainly used for communication and social media apps (Statista 2019), may not deliver effective video advertising exposures. In social media, most video advertising is watched in silence (Patel 2016), and without much interest (Kelly et al. 2010). Facebook's (2016a) own research shows that ads in a social media context are watched for a shorter time on mobile screens than on desktop screens. Our results also show that video ads are watched for a shorter time, and consequently are less effective, measured by free brand recall, on a mobile phone screen in a social media context, than on a desktop computer in a news context. These differences in advertising effectiveness were caused by device differences (e.g., screen size), but in our experiment these device differences were magnified by differences in context. The context surrounding the ads was news on the desktop computer, and social media on the smartphone. Prior research has shown that people are more interested in advertising in a news context (Wojdynski and Bang 2016). The main purpose of our desktop news environment, however, was to provide an environment in which muted and unmuted video ads might show greater variation in effectiveness, compared to where muted video ads are generally seen, in social media on a mobile device. Because, except for one measure, brand recognition, muting made no difference to ad effectiveness in that typical mobile social media environment, our results may have given advertisers the wrong impression that muted ads are just as effective as unmuted ads, in all viewing contexts. Having an audible soundtrack may not provide much benefit in mobile environments, but it may provide a boost to more difficult memory tasks, such as free recall, when ads are seen on a desktop computer, or in a news context.

Advertisers could use Campbell and Pearson's (2019) visual advertising strategies, particularly strategy 1 (visual storytelling) and strategy 2 (reference to shared understandings), to compensate for the low effectiveness of high audio information ads when they are seen muted. However, since most muted video ads will be seen in a mobile social media context where muting makes little difference to effectiveness (affecting only brand recognition in our results), advertisers could save money by simply running unmodified versions of their ads. Instead, advertisers could improve the effectiveness of their video ads, when seen in a mobile social media context, by spending more on increasing frequency of exposure, gradually building up to a level of exposure as effective, measured by free brand recall, as a single exposure in a desktop news environment. Alternatively, advertisers could

spend their money reaching different people with each ad exposure, rather than the same people many times, by advertising in media where video ads are watched for longer, with the sound on (e.g., video streaming networks).

Our results showing no differences in effectiveness between muted and unmuted ads suggest that social media networks should persist with offering the ability to mute video advertising, which makes consuming social media less annoying for others (Patel 2016). Muting also improves ad liking, although this effect was significant only in a desktop news environment. The need for advertisers to buy more ads in social media, to deliver the higher frequency needed to compensate for lower free brand recall from single exposures in that context, is another favorable implication from our results for social media networks.

7 Limitations and future research

This research had several limitations, which suggest possibilities for future research. Our results are based on one experiment and so need further replication. Our findings may be confined to the specific ads we tested, which were recommended examples of superior silent advertising. Future studies should test whether the recommended strategies (e.g., subtitling) improve the performance of average ads when they are muted. Because we tested existing ads, our results investigating the effects of audio information elements (e.g., sound effects) and visual strategy (e.g., reference to shared understandings) are only exploratory. We encourage future researchers to create ads that independently manipulate the presence of audio information elements and the use of compensatory visual strategies. We coded our test ads for the presence of four audio information elements (sound effects, music, speech, and audio branding), but future research could further differentiate these codes. For example, "music" is a broad category that includes jingles specially composed for brands, popular songs (with or without brand-specific lyrics), and background music that may not be uniquely associated with the advertising brand (Romaniuk 2018). Our study tested the effects of single exposures to muted advertising, but a future study should test the effects of repeated exposure. The environment manipulation in our experiment confounded device and context (news vs. social media). Both effects potentially explain our results. A future study should test the same context across devices (e.g., ads in social media across mobile phones and desktop computers [Facebook 2016a]). Finally, we used a controlled lab study, in which exposure times were much longer than the averages reported by Facebook. Future studies should test the effects of muted advertising in more realistic environments, using each participant's own mobile phone and

social media feed (e.g., Nelson-Field 2020), with distractions present (Jayasinghe and Ritson 2013), in which lack of sound may reduce video advertising effectiveness even further.

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Table 1 Categories of information present in each test advertisement's soundtrack

Ad	Sound Effects	Music	Speech	Audio Branding	Total
Wendy's "4 for $4"					0
AI Steak Sauce "New Friend Requests"	●	●			2
5 Gum "Skinny Dip"	●	●			2
Hotels.com "Piano"	●	●			2
Huggies "Hug the Mess"	●	●	●		3
Kleenex "A Shining School"	●	●	●		3
Geico "Life's a Beach"	●		●	●	3
VW "An Idea Destined to Fail"	●	●	●	●	4
Wells Fargo "Team Run"	●	●	●	●	4

Table 2 Strategies and ads tested

Strategy	Tactics	Example ads tested in the experiment
1. Visual rather than verbal storytelling	"Showing" rather than "telling" Deliberate shot framing Emotion-inducing shots Miming, gesturing Slapstick, visual humor	Huggies "Hug the Mess" VW "An Idea Destined to Fail"
2. Reference to shared understandings	Well-known stories Well-known celebrities Stereotypes	Kleenex "A Shining School" A.1. Sauce "New Friend Requests"
3. Increased visual intensity and energy	Arresting start image Avoid long shots Camera motion Varied shots Exaggerated angles Editing pace	5 Gum "Skinny Dip" Hotels.com "Piano"
4. Avoidance or tactical integration of subtitles	Avoid subtitles Subtitle thoughts Avoid distraction Use to direct attention Use styled text	Wendy's "4 for $4" Geico "Life's a Beach" Wells Fargo "Team Run"

Notes: URLs for the test ads:
Huggies (https://www.facebook.com/ads/creativehub/gallery/693874540760130/)
VW (https://www.facebook.com/ads/creativehub/gallery/1297142370296409/)
Kleenex (https://www.facebook.com/Kleenex/videos/10153097054618199/)
A1 Sauce (https://youtu.be/I2XFglTo6bg)
Five Gum (https://www.facebook.com/business/news/building-video-for-mobile-feed#)
Hotels.com (https://youtu.be/AMo9RC8R9p0)
Wendy's (http://adage.com/article/digital/silent-video-speaks-volumes/307254/)
Geico (https://www.nytimes.com/2016/09/26/business/media/making-video-ads-that-work-on-facebooks-silent-screen.html)
Wells Fargo (https://www.facebook.com/business/news/building-video-for-mobile-feed/)

Table 3 MANOVA results for analyses of all dependent variables (advertising processing and effectiveness)

	All Dependent Variables (Free Recall, Cued Recall, Brand Recognition, Ad Liking, Viewing Time, Negative Emotion)			
Effect	***F***	***df***	***p***	**ηp^2**
Intercept	945.07	6, 130	< .001	.98
Environment	10.43	6, 130	< .001	.33
Muting	2.40	12, 124	.01	.19
Muting × Environment	1.99	12, 124	.03	.16

F-statistics (based on Wilks' Λ), degrees of freedom (*df*), significance (*p*), and effect sizes (partial eta squared: small = .01, medium = .06, large = .13 [Cohen 1988]). **All effects were significant**.

Table 4 MANOVA within-participants univariate results for each dependent variable

	Muting				**Muting × Environment**			
Dependent Variable	***F***	***df***	***p***	**ηp²**	***F***	***df***	***p***	**η_p^2**
Free Brand Recall	**8.52**	**2, 270**	**<.001**	**.06**	**4.00**	**2, 270**	**.02**	**.03**
Cued Brand Recall	**5.13**	**2, 270**	**.01**	**.04**	0.59	2, 270	.56	.004
Brand Recognition	**6.30**	**2, 270**	**.002**	**.05**	0.16	2, 270	.86	.001
Ad Liking	0.32	1.89, 255.75	.71	.002	**4.48**	**1.89, 255.75**	**.01**	**.03**
Viewing Time (log)	**5.66**	**2, 270**	**.004**	**.04**	1.49	2, 270	.23	.01
Negative Emotion	0.19	2, 270	.83	.001	0.19	2, 270	.83	.001

F-statistics (based on Wilks' Λ), degrees of freedom (*df*), significance (*p*), and effect sizes (partial eta squared: small = .01, medium = .06, large = .13 [Cohen 1988]). **Significant effects in bold**. Huynh-Feldt corrected results reported for Ad Liking (Mauchly's test of sphericity $p = .004$; this test was not significant for the other effectiveness measures).

Table 5 Experiment cell means: Normal ads versus muted ads and muted ads with subtitles, in either a mobile or a desktop environment

	Mobile Social Media					**Desktop News**			
Measure	**Normal**	**Muted**	**Subtitles**	**Overall**		**Normal**	**Muted**	**Subtitles**	**Overall**
Free Brand Recall (%)	26 [19, 33]	24 [17, 31]	20 [13, 27]	**23**^{z} [18, 29]		43^{xy} [35, 50]	25^{x} [18, 32]	29^{y} [22, 36]	**32**^{z} [26, 37]
Cued Brand Recall (%)	50 [42, 58]	47 [38, 55]	41 [33, 50]	**46** [39, 53]		61 [53, 69]	51 [43, 60]	51 [42, 59]	**54** [47, 61]
Brand Recognition (%)	51^{xy} [43, 59]	42^{x} [33, 50]	40^{y} [31, 48]	**44** [37, 51]		57 [49, 64]	50 [41, 58]	48 [40, 57]	**52** [45, 58]
Ad Liking (1–6)	4.37 [4.17, 4.57]	4.27 [4.09, 4.45]	4.34 [4.16, 4.52]	**4.33** [4.15, 4.50]		4.34^{x} [4.14, 4.54]	4.49^{xy} [4.31, 4.66]	4.36^{y} [4.18, 4.54]	**4.39** [4.22, 4.57]
Viewing Time (*s*)	14.76^{x} [10.46, 19.07]	13.33 [9.39, 17.27]	10.10^{x} [7.22, 12.98]	**12.73**^{z} [8.01, 17.46]		35.28 [28.82, 41.75]	34.14 [27.19, 41.08]	32.83 [26.29, 39.38]	**34.08**^{z} [29.26, 38.91]
Negative Emotion (*t*)	0.13 [−0.01, 0.26]	0.14 [0.001, 0.28]	0.12 [−0.02, 0.25]	**0.13** [0.00, 0.26]		0.23 [0.09, 0.36]	0.23 [0.09, 0.36]	0.23 [0.09, 0.36]	**0.23** [0.09, 0.36]

Least squares means from MANOVA results [95% confidence intervals in square parentheses]. **Environment (mobile vs. desktop) means in bold**. (*s*) = seconds, (*t*) = *t*-statistics from resting baseline. Means in the same row with the same superscript letters are significantly different from each other ($p < .05$).

Table 6 Generalized linear mixed regression model results analyzing effects of high audio information

	Free Brand Recall			**Cued Brand Recall**			**Brand Recognition**		
Effect	χ^2	*df*	*p*	χ^2	*df*	*p*	χ^2	*df*	*p*
Intercept	**101.98**	**1**	**< .001**	0.18	1	.67	0.16	1	.69
Muting	**17.77**	**2**	**< .001**	**10.48**	**2**	**.01**	**10.13**	**2**	**.01**
Environment	2.97	1	.08	2.96	1	.09	2.96	1	.09
High Audio Information (1/0)	**12.32**	**1**	**< .001**	0.91	1	.34	**18.56**	**1**	**< .001**
Muting × Environment	**9.01**	**2**	**.01**	1.13	2	.57	0.62	2	.74
Muting × High Audio Information	0.71	2	.70	0.23	2	.89	1.27	2	.53
Environment × High Audio Information	0.11	1	.74	1.07	1	.30	0.55	1	.46
Muting × Environment × High Audio Information	2.58	2	.27	3.33	2	.19	3.61	2	.16

Wald Chi-squared (χ^2), degrees of freedom (*df*), and significance (*p*). **Significant effects in bold**.

Table 7 Generalized linear mixed regression model results analyzing effects of visual strategies

	Low Audio Information									**High Audio Information**								
	Free Brand Recall			**Cued Brand Recall**			**Brand Recognition**			**Free Brand Recall**			**Cued Brand Recall**			**Brand Recognition**		
Effect	χ^2	*df*	*p*	χ^2	*df*	*p*	χ^2	*df*	*p*	χ^2	*df*	*p*	χ^2	*df*	*p*	χ^2	*df*	*p*
Intercept	**92.61**	**1**	**< .001**	**9.18**	**1**	**.002**	**5.42**	**1**	**.02**	**40.25**	**1**	**< .001**	0.14	1	.71	2.59	1	.11
Muting	5.21	2	.07	2.70	2	.26	2.43	2	.30	**7.43**	**2**	**.02**	**7.34**	**2**	**.03**	**11.56**	**2**	**.003**
Environment	2.26	1	.13	0.54	1	.46	3.00	1	.08	3.09	1	.08	3.23	1	.07	2.27	1	.13
Strategy	3.39	2	.18	**77.99**	**2**	**< .001**	**21.27**	**2**	**< .001**	0.94	2	.63	**9.49**	**2**	**.01**	**15.78**	**2**	**< .001**
Muting × Environment	**7.53**	**2**	**.02**	2.35	2	.31	3.11	2	.21	2.48	2	.29	4.46	2	.11	0.20	2	.91
Muting × Strategy	6.73	4	.15	4.29	4	.37	3.42	4	.49	4.38	4	.36	0.85	4	.93	4.99	4	.29
Environment × Strategy	1.24	2	.54	2.82	2	.24	**12.42**	**2**	**.002**	1.86	2	.40	0.12	2	.94	**10.69**	**2**	**.01**
Muting × Environment × Strategy	2.12	4	.71	9.45	4	.05	4.07	4	.40	**10.14**	**4**	**.04**	8.74	4	.07	3.50	4	.48

Wald Chi-squared (χ^2), degrees of freedom (*df*), and significance (*p*). **Significant effects in bold**.

Fig. 1 Effects, on free brand recall of high audio information ads, of the three-way interaction between muting, environment, and strategy (error bars indicate 95% confidence interval).