Understanding Mass-Market Mobile TV Behaviors in the Streaming Era

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ABSTRACT

Despite claims of Mobile TV's mainstream arrival in 2010, it took until 2017 for watching professionally-produced television content on mobile phones to truly become a mass-market phenomenon in America, with half of all TV content expected to be watched on mobile phones by 2020. But what professionally produced content are people watching on their phones and when are they watching it? Are there any clusters of behavior that emerge in the broader population when it comes to watching TV on the phone? We set out to answer these questions through two surveys deployed to representative samples of online Americans. We discuss our findings on the mass-market arrival of Mobile TV viewing and differences from how the HCI community has previously envisioned mobile video. We conclude with implications for the design of future Mobile TV systems.

CCS CONCEPTS

• **Information systems** → **Multimedia streaming**; *Video search*; • **Human-centered computing** → *Empirical studies in HCI*;

KEYWORDS

Television; Streaming; Mobile; Smartphone; Survey

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1 INTRODUCTION

Mobile television services, providing access to long-form, professionally produced video programs on mobile devices, have been researched and deployed since 2002. Through successive waves of technology (DMB [22], DVB-H [21], etc.), many services were launched, but few saw mass adoption in America. While these early video systems focused on live broadcasts, the growth of 4G networks and the mass popularity of online television streaming sites (e.g. Netflix, Hulu, and Amazon Prime Video) have led to a new mobile television ecosystem.

In addition, many cable operators have starting providing mobile access to live content and recorded shows on mobile devices through the data network. New Over the Top (OTT) television solutions have also launched, such as YouTube TV, Sling, and DirectTV. These services provide access to cable television content on phones and laptops without purchasing wired cable service to the home.

These new services have massively changed the ways that Americans consume television content. The trends are such that six in ten young adults were getting the majority of their television content through streaming services in 2017 [15] and by 2020, half of all TV content in America will be consumed on mobile devices [9]. This rise of cord-cutting and smartphone penetration (80% of Americans own smartphones [10]) is radically transforming a cable industry that has been operating under many of the same basic practices since the 1980s.

Despite the massive adoption of mobile television streaming through OTT video sources, little is understood about how Americans are using these services. Which combinations of services are being used? When are people watching television content on their phones? What content is being viewed? Are they watching along or together? We set out on this research with several broad questions, to better understand the use of mobile television viewing in America. Specifically, we wanted to know:

(1) What types of professionally-produced content are users watching on their mobile phones?
(2) How and where are people watching Mobile TV? (using headphones, locations of use, the social context, etc.)

(3) Are there clusters of behaviors across large numbers of users that can help us target the design of new Mobile TV services?

We will begin by setting this work in the context of existing research on mobile television services and use. We will then describe our method and the backgrounds of our participants before exploring answers to each of our research questions in depth. We will conclude with a discussion of how current mobile television viewing practices are quite different from what was imagined only eight years ago, and what this means for the design of future mobile television services.

2 BACKGROUND

The concept of Mobile TV has existed in the research and consumer electronics field for some time. Early work focused on standards for broadcasting television on separate frequencies from the mobile data networks. Technologies such as DVB-H gained popularity in the 2000's and were even included in a variety of handsets, mostly outside the US. These radio broadcast technologies were still seen as the probable future of mobile television as late as 2009, when an influential book on "Mobile Television" was published by many members of the CHI community. [12] Kitson, in a chapter titled "Mobile TV's Time to Shine has Arrived," [8] wrote that "over-the-air digital television to mobile devices" was the future of television and Shuurman et al. [18] declared that delivery of television over a mobile network has "ceased to be viable" given low bitrates and network congestion, meaning that live broadcasts on dedicated radio frequencies would be the only way to get television content to mobile handsets.

In an early field study that explored how people used mobile broadcast television (DVB-H) in Europe, Leivens et al. [11] cataloged how 70 participants used a system that had 12 broadcast channels in Ghent. They found that participants preferred short, 10 to 15-minute sessions of use, that usage was very rare and sporadic, that usage fit into spare moments of the day (eating, driving, waiting), and that use was almost always alone. They even went on to state that Mobile TV "cannot generate" a relaxing experience like a television set because the screen is so small. We will return to most of these findings below, as we explore how Mobile TV is currently being used in a world of near infinite program choice and ubiquitous high-resolution smart devices. There are many differences from these early deployments.

A similar study was conducted in Japan by Miyauchi et al. [14] for a multi-channel broadcast system that was deployed in Tokyo. Participants most preferred watching variety shows during their evening train commutes. They also observed participants using Mobile TV at home in another room from the main television or while cooking. They were one of the first to discuss co-viewing on the mobile screen, although they mention only a few anecdotes. We were interested in quantifying behaviors like this in the general American population given the new spread of access to TV content on mobile devices.

Schuurman et al. [18] were interested in the content that should be displayed on Mobile TV and argued that "Mobile TV should be considered as a new mass medium with its own content and usage modes." They explored the types of content that were best suited to this medium, and argued that new types of content should be created solely for the mobile viewing experience. While they point to the considerable issues in business models, they highlight that making content for a shorter attention span that can be viewed in noisy environments is a unique opportunity for Mobile TV systems. They also discussed the importance of having the "triumvirate" of content — news, entertainment, and sports — but highlighted that news was the most desired, making Mobile TV more of a "visual radio" than an entertainment platform. By contrast, we will show how, in the end, the content that was "king" was the already very-popular cable and streaming TV entertainment shows.

Several researchers have studied Netflix behaviors, focusing on mobile viewing. Rigby et al. [16] found that viewers reported lower immersion with content when viewed on smaller mobile devices. Rigby et al. [17] also explored cross-device viewing, finding that the nine households they studied preferred mobile viewing for shorter clips, to watch content that others were not interested in, and to entertain kids. Groshek et al. [6] explored binge watching on Netflix finding "differential and largely non-negative effects across emotional and health domains" of watching multiple episodes at once.

Beyond studying "Mobile TV" (professionally produced television content on smartphones) other researchers have more broadly studied mobile video practices on smartphones [3, 19, 23]. Brown et al. [3] found that 0.5% of all mobile phone use was spent in YouTube in a study from 2013. Interestingly, they found that reading was far more prevalent than any video or audio experiences. Sun et al. [19] explored challenges when trying to watch YouTube together with others on a mobile phone, and discussed scenarios where viewers watched together with others on one device or casted to a larger display. Bentley and Murray [1] explored rewatching a variety of different types content and found that mobile devices were rarely used to re-watch TV content, which was much more prevalent on desktops and television sets.

Finally, McNally and Harrington [13] explored how millennials were using mobile video in their lives, again using this broader definition of video that went beyond television content. While professional TV content such as Netflix did come up, most of the discussion was on short user generated

videos on Instagram, YouTube, or Snapchat, leaving many questions open as to their TV content use.

The Mobile TV landscape in America has vastly changed since the earlier Mobile TV research was conducted around 2010. Streaming services such as Netflix and Hulu, mobile apps for premium cable channels such as HBONow and ShowtimeNow, and streaming apps from cable providers providing access to live and recorded cable TV shows have provided access to vast libraries of on-demand content. This is very different from the dozen or so channels of digital broadcast content studied in much of the work above. Television on mobile devices is no longer a second-class citizen to cable TV content-wise, but has as much (or more) content available to stream on-demand. It is in this new Mobile TV environment that we wanted to explore current behaviors in the American population.

3 METHOD

To answer our research questions, we conducted two surveys that were deployed to representative samples of online Americans. Both surveys used SurveyMonkey to reach their target audiences, a service that has shown to be accurate to within several percentage points of the American population [2] when studying technology use and is used by polling companies such as FiveThirtyEight to assess American opinions. Since these panels are largely not validated outside of the United States, we restricted our sampling to US participants. Both surveys were fielded in the fall/winter of 2017. All methods used were approved by our institution's standard review processes before the study was conducted.

Survey 1 (S1) was completed by 306 participants, aged 18-60+, 53% of whom were female. Survey 2 (S2) was completed by 509 participants, also aged 18 to 60+, 54% of whom were female. Participants in both surveys had education and income distributions that matched the broader American population (44% made less than $50k in household income, with 14% making over $125k) and were distributed throughout the United States in a similar pattern to the overall population (New England 6%, Mid-Atlantic 11%, E North Central 14%, W North Central 8%, S Atlantic 18%, E South Central 7%, W South Central 14%, Mountain 6%, Pacific 17%). We were quite happy with the samples we received and as discussed in the Findings below, the participants scored within a few percentage points of larger national surveys on questions that we asked in common to test for representativeness.

In addition to analyzing the results for each question and question grouping, we used cluster analysis to find patterns in behaviors, preferences, and demographics from the second survey (which was also why we recruited more participants for this survey). We performed a K-means clustering to find a solution where no group had less than 75 participants. K-means clustering was chosen as a standard technique for exploratory data analysis [24]. The default algorithm for initial k-means centers (initial scanning of data) was used. We explored subgroup composition for n+/-1 clusters to confirm stability of subgroups.

4 FINDINGS

In the following sections we will explore the data from the two surveys in order to answer our broader research questions. We will begin by exploring what types of television content Americans are watching on their mobile phones. Then we will explore how they are watching it, followed by the context of watching. Finally, we will explore behavioral clusters among mobile television watchers, highlighting the behaviors that specific groups of users share. The following section will then discuss the importance of these findings, how current mobile television deployments are quite different from what the HCI research community once predicted, and implications for the design of new mobile television services.

What are people watching?

First, we will explore the types of television content that people are watching on their mobile phones, including the services that they are using to access this content. Table 1 highlights the broad array of sources that participants were using to watch professionally-produced video content on their phones. Many traditional cable TV sources appear: 40% of participants had used an app from a cable provider, 31% had used the HBO app, 26% had used Hulu (network TV), and 23% had used Showtime. However, the most popular source of mobile television was Netflix, with 56% of participants watching a show on their phones, and 37% doing this at least once a week.

Now that we know the sources of content that were being used, we wanted to dig deeper into the specific types of shows that were being watched. Early Mobile TV systems focused on live events such as sports [8]. But with these new services, had this changed?

Table 2 highlights the genres of content that participants reported liking to watch on their smartphones. What is most interesting to us is that the types of live TV that were most popular in early Mobile TV deployments are not as popular in real use today. While 65% of people reported liking to watch Comedy shows on their phones, only 34% reported liking to watch Sports. Documentary (50% liked) and Tutorial (46% liked) were also surprisingly high. There is little existing research on these types of television shows on mobile devices and perhaps it is an opportunity for new services to approach these types of content in more depth.

We were also curious to what extent mobile phones had eclipsed other devices for viewing television content. Were

	Have Not Watched	Less Than Monthly	At Least Once a Month	At Least Once a Week	Most Days
Netflix	44%	11%	8%	15%	22%
Cable Provider App	60%	11%	11%	9%	10%
Facebook Watch	62%	11%	5%	10%	12%
HBO	69%	11%	8%	9%	3%
Hulu	74%	10%	6%	5%	7%
Snapchat Discover	77%	5%	6%	5%	7%
Showtime	77%	10%	6%	4%	2%

Table 1: The services that participants were using to watch professionally produced content on their mobile phones along with the relative frequencies of viewing this content. (S2)

	Strongly Dislike	Dislike	Neutral	Like	Strongly Like
Comedy	7%	3%	25%	34%	31%
Documentary	11%	6%	32%	32%	18%
Tutorial	14%	9%	30%	29%	17%
Sports	27%	14%	25%	18%	16%
News	12%	8%	30%	34%	15%
Drama	12%	10%	36%	28%	14%
Kids	26%	16%	36%	14%	7%
Reality TV	33%	17%	30%	13%	7%
Celebrity	35%	19%	25%	15%	6%

Table 2: Genres of content that participants reported liking to watch on their phones. (S2)

	2 min	5 min	10 min	30 min	60 min	90+ min
In the morning	43%	23%	18%	12%	3%	2%
Commuting	41%	18%	19%	17%	3%	2%
Free time during the day	26%	20%	22%	20%	9%	4%
In the evening	21%	14%	18%	20%	19%	8%
When traveling	24%	13%	13%	16%	14%	21%

Table 3: Ideal lengths for professionally produced video content on the phone in a variety of situations. (S2)

Americans watching shows exclusively on their mobile devices now? Or were smartphones augmenting other devices? Figure 1 shows the number of shows that participants had watched only on their phones in the past month. By far the most common response, at 68% of participants, was that all of the shows that they watched on their mobile phones they also watched episodes of on another device, such as a computer or television. However, that also means that 32% of participants had watched at least one show solely on their mobile devices.

At least currently, mobile phones are still a part of a larger ecosystem of television viewing, and for the vast majority of people the other devices still account for a majority of television viewing time. Any service that offers television content would be at a significant disadvantage in the current market if it only offered content on the mobile platform, as users expect to be able to watch a television series on any device as they move throughout their day.

Mobile television opens up the possibility to watch content in many different situations. We were interested in the different places and activities where people watched TV content on their phones. Figure 2 shows these situations. Watching television before bed was the most common response, with 44% of participants watching this way. Traveling (37%), while

Figure 1: "In the past month, how many different TV series have you only watched on your phone (i.e. you did not watch any episodes on a TV or computer)?" (S1)

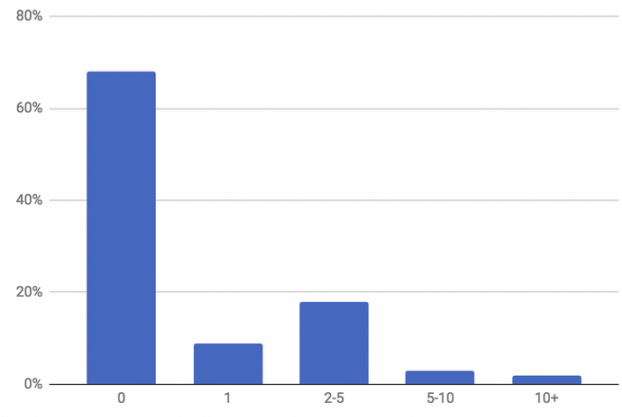
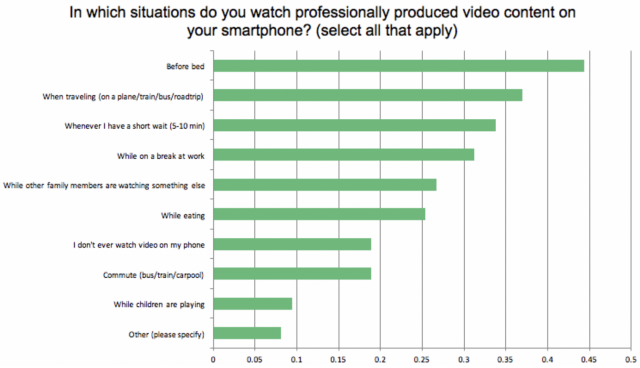


Figure 2: The situations where people watched mobile television. (S1)



having a short wait (34%) and when having a break at work (31%) were other popular times to watch video content. We found it interesting that 27% reported watching mobile television while other family members were watching different content on the television, quantifying an early qualitative finding from Holz et al [7]. 25% reported watching TV on their phones while eating, another situation that has not been explored in great detail.

As mobile television services continue to expand, and OTT solutions free themselves from the strict 30 or 60-minute long show formats of linear broadcast television, the opportunities for different show lengths emerged. We asked participants what their ideal show length would be for watching mobile television in in a variety of situations. Table 3 shows the results. Interestingly, participants preferred very short formats for professionally produced mobile video. This aligns well with some of the micro-show formats that services such as Snapchat and Facebook have been exploring. Shows such as The Voice for Snapchat were 5 minutes long[1]. During the evening and while traveling participants wanted longer form content, with 47% of participants wanting 30+ minute content in the evening and 51% wanting this type of content while traveling. That compares to only 17% who wanted this type of content in the morning or 22% who wanted it while commuting.

Overall, our participants were watching a variety of different television genres (favoring Comedy, Documentary, and Tutorials) from a variety of providers (OTT, cable packages, cable networks). They watched content on their phone before bed, while traveling, and while having short breaks during the day, preferring shorter content during daytime hours and longer forms at night. Mobile was just one device that they used to watch television, with the vast majority of series that they watched on the phone also watched on another device.

	Never	Rarely	Sometimes	Most of the Time	All of the Time
Use Headphones	33%	15%	22%	18%	12%
Use Closed Captioning	59%	14%	15%	6%	6%

Table 4: The use of headphones and closed captioning. (S1)

How are people watching?

We will now turn to an exploration of how people are watching television content on their mobile phones. We were interested in exploring the use of features such as captioning and headphones as well as in exploring how often people watched with others and if they turned their phone horizontal to watch content, given that most television content is produced for landscape viewing.

Since mobile devices are often used in public or other locations where sound is often not permitted, we were curious about the use of headphones and closed captioning while watching TV shows. Surprising to us was the high use of closed captioning, as shown in Table 4. Overall, 41% of participants had used closed captions while watching mobile

[1]https://www.snapchat.com/discover/The-Voice/0306340785

	Never	Less than Half the Time	About Half the Time	Greater than Half the Time	Almost Always
By Yourself	18%	4%	10%	15%	52%
With a Partner	51%	31%	12%	3%	3%
With Kids	69%	20%	6%	4%	2%
With Friends	61%	26%	7%	3%	2%

Table 5: The Social context of mobile television viewing. (S2)

television in the past. Also, 66% had reported using headphones, with 30% reporting using them most or all of the time that they watched television on their phones.

We were also interested in the social context of mobile television watching. While the home television has been typified as the device that brought the family together in the evenings, the mobile phone is seen in the popular press as more of an isolating device [20]. Were people watching together on these small screens? Table 5 shows the details. While over half of participants (52%) almost always watch alone, 18% watch half the time or more often with their partner, 12% watched this often with kids, and 12% also watched this often with friends. This is not an insignificant percentage of the time, and more often than we had expected before conducting this research. Phones are not always an isolating force, where people watch videos alone, but a significant percent of the time about half of users are watching with others on the single phone screen.

Interestingly, when further exploring the 18% who "never" watched alone, only 9% of this group was in the 18-24 range, with increasing percentages in each age group up to the 60+ group which comprised 42% of those who never watched alone. While younger people are often seen as being more social with their phones, it is the older adults who are more likely to watch television content together with others on the small screen of the phone.

Finally, we wanted to explore how participants were holding their devices. As watching video full screen involves turning the device, we were curious how often this happened. When asked to think beyond TV to any type of video watched on the phone, participants stated that YouTube videos were most commonly watched vertically (52% of participants who watched this type of content watched vertically in the past month), followed by Social posts on Facebook/Twitter (40%), and News clips on Facebook/Twitter (31%) and Snapchat Stories (21%). Only 6% had watched live sports vertically and 10% had watched TV episodes this way in the past month.

Older adults were the most likely keep their phone vertical (50% for those 60+) (perhaps due to using orientation locks) for the last video watched. Women were also slightly less likely to turn their device, with 23% not turning the device, compared with only 16% of men.

Overall, about half of participants were watching mobile television content with others at least some of the time and many utilized closed captioning or headphones at least some of the time. Most of the time, devices were rotated to watch television content full screen in a horizontal orientation.

Cluster Analysis

Finally, we will explore how the behaviors discussed above cluster together. Through a K-means cluster analysis, we identified five well-sized, distinct clusters of users based on their behaviors. The clusters converged in 19 iterations. All variables in Table 6 were significant at $p < 0.04$ and each cluster had more than 15% of the 509 total participants. We will discuss the demographics of each cluster as well as their most salient behaviors that differ from the other clusters.

Cluster 1 (15% of participants): No free time, low video users. This cluster was the highest educated, oldest, and generally upper middle class. On average, they reported not watching videos during the little free time they had. Most notably, they reported having the lowest interest in most types of content, had the least frequent video watching behaviors on their mobile devices and mostly did not subscribe to any video services. They strongly favored short-form video and, for the little content that they watched, they watched it alone.

Cluster 2 (23% of participants): Long form, watch alone user. This cluster strongly preferred watching longer form content on their mobile devices, with longest form preferences (60 minutes) during travel. They liked watching Comedy, Drama, Documentary, and Tutorial shows and were less likely to be into Sports. They tended to be mid income (~$50k) and were more likely to be subscribed to Netflix, Hulu, HBO, and cable. They love traditional longer form shows and use the mobile phone to augment existing viewing on television sets.

Cluster 3 (25% of participants): Shorter form, watch alone. Cluster 3 is similar to Cluster 2 in demographics and tending to watch videos alone, however this segment watches subscriptions less often and the majority has never watched a series solely on a mobile phone despite having a stronger preference for shorter programs (2-5 minutes). Also in contrast to Cluster 2, who watched videos before bed and during travel, those in Cluster 3 did not watch videos as often in those situations.

	Cluster 1: No free time, low video	Cluster 2: Long form, watch alone	Cluster 3: Shorter form, watch alone	Cluster 4: Mobile video lovers.	Cluster 5: High income, multi-length viewers
Education	Bachelor's Degree	Assoc/Trade	Assoc/Trade	Assoc/Trade	Assoc/Trade
Age	45-60	30-44	30-44	30-44	30-44
Income	100k-125k	50k-75k	50k-75k	25k-50k	>200k
Free time watching video	none	> half	about half	most of free time	> half
Use of the following services in the past three months:					
Netflix	never	monthly	< monthly	weekly	monthly
HBO	never	< monthly	never	monthly	< monthly
Showtime	never	never	never	< monthly	never
Hulu	never	< monthly	never	< monthly	< monthly
Snapchat	never	< monthly	never	< monthly	< monthly
FB Watch	never	< monthly	< monthly	monthly	< monthly
Cable App	never	< monthly	< monthly	monthly	< monthly
TV series only on phone	none	1 series	none	1 series	1 series
Use closed captioning	never	rarely	rarely	rarely	rarely
Situations of watching professionally produced video content on the phone: (0=Don't do this, 1=Do this)					
Before bed	0	1	0	1	1
While Traveling	0	1	0	1	0
Watching mobile video:					
By yourself	< half	> half	> half	> half	> half
With a partner	never	< half	< half	< half	< half
With kids	never	never	never	< half	never
With friends	never	never	never	< half	< half
Genre Preferences (1=Strongly dislike, 2=Dislike, 3=Neutral, 4=Like, 5=Strongly like)					
Comedy	2	4	4	4	4
Drama	2	4	3	4	3
Kids Programming	2	3	3	3	2
Reality TV	2	3	2	3	2
News	2	3	3	4	3
Celebrity TV	2	2	2	3	2
Documentaries	2	4	4	4	3
Tutorials	2	4	3	3	3
Sports	2	2	3	4	3
Ideal content length (1=2min, 2=5min, 3=10min, 4=30min, 5=60min, 6=90min+)					
Morning	1	3	1	3	2
Commuting	1	3	1	3	2
FreeTime	1	4	2	4	3
Evening	1	4	2	4	4
Travel	1	5	2	4	4
Services Used: (1= Do not use, 2=Share an account, 3=Pay for my own account)					
Netflix	2	2	2	2	2
Hulu	1	2	1	2	1
HBO	1	2	1	2	1
Showtime	1	1	1	2	1
Starz	1	1	1	2	1
Cable	2	2	2	2	2
PPV	1	2	1	2	1
When watching video on your phone, which of the following genres do you prefer?					
Daily Comedy	1	2	2	4	3
Sitcoms	1	2	2	4	2
Dramas	1	2	2	3	2
Reality TV	1	2	2	3	2
News	1	2	2	3	2
Sports	1	1	2	4	2

Table 6: Cluster Centers, Most Relevant Variables included in Cluster analysis. (S2)

Cluster 4 (19% of participants): Mobile video lovers. This was the lowest income group, and tended to be younger. They watch the most video on their phones from a wide variety of paid subscriptions (HBO, Showtime, Hulu, Cable Apps) as well as Snapchat and Facebook Watch. They reported having the most free time and watched video content in their downtime and sometimes with friends. They strongly preferred longer form shows (10-30 minutes) over shorter form clips or programs. Overall, these are mobile video fanatics.

Cluster 5 (17% of participants): High income, multi-length viewers. This group was the highest income group. They had the widest range of preferences in terms of variety of different content lengths to fit different parts of their day, preferring shorter content in the morning and long-form content in the evenings and when traveling. Similar to Cluster 4, they occasionally watch with friends.

Overall, each of these clusters shows a different type of mobile television viewer, and different types of services can be targeted to each cluster. While some want shorter form content in the mornings, others heavily watch longer form programs in bed with their partner. Some "snack" on episodes of shows that they also watch on other devices, while others consume large amounts of video content multiple times per week. The demographics of each cluster also indicate which are most lucrative for higher-cost packages of premium content, although it is notable that lower-income clusters (e.g. Cluster 4) subscribe to many different video services.

5 DISCUSSION

Mobile television viewing has now reached mass-market adoption in the United States. With this growth in use, Mobile TV turned out to be quite different from what many in our community were proposing in 2010 in the Mobile TV book [12]. While earlier research focused on live broadcasting of linear TV channels, most viewing in 2017 occurs via streaming sites such as Netflix, HBONow, or Hulu.

And while that earlier research often pointed to news or other "visual radio" content being most appreciated [14], our participants reported strongly preferring traditional entertainment TV formats such as 30-minute comedies or 60-minute drama shows, watched on demand and often while in bed or while traveling.

It is interesting to think about why the HCI community was so wrong about the future paths of technology and content consumption, with most discussion in 2010 focusing on DVB-H [8, 11, 12] and related broadcast technologies as the future of Mobile TV. Partially, this is a common error in underestimating the impact and rapid deployment of new infrastructure. Similar to the case study of the Iridium satellite phone service, [4] where executives failed to anticipate how quickly cellular infrastructure would be deployed, our community did not anticipate the rapid rollout of 4G/LTE networks that would enable streaming services. This in turn limited our ability to see the rise of streaming as the primary mode of television content delivery and led to our focus on broadcast and other multi-cast technologies.

Current content preferences can also be driven substantially by marketing. Netflix alone is now spending $1B per year just on advertising their content and original shows [5]. Big cable networks such as HBO also spend significant amounts on advertising, taking over large percentages of billboards and subway stations in major cities for the premier of each of their big-budget shows. As people turn to mobile devices for more and more of their media consumption, it makes sense that they also watch more of the blockbuster entertainment content on these devices.

The true mass-market nature of mobile television consumption was also quite interesting to us. In our cluster analysis, only 15% of our representative online American sample was in the low/no Mobile TV use cluster. The vast majority of Americans with smartphones are using them at least some time in a month to watch a television program. And many are using them daily to watch television content in the morning, on commutes, while cooking/eating, in bed, or while others are watching something else on the main television set.

Cluster analysis enabled us to observe different patterns indicative of behavior related to "snacking" on short videos, watching one or a few episodes or "binge watching" for longer sessions. Cluster 1 "No free time, low video users" have no free time for video "snacking" throughout the day, whereas the others did, especially Cluster 4. One might expect a cluster that prefers snacking over other types of watching, however this pattern did not exist; Participants in Cluster 4 were overall enthusiasts with the strongest desire for short-form as well as long-form content.

Most interesting to us is the rapid pace at which video practices have changed in America. The behaviors that we have observed are so new that even papers published a few years ago seem to describe another world. While most video watching just a few years ago was on services such as YouTube and television content was mostly relegated to larger-screened televisions and laptops, our survey participants were extremely engaged in watching mobile television content. Mobile rights are now available for sites like Netflix to stream large TV content libraries and new services from cable networks, such as dedicated mobile apps to purchase and stream content from industry powerhouses such as HBO, Showtime, and CBS have entered the market. Yet the phone is still a complementary device to the television set, with the majority of TV series where an episode or more was watched on the phone also watched on the television set for other episodes in the series.

6 IMPLICATIONS FOR DESIGN

Overall, this study has enabled us to look at mainstream mobile television viewing practices and content preferences. This opens up several implications for the design of new mobile television services and content.

Design for Complementary Use

While Mobile TV viewing was quite high across our sample, most shows continued to be watched on other devices, such as a television, with the occasional episode being watched on a mobile phone while traveling or when in bed for the night. Services that only provide content on mobile devices are missing out from the user expectation that content is available everywhere. Providing content on all devices is critical for future professional video services.

This often runs into the many issues of content rights. But this is a concept that most users do not fully understand. From other interviews we have conducted, we have seen that users are often confused when services offer content only on one type of device. Viewing on a TV through a cable provider, or Chromecasting from a laptop or phone to the TV seem to be the same use case to users, but are often different types of rights that must be acquired, even though they result in the same experience — viewing a show on the television set.

Design Content for Mobile

The TV content that our participants watched was designed for a larger screen. When it is viewed on a small device, it tends to be viewed horizontally and details that are visible on a television set might be lost. As mobile television use grows (to over half of all TV viewing by 2020 [9]), content producers should consider these smaller format screens when crafting their scenes, special effects, and any on-screen text that will be much harder to read on a small device. Other content that is less visually dynamic, such as stand-up comedy, can be cropped vertically, which would increase the size of the actor and take advantage of typical way that smartphones are held. Popular shows such as The Voice are already exploring these types of formats on Snapchat.

Mix Long-form and Short-form Content

Our participants had preferences for all lengths of content. Short form content was most frequently preferred on the mobile device for morning activities. Quick mini-episodes, similar to those being produced for Snapchat, can make for quick entertainment in the morning. However, participants also strongly preferred traditional long-form TV content for the evening and while traveling.

Thirty-minute sitcoms and sixty-minute dramas remain incredibly popular to watch on mobile devices. New mobile streaming services should balance these two types of content to engage users throughout the day. The temporal preferences that we observed can also be leveraged here. Short (2-10 minute) teasers, behind the scenes "extras" content, or mini-episodes could be created for the morning with longer episodes meant to be consumed in the evenings.

Premium Content Remains King (As Does Content Advertising)

The types of content that our participants engaged with were the big blockbuster cable (and premium streaming site) content. What users are advertised and what everyone is talking about remain to be what people are watching on their handheld devices. The large video services have budgets in the billions of dollars for content creation and marketing, and have now taken over from lower budget sources of content for mobile viewing. While the big networks were late to the game (HBONow only launched in 2015), they now dominate viewing on this platform. New mobile television services need to recognize this reality and compete with the large content players.

7 LIMITATIONS

While our study enabled us to get feedback from a broad, representative sample of Americans, there are some limitations that we would like to point out. The survey data is based on self-reported use, and is subject to the usual biases that can appear when people are asked to remember their behaviors. For most questions, we sought to limit these biases by asking participants about activities that they have performed in the last month and also grounding some questions in specific last instances of use. We specifically did not ask about frequency of viewing specific types of shows, as people are generally not able to accurately answer these types of questions about everyday behaviors.

In addition, our surveys were only conducted in the United States. Behaviors in other countries may be different, and are topics for future work. Given the large media ecosystem in America, and these ease of conducting surveys with representative samples of users, we feel that it is a good place to start.

Overall, we see our key contribution in the broad sample of our research participants and understanding new patterns of Mobile TV behavior at scale. The tradeoffs above were necessary to collect data with such a broad sample of people across a variety of services that do not provide researchers with access to usage data. Additional research would be necessary to qualitatively understand why people are choosing the content that they are, or the details around logistics for co-watching. We hope that this research can open up a variety of interesting questions for future smaller-scale ethnographic-style research to further understand user motivations.

8 CONCLUSION

Mobile TV has greatly evolved from the earlier research in the CHI community around digital video broadcast technologies. The way that television content is viewed on mobile devices today in America is not in the form of a linear broadcast, but rather on-demand via a variety of streaming apps from mass-market brands such as Netflix, HBO, and major cable networks, with preferences for certain content types especially suited to the handheld format.

The evolution in how people receive television content on their phones has led to a wide variety of changing behaviors, including strong preferences for traditional programming, however documentaries and tutorials were also surprisingly popular. Mobile TV did not replace viewing on a traditional television set or computer – it augmented this behavior through watching some episodes on the mobile device when it was most convenient (e.g. in bed, while commuting or traveling, etc.). Surprisingly, given the personal nature of the mobile phone, half of participants had watched a show together with other people simultaneously on the same mobile device.

We hope that this study opens up even more questions for future qualitative exploration. We believe it is incredibly important to conduct studies like this one in order to size certain behaviors at a country level and to see where certain behaviors might be more niche or widespread. Future ethnographic work can better understand the motivations and emotional reactions to various Mobile TV content types or viewing situations.

REFERENCES

[1] Frank Bentley and Janet Murray. 2016. Understanding Video Rewatching Experiences. In *Proceedings of the ACM International Conference on Interactive Experiences for TV and Online Video (TVX '16)*. ACM, New York, NY, USA, 69–75. https://doi.org/10.1145/2932206.2932213

[2] Frank R Bentley, Nediyana Daskalova, and Brooke White. 2017. Comparing the reliability of Amazon Mechanical Turk and Survey Monkey to traditional market research surveys. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, 1092–1099.

[3] Barry Brown, Moira McGregor, and Donald McMillan. 2014. 100 days of iPhone use: understanding the details of mobile device use. In *Proceedings of the 16th international conference on Human-computer interaction with mobile devices & services*. ACM, 223–232.

[4] Sydney Finkelstein and Shade H Sanford. 2000. Learning from corporate mistakes: The rise and fall of Iridium. *Organizational Dynamics* 29, 2 (2000), 138–148.

[5] Wayne Friedman. 2017. Netflix Ups Marketing Budget to $1 Billion. (2017). https://www.mediapost.com/publications/article/307175/netflix-ups-marketing-budget-to-1-billion.html

[6] Jacob Groshek, Sarah Krongard, and Yiyan Zhang. 2018. Netflix and Ill?: Emotional and Health Implications of Binge Watching Streaming TV. In *Proceedings of the 9th International Conference on Social Media and Society (SMSociety '18)*. ACM, New York, NY, USA, 296–300. https://doi.org/10.1145/3217804.3217932

[7] Christian Holz, Frank Bentley, Karen Church, and Mitesh Patel. 2015. I'm just on my phone and they're watching TV: Quantifying mobile device use while watching television. In *Proceedings of the ACM International Conference on Interactive Experiences for TV and Online Video*. ACM, 93–102.

[8] Fred Kitson. 2010. Mobile TV's Time to Shine Has Arrived. In *Mobile TV: Customizing Content and Experience*. Springer, 5–9.

[9] Ericsson Consumer Lab. 2017. TV and Media 2017: A consumer-driven future of media. (2017). https://www.ericsson.com/en/networked-society/trends-and-insights/consumerlab/consumer-insights/reports/tv-and-media-2017

[10] Adam Lella. 2017. U.S. Smartphone Penetration Surpassed 80 Percent in 2016. (2017). https://www.comscore.com/Insights/Blog/US-Smartphone-Penetration-Surpassed-80-Percent-in-2016

[11] Bram Lievens, Eva Vanhengel, Jo Pierson, and An Jacobs. 2010. Does Mobile Television Enhance a New Television Experience? In *Mobile TV: Customizing Content and Experience*. Springer, 81–96.

[12] Aaron Marcus, Anxo Cereijo Roibás, and Riccardo Sala. 2009. *Mobile TV: Customizing Content and Experience*. Springer.

[13] Jennifer McNally and Beth Harrington. 2017. How Millennials and Teens Consume Mobile Video. In *Proceedings of the 2017 ACM International Conference on Interactive Experiences for TV and Online Video*. ACM, 31–39.

[14] Koji Miyauchi, Taro Sugahara, and Hiromi Oda. 2010. Different attitudes concerning the usage of live mobile tv and mobile video. In *Mobile TV: Customizing Content and Experience*. Springer, 165–193.

[15] Lee Rainie. 2017. About 6 in 10 young adults in U.S. primarily use online streaming to watch TV. (2017). http://www.pewresearch.org/fact-tank/2017/09/13/about-6-in-10-young-adults-in-u-s-primarily-use-online-streaming-to-watch-tv/?utm$_{c}$ontent=buffer45fc5&utm$_{m}$edium=social&utm$_{s}$ource=twitter.com&utm$_{c}$ampaign=buffer

[16] Jacob M. Rigby, Duncan P. Brumby, Anna L. Cox, and Sandy J. J. Gould. 2016. Watching Movies on Netflix: Investigating the Effect of Screen Size on Viewer Immersion. In *Proceedings of the 18th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct (MobileHCI '16)*. ACM, New York, NY, USA, 714–721. https://doi.org/10.1145/2957265.2961843

[17] Jacob M. Rigby, Duncan P. Brumby, Sandy J. J. Gould, and Anna L. Cox. 2018. "I Can Watch What I Want": A Diary Study of On-Demand and Cross-Device Viewing. In *Proceedings of the 2018 ACM International Conference on Interactive Experiences for TV and Online Video (TVX '18)*. ACM, New York, NY, USA, 69–80. https://doi.org/10.1145/3210825.3210832

[18] Dimitri Schuurman, Lieven De Marez, and Tom Evens. 2010. Content for Mobile Television: Issues Regarding a New Mass Medium Within Today's ICT Environment. In *Mobile TV: Customizing content and experience*. Springer, 143–163.

[19] Emily Sun, Rodrigo de Oliveira, and Joshua Lewandowski. 2017. Challenges on the Journey to Co-Watching YouTube. In *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*. ACM, 783–793.

[20] Sherry Turkle. 2017. *Alone together: Why we expect more from technology and less from each other*. Hachette UK.

[21] European Broadcasting Union. 2004. ETSI EN 302 304 V1.1.1 (2004-11) Digital Video Broadcasting (DVB); Transmission System for Handheld Terminals (DVB-H). (2004). https://www.etsi.org/deliver/etsi$_{e}$n/$302300_{3}02399/302304/01.01.01_{6}0/en_{3}02304v010101p.pdf$

[22] European Broadcasting Union. 2009. ETSI TS 102 428 V1.2.1 (2009-04) Digital Audio Broadcasting (DAB); DMB video service; User application specification. (2009). https://www.etsi.org/deliver/etsi$_{t}$s/$102400_{1}02499/102428/01.02.01_{6}0/ts_{1}02428v010201p.pdf$

[23] W Alex Vorbau, April Slayden Mitchell, and Kenton O'Hara. 2007. " My iPod is my Pacifier": An Investigation on the Everyday Practices of Mobile Video Consumption. In *Eighth IEEE Workshop on Mobile Computing Systems and Applications*. IEEE, 29–33.

[24] Kyrylo Zakharov. 2016. Application of k-means clustering in psychological studies. *Tutorials in Quantitative Methods for Psychology* 12, 2 (2016), 87–100.