

Understanding and Comparing Smartphone and Tablet Use: Insights from a Large-Scale Diary Study

Hendrik Müller^{1,4}, Jennifer L. Gove², John S. Webb³, and Aaron Cheang¹

¹ Google Australia Pty Ltd., 5/48 Pirrama Road, Pyrmont, NSW 2009, Australia

² Google Inc., 1600 Amphitheatre Parkway, Mountain View, CA 94043, United States

³ Google Inc., 76 Ninth Avenue, New York, NY 10011, United States

⁴ The University of Sydney, Design Lab, Wilkinson building, NSW 2006, Australia

{hendrikm, jgove, jwebb, aaronc}@google.com

ABSTRACT

In recent years, smartphone and tablet ownership has shown continued growth; however, there is a lack of research thoroughly investigating the use of these devices within the general public. This paper describes a large-scale diary study with U.S. mobile device owners, examining details of smartphone and tablet use. Results provide a comprehensive breakdown of frequent activities and contexts of use, highlighting key differences in smartphone and tablet use. Activities on smartphones were found to be dominated by communication needs, while tablets were frequently used for consumption and entertainment. Both devices were most often used at home, with tablets rarely leaving the home. Within the home, smartphones were used mostly in the bedroom, and tablets in the living room. Both devices were used frequently while doing something else, such as using tablets primarily while watching TV. Conclusions discuss implications for enriching the experience of mobile devices and opportunities for future research.

Author Keywords

Tablet; smartphone; mobile devices; diary study

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Following the introduction of the Apple iPhone in 2007, mobile device ownership has grown rapidly and quickly to become an established aspect of daily life. In the U.S., adult smartphone device ownership was at 33% in 2011 (Pew Research, 2011) growing to 56% at the end of 2013 (Pew Research, 2013a) and to 64% in early 2015 (Pew Research, 2015) Tablet device ownership followed a similar trend. After the introduction of the Apple iPad in 2010, 10% of U.S. adults owned a tablet device by the end of 2011 (Pew Research, 2012), 33% by 2013 (Pew Research, 2013b) and 42% at end of 2014 (Pew Research,

Permission to make digital or hard copies of part or all of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for third-party components of this work must be honored. For all other uses, contact the Owner/Author.

Copyright is held by the owner/author(s).

OzCHI '15, December 07 - 10 2015, Melbourne, VIC, Australia

ACM 978-1-4503-3673-4/15/12

DOI: <http://dx.doi.org/10.1145/2838739.2838748>

2014). Despite this rapid integration of smartphones and tablets into the daily lives of many, there is limited research on mobile device ecosystems (Kjeldskov & Paay, 2012), and how these devices are used and integrated into everyday contexts. Indeed, as these devices continue to evolve, it is important to understand patterns of use to inform future design.

While marketing studies have assessed the growth of mobile device ownership within the general population quantitatively, and academic research has focused on qualitatively examining the use of mobile devices within specific contexts and user groups, research has yet to systematically and thoroughly investigate smartphone and tablet use within the general public. Research presented in this paper was conducted to address this gap within the U.S. population for both smartphones and tablets, combining quantitative and qualitative methods.

RELATED WORK

Various behaviors have been studied to understand particular aspects of smartphone use, including web search (e.g., Church, Cousin, & Oliver, 2012), locations (e.g., Patil, Norcie, Kapadia, & Lee, 2012), and apps (e.g., Hang, De Luca, Hartmann, & Hussmann, 2013). A number of research methods have also been applied (Kjeldskov & Paay, 2012), including interviews (e.g., Gustarini, Ickin, & Wac, 2013), questionnaires (e.g., Lee et al., 2014), and logs analysis (e.g., Tossell, Kortum, Rahmati, Shepard, & Zhong, 2012). Findings from these studies revealed some insight into usage behavior within specific contexts. Common smartphone activities have been found to include communicating via text messages and emails, social networking, web browsing, using location-based services, shopping, and entertainment (Nielsen, 2013). Studies of app use have found the most popular apps are games and social networking (Nielsen, 2013). The impact of location on behavior is also discussed widely. Smartphones are frequently used in stationary familiar environments, such as at work or home (Church & Oliver, 2011; Nylander, Lundquist, & Brännström, 2009). Search behavior is shaped by location of use, social factors, and other aspects of context (Church & Oliver, 2011). For communication, SMS is preferred while indoors, and voice calls are chosen while on public transit, shopping, or at the park (Do, Blom, & Gatica-Perez, 2011). Despite this research, there remains a lack of qualitative research providing a systematic overview of everyday smartphones use (Barkhuus & Polichar, 2011; Müller, Gove, & Webb, 2012).

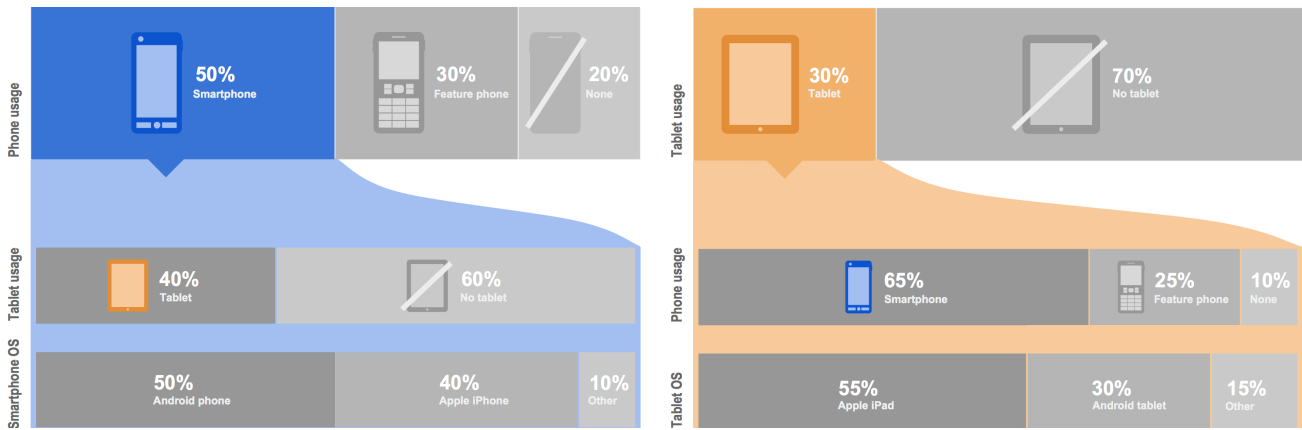


Figure 1. Mobile device use within U.S. adults. Left: Cell phone use. Right: Tablet device use.

The everyday use of tablets by the general public has similarly not received wide attention in research. Instead, investigations have focused on specific aspects of use, such as education (e.g., Jahnke, Svendsen, Johansen, & Zander, 2014), healthcare (e.g., Lin et al., 2013), touch and gestures (e.g., Kleimola, Laine, Litvinova, & Vuorimaa, 2013), and the use of styli (e.g., Badam, Chandrasegaran, Elmquist, & Ramani, 2014). Further, only specific populations have been studied, such as children (e.g., Mohd Shukri & Howes, 2014), students (e.g., Bryfczynski, Pargas, Cooper, & Klymkowsky, 2012), those with autism (e.g., Hourcade, Williams, Miller, Huebner, & Liang, 2013), health care providers (e.g., Li & Alem, 2013), patients (e.g., Jacobs, Clawson, & Mynatt, 2014), and office workers (e.g., Stawarz, Cox, Bird, & Benedyk, 2013). Other research has focused on specific behaviors, such as search (e.g., Song, Ma, Wang, & Wang, 2013), programming (e.g., Fagen & Kamin, 2013), and personal information management (e.g., Buttfield-Addison, Lueg, Ellis, & Manning, 2012) rather than a broader exploration of all activities. Marketing research has explored the use of tablets for shopping (e.g., Nielsen, 2012) and as a second screen accompanying TV viewing (e.g., Nielsen, 2012a). Müller et al., 2012 has explored everyday tablet use of U.S. adults through diary research and interviews, identifying primary activities as checking emails, gaming, social networking, and searching for information. This study found that tablets were used more often and for longer durations on a typical week day than a weekend day. The research also explored common co-occurring activities such as email checking while watching TV and listening to music while cooking. Further research is required to update the understanding of general tablet use as devices evolve.

Few studies have compared smartphone and tablet use. Lu, Wang, & Ma, 2013 investigated design needs for news sites across iPhones, iPads, and desktops, revealing users of news sites on smartphones required a more efficient use of space and expected to do less typing and clicking than when using larger screens. By analyzing logs data, Song et al., 2013 explored search behavior, highlighting that search query length, categories, location of use, and use time differed between desktop, tablet, and phones. This research also revealed that tablet users typed more local and commerce queries than users of mobile phones or desktops. While devices have been compared

for specific contexts and topics, there has not been a systematic comparison of general use between smartphones and tables.

Results presented in this paper begin to address the limitations of previous research by exploring everyday use of smartphones and tablets within the general population across all activities and contexts, in addition to comparing use activities between smartphone and tablets.

STUDY METHODOLOGY

The goal of this research was to examine and compare smartphone and tablet use in U.S. adults. To this end, preliminary research was conducted to identify segments of mobile device ownership across U.S. adults; these segments were then used to inform a retrospective diary study designed to collect qualitative and quantitative data on smartphone and tablet use within the U.S. adult population in November 2013.

Preliminary Research

A preliminary study was conducted to quantify the landscape of smartphone and tablet use across the U.S., in particular to identify proportions of device ownership and the overlap between smartphone and tablet ownership.

Several surveys with a total of 32 items were distributed using the Google Consumer Surveys platform (to ensure generalizability across the U.S. adult Internet population McDonald, Mohebbi, & Slatkin, 2012). With an average question response rate of 71.3%, a total of 109,819 responses were collected from 82,640 respondents. As displayed in Figure 1, findings showed 50% of U.S. adults used a smartphone (50% Android-based, 40% Apple iPhones, and 10% others) and 30% used a tablet (55% Apple iPads, 30% Android-based, and 10% others). Of respondents who used a smartphone, about 40% also used a tablet; of those who used of a tablet, 65% also used a smartphone. For 10% of U.S. adults, the tablet was their only mobile device. Collating this data resulted in an overview of multi-device use, as depicted in Figure 2.

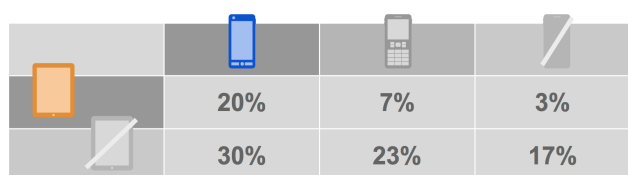


Figure 2. Overlap in U.S. adults' smartphone and tablet use.

Operating system	Apple iOS 48% (86)	Android 48% (86)	Others 4% (7)
Internet access	Wifi 49% (88)	Data plan 50% (90)	None 1% (1)

Table 1. Details about all smartphones.

Operating system	Apple iOS 58% (84)	Android 41% (60)	Others 1% (1)
Device size	≈10 inch 62% (90)	≈7 inch 38% (55)	
Internet access	Wifi 83% (120)	Data plan 6% (9)	None 11% (16)

Table 2. Details about all tablets.

For the purpose of the diary study, we identified three key segments: Smartphone-only (SO) individuals who use a smartphone but not a tablet (30%), tablet-only (TO) individuals who use a tablet but not a smartphone (10%), and smartphone-and-tablet (ST) ones using both (20%).

Diary Study Participants

A total of 176 participants successfully completed a diary study (94% completion rate). Insights from preliminary research described above formed the target proportions for primary recruiting criteria. To enable comparisons between mobile device types given the small proportion of tablet owners within the general U.S. population, tablet owners were over-recruited within the study sample.

The final sample comprised a segment breakdown of 28% SO (n = 49), 13% TO (n = 23), and 59% ST (n = 104) participants. As some participants used more than one smartphone or tablet, the total number of mobile devices came to 179 smartphones and 145 tablets (refer to Table 1 and Table 2 for distributions across operating systems, sizes, and Internet access methods). Secondary recruiting criteria ensured a mix across demographics, including age, gender, education, tech-savviness, commuting habits, and occupation. Participants ranged in age from 18 to over 61, with 32% 18–30, 44% 31–50, and 24% 51–61+ years old. Furthermore, 68% identified their gender as female and 32% as male.

Diary Study Procedure

Introductory tasks coupled with an 11-day retrospective diary was used to collect data about participant device use. Introductory tasks collected characteristics about participants and their devices through an introduction by the participant, a device details questionnaire, photos of their mobile devices, and concluded with instructions for the daily diary with a practice diary entry. The retrospective method was chosen over an incidence diary to improve the validity of the data through limiting interruptions for data collection throughout the day and allowing for combined reporting of repetitive tasks from a single day.

Using information from introductory tasks, each participant diary questionnaire was personalized with the devices they owned. The online questionnaire was designed to be filled out on any device with responses saved at each step to allow for sequential or end-of-day completion. To record reflections on all mobile device

use for a given day, the questionnaire started with an overview of all activities, i.e., "List the different activities you used your [device] for on [day]" with 20 separate open-ended text fields. For each reported activity, open and closed-ended questions then captured rich details, including further explanations of the activity itself, its frequency and times throughout the day, and several aspects of the contexts of use.

Participants were given a unique login to their diary for each day and were required to complete their diary at least once a day irrespective of device use. Participants were asked to take screenshots or otherwise keep short reminders throughout the day about their device use to reduce memory bias. To ensure daily compliance, participants were sent reminders; additional ones were sent after non-compliance.

RESULTS

Over the 11 days of the diary study, a total of 1,846 diary submissions across 176 participants describing 38,017 incidences of smartphone and tablet use were collected. Each participant submitted entries for a median of 11 days (mean = 10.5, min = 8, max = 11, SD = 0.7) and reported a median of 158 incidences of use (mean = 216.0, min = 14, max = 1086, SD = 181.4). Note that this research did not collect data on activity durations, but only incidences of use. See Table 3 for breakdowns of the collected incidences.

As the diary included several open-ended questions with thousands of responses each, coders created a coding system using a bottom-up approach, established inter-rater reliability, and subsequently categorized the data. Through the analysis of both the closed and open-ended diary responses, the study uncovered use patterns and contexts in which smartphones and tablets were used by U.S. adults.

Frequency of Mobile Device Use

Smartphones received about four times more frequent use than tablets. While smartphones were used at least once

	SO	TO	ST	Total
Smartphone	8,005	n/a	25,227	33,232
Tablet	n/a	1,501	3,284	4,785
Total	8,005	1,501	28,511	38,017

Table 3. Number of collected mobile device use incidences by device type and segment.

	SO	TO	ST	Total
Smartphone	94.0%	n/a	96.7%	95.8%
Tablet	n/a	87.1%	53.6%	59.7%
Total	94.0%	87.1%	98.7%	95.9%

Table 4. Percentage of days on which each device was used at least once, by device type and segment.

	SO	TO	ST	Total
Smartphone	17.5	n/a	25.3	22.8
Tablet	n/a	8.1	10.9	10.3
Total	17.5	8.1	27.1	22.5

Table 5. Incidences of daily use by device type and segment (for days device was used).

almost every day, tablets were used on just over half of the days. Those in the ST segment used their smartphone on more days and their tablet on less days, when compared to those who owned only a single mobile device (see Table 4). On days the device was used at least once, SO participants used their smartphone 22.8 times whereas TO participants used their tablet about half as often. ST participants showed increased total use across *both* devices (see Table 5).

Smartphones were used more often on a typical weekday compared to a typical weekend day (24 vs. 19 use incidences); however, activity patterns were similar across weekend and weekdays, though participants tended to use text messages and social networks more often on weekends, while there was more email and phone use on weekdays. Tablet use frequency did not notably differ between a typical weekday and weekend day (10 vs. 11 incidences); however, tablets tended to be used more frequently for emails, social networking, and watching TV/videos on weekdays vs. weekends.

While smartphone use was relatively equal throughout the day, tablet use peaked in the mornings and especially in the evenings. While the total use of smartphones was still higher than tablets at any given time during the day; during evenings and on weekends, tablet use started encroaching smartphone use (see Figure 3 for details).

Mobile Device Activities

Smartphone and tablet use showed different patterns, both in terms of which activities were done on each device type and the relative frequencies of these activities.

Smartphone Activities

Smartphones were used primarily for communication needs (69.3%) followed by consumption and entertainment activities (14.5%), utilitarian and

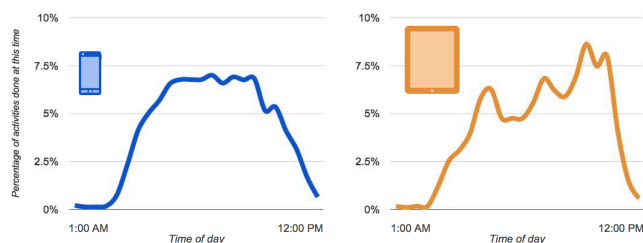


Figure 3. Relative device use incidences throughout the day for smartphones (left) and tablets (right).

information needs (11.1%), content creation (3.2%), device management (0.5%), and other themes (1.4%). Overall, top activities were related to text messages, emails, and phone calls (see Table 6 for details).

When used for communication, smartphone activities related to text messages, emails, phone calls, social networking (messaging, commenting, posting), chat, and video calls; e.g., “I was texting, watching *Real Housewives of Atlanta*, [on TV] and folding clothes”. Consumption and entertainment activities, as defined here, included social networking (reading content), playing games, listening to music, reading (books, news, magazines, blogs), and watching TV/videos; e.g., “I checked Facebook. I don't like having notifications on my phone and wanted to see what people were sharing”. Utilitarian and information needs related to using the clock, shopping, looking up information, finances, places, calendar, weather, cooking, contacts, and calculator; e.g., “I always use my phone while I am in bed to check the time” and “I woke up for work and shut off my alarm. Had 2 alarms”. Finally, content creation activities, while infrequent, related to photos, documents, videos, audio, drawings, and lists/notes.

Activity	Incidences	Participants
Text messages	11,914 35.8%	141 92.7%
Emails	5,253 15.8%	139 91.4%
Phone calls	4,501 13.5%	136 89.4%
Social networks	3,705 11.1%	105 69.0%
Games	1,441 4.3%	76 50.0%
Clock	969 2.9%	70 46.0%
Photos	707 2.1%	86 56.5%
Shopping	666 2.0%	92 60.5%
Looking up info	467 1.4%	84 55.2%
Music	462 1.3%	80 52.6%
Finances	408 1.2%	67 44.0%
Places	402 1.2%	89 58.5%
Chat	397 1.1%	22 14.4%
Reading	371 1.1%	48 31.5%
Calendar	237 0.7%	50 32.8%
Weather	232 0.7%	56 36.8%
Videos/movies/TV	169 0.5%	49 32.2%
Apps management	122 0.3%	48 31.5%
Cooking	70 0.2%	24 15.7%
Documents	22 <0.1%	8 5.2%
Video calls	16 <0.1%	14 9.2%

Table 6. Top smartphone activities.

Activity	Incidences	Participants
Emails	1,050 21.9%	69 59.4%
Games	698 14.5%	63 54.3%
Social networks	452 9.4%	47 40.5%
Looking up info	425 8.8%	56 48.2%
Shopping	308 6.4%	54 46.5%
Videos/movies/TV	283 5.9%	57 49.1%
Reading	250 5.2%	48 41.3%
Chat	227 4.7%	3 2.5%
Photos	132 2.7%	27 23.2%
Music	115 2.4%	24 20.6%
Documents	68 1.4%	13 11.2%
Cooking	57 1.1%	14 12.0%
Finances	55 1.1%	22 18.9%
Calendar	49 1.0%	13 11.2%
Weather	46 0.9%	17 14.6%
Apps management	46 0.9%	19 16.3%
Text messages	46 0.9%	10 8.6%
Phone calls	35 0.7%	8 6.9%
Clock	10 0.2%	4 3.4%
Places	40 0.8%	20 17.2%
Video calls	31 0.6%	16 13.7%

Table 7. Top tablet activities.

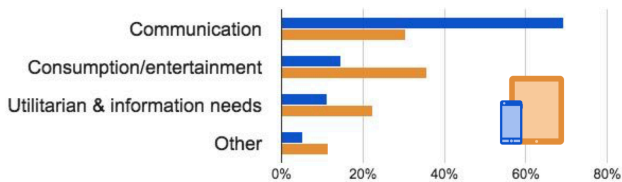


Figure 4. Activity themes compared.

Delving into activities more, most email activities consisted mainly of reviewing and triaging email (66.3% of all email-related activities) compared to sending and replying to email (30.0%). Similarly, the majority of social networking activities consisted of passively reading content (63.9%) while actually creating/posting content was less frequent (17.5%). In contrast to email and social networking, almost all text message related activities (95%) involved actively sending or replying while only some of these were limited to reviewing.

Tablet Activities

Tablets were most prevalently used for consumption and entertainment activities (35.7%), communication activities (30.5%), and utilitarian and information needs (22.5%). Overall, the top tablet activities included reviewing and triaging email, playing games, social networking, and looking up information (see Table 7).

When the tablet was used for consumption and entertainment activities, participants were reading social network content, playing games, watching TV/videos, reading books, and listening to music; e.g., “I played Candy Crush. I wanted to progress in levels and needed something to do while I waited for my kids”. Communication activities included email, using social networks (messaging, posting, commenting), chat, text messaging, phone calls, and video calls; e.g., “I was catching up with my friend over IM while I was in my kitchen watching a show on my laptop”. Utilitarian activities included looking up information, shopping,

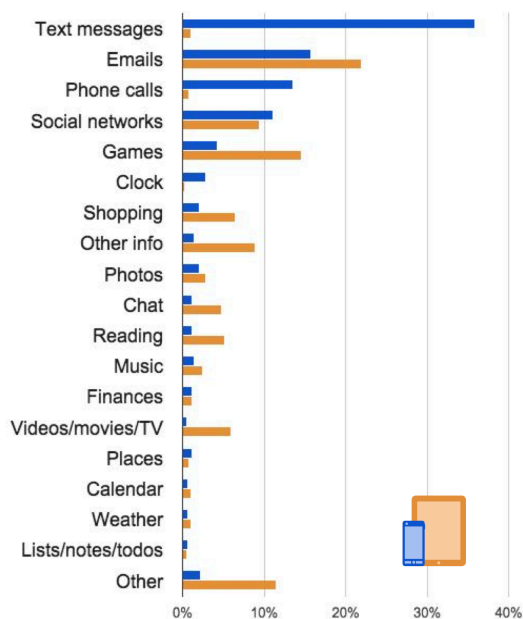


Figure 5. Activities compared.

cooking, finances, using the calendar, checking the weather, using the clock, and places; e.g., “My sister needed to know the name of a movie so I looked up the actor in it to find the name”.

Most email activities on the tablet consisted of reviewing and curating email (64.4%) compared to sending email and replying to email (32.0%). The same pattern holds true for social network use (80.5% related to passively reading content, 9.3% to creating/posting content). When looking at shopping activities on the tablet more closely, participants primarily reported browsing products (56.2% of all shopping activities) and making purchases (11.0%).

Activities Comparison

The use of smartphones primarily for communication activities stood in contrast to tablets, which showed more variety of use (see Figure 4). Further comparison revealed smartphones were used more for text messages, phone calls, and social networks, whereas tablets had more use for emails, playing games, shopping, looking up information, and watching videos (see Table 6 and Table 7, and Figure 5 for details). Comparing further details of primary activities between tablets and smartphones showed no notable differences.

Correlating the percentage of participants who reported an activity to the total incidences for that activity revealed that while smartphones were used for a small and very similar set of activities across all participants, tablet use showed large variety across participants (see Figure 6). Activities on smartphones that were most frequent overall and also done by most participants included text messaging, email, phone calls, and social networking. By contrast, for the tablet, such activities were limited to emails and playing games (see top right quadrant in Figure 6).

Mobile Device Use Locations

To fully understand mobile device use, it was important to explore the context in which it occurred.

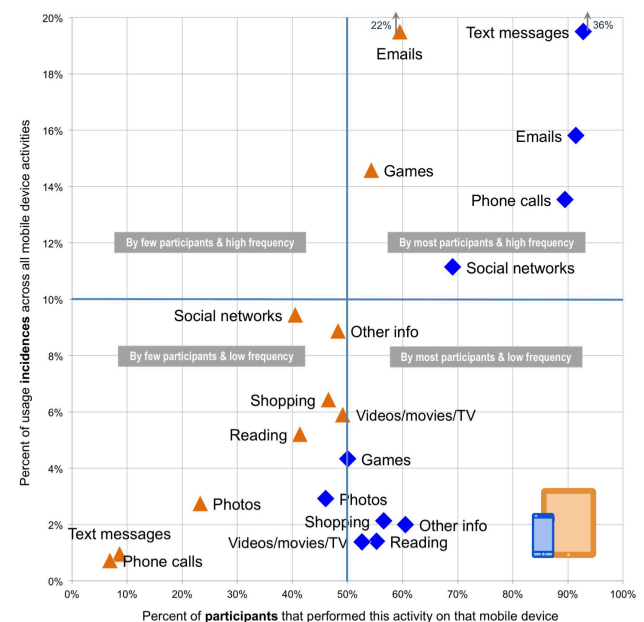


Figure 6. Top smartphone and tablet activities by incidences (vertical) and participants (horizontal).

Location	Incidences		Participants	
At my home	14,475	43.5%	151	99.3%
At my workplace	6,401	19.2%	110	72.3%
In a car	4,398	13.2%	137	90.1%
Outside, publ. space	1,648	4.9%	103	67.7%
At school/university	1,043	3.1%	36	23.6%
At other's home	985	2.9%	64	42.1%
In a store	969	2.9%	94	61.8%
At a restaurant/café	910	2.7%	94	61.8%
At service provider	583	1.7%	52	34.2%
In public transport	462	1.3%	30	19.7%

Table 8. Top smartphone use locations.

Home location	Incidences		Participants	
Bedroom	7,910	45.0%	133	89.3%
Living room	5,117	29.1%	126	84.6%
Kitchen	2,720	15.5%	106	71.1%
Home office	469	2.7%	39	26.2%
Bathroom	458	2.6%	43	28.9%
Dining room	429	2.4%	30	20.1%

Table 9. Top smartphone use locations in the home.

Smartphone Use Locations

While our data showed smartphones being used more outside of the home than inside, 43.5% of smartphone use incidences occurred at home. Outside the home, smartphones were most frequently used at work and in the car (see Table 8 for details). While at home and at work, participants mostly used their smartphones for text messages, email, phone calls, and social networking activities; e.g., “I checked my email [at home] and deleted all I didn't need, responded to all that needed my attention, and then filed emails that I needed to hold on to”. When in the car, participants primarily used their smartphones to receive and send text messages and to make phone calls, e.g., “I called my Mom on my way to work like every morning to check see how she's doing”.

Within the home, smartphone use occurred in the bedroom, living room, and kitchen (see Table 9 for details). Patterns of use in the bedroom or living room were similar, with smartphones used most frequently for text messaging, emails, phone calls, social networking, and playing games. In the bedroom, smartphones were used for keeping track of time and as an alarm, e.g., “My phone wakes us up and stays near me when we sleep”.

Tablet Use Locations

The vast majority of tablet activities occurred in the home. Outside the home, tablets were used mostly at work, and at school/university (see Table 10 for details). At home, tablets were mostly used for email, playing games, social networking, looking up information, shopping, and watching TV/videos. If tablets were taken out of the home, they were most likely used at work for activities almost exclusively related to email, but also for a wide variety of work-specific tasks, e.g., “I used an electronic medical records app at work, this is how I do my job”. When used at school, tablets were mostly used for chatting, looking up information, listening to music, and email-related activities.

Location	Incidences		Participants	
At my home	3,527	73.3%	112	96.5%
At my workplace	526	11.0%	30	25.8%
At school/university	195	4.1%	5	4.3%
At other's home	153	3.2%	20	17.2%
In a car	110	2.3%	14	12.0%
Outside, publ. space	48	1.0%	10	8.6%
In public transport	24	0.5%	7	6.0%
At service provider	23	0.4%	7	6.0%
At a restaurant/café	21	0.4%	11	9.4%
In a store	19	0.4%	8	6.9%

Table 10. Top tablet use locations.

Home location	Incidences		Participants	
Living room	1,425	41.0%	82	77.4%
Bedroom	1,222	35.1%	73	68.9%
Kitchen	427	12.3%	44	41.5%
Dining room	191	5.5%	15	14.2%
Home office	100	2.9%	18	17.0%
Bathroom	38	1.1%	12	11.3%

Table 11. Top tablet use locations in the home.

Within the home, tablet use occurred primarily in the living room, bedroom, and kitchen (see Table 11). In the living room, tablets were most frequently used for emails, playing games, social networking, looking up information, and shopping. In the bedroom, tablet use was evenly spread across several activities including email, social networks, playing games, chat, shopping, and watching TV/videos.

Use Locations Comparison

Comparing smartphone and tablet use locations revealed that while both device types were used frequently at home, tablets rarely left the home (see Figure 7). While locations of use outside the home showed only minor differences between device types, use inside the home differed significantly. Smartphones were used most frequently in the bedroom (for more communication activities), while tablets received most use in the living room (for more consumption activities); see Figure 8.

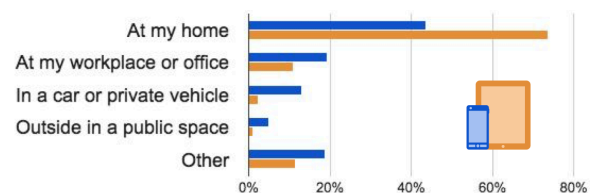


Figure 7. Locations of use compared.

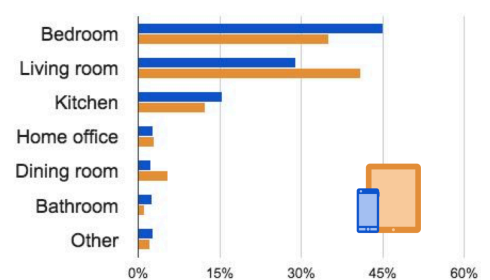


Figure 8. Locations of use at home compared.

Secondary activity	Incidences		Participants	
Watching TV/videos	2,414	14.9%	96	67.6%
Driving	2,060	12.7%	94	66.2%
Working	1,727	10.7%	85	59.9%
Eating/Drinking	1,499	9.3%	88	62.0%
Device multi-tasking	1,393	8.6%	80	56.3%
Talking with others	940	5.8%	65	45.8%
Walking	761	4.7%	56	39.4%
Shopping	709	4.4%	76	53.5%
Watching somewhere	572	3.5%	54	38.0%
Getting ready (am)	567	3.5%	50	35.2%
Listening to music	560	3.5%	37	26.1%
Cooking	478	3.0%	61	43.0%

Table 12. Top second. activities during smartphone use.

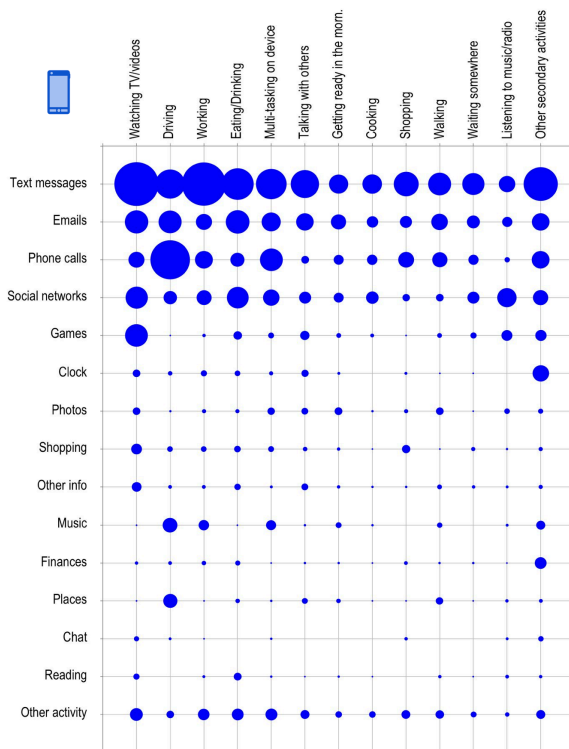


Figure 9. Smartphone activities by secondary activities.

Mobile Device Secondary Activities

To further understand the context of mobile device use, other activities people were doing while using their mobile device were investigated. Participants reported using their device while simultaneously involved in some other activity during 47.8% of all smartphone and 42.5% of all tablet use incidences.

Smartphone Secondary Activities

When participants were engaged in a secondary activity while using their smartphones, they were most frequently watching TV/videos, driving, working, eating/drinking, or multi-tasking on their device(s) (see Table 12).

Figure 9 relates secondary activities to the activities that took place on smartphones, providing further insights into contextual factors. While watching TV/videos, smartphones were primarily used for activities related to text messages, emails, and playing games. Sometimes, smartphone use related to what was being watched on TV, e.g., “I communicate with a friend during reality

Secondary activity	Incidences		Participants	
Watching TV/videos	765	37.6%	61	65.6%
Working	423	20.8%	22	23.7%
Eating/Drinking	163	8.0%	32	34.4%
Talking with others	104	5.1%	28	30.1%
Cooking	81	4.0%	22	23.7%
Device multi-tasking	69	3.4%	26	28.0%
Getting ready (am)	62	3.1%	13	14.0%
Attending to kids	57	2.8%	6	6.5%
Listening to music	54	2.7%	12	12.9%
Waiting somewhere	44	2.2%	8	8.6%
Exercising	25	1.2%	5	5.4%
Lying in bed	24	1.2%	7	7.5%

Table 13. Top secondary activities during tablet use.

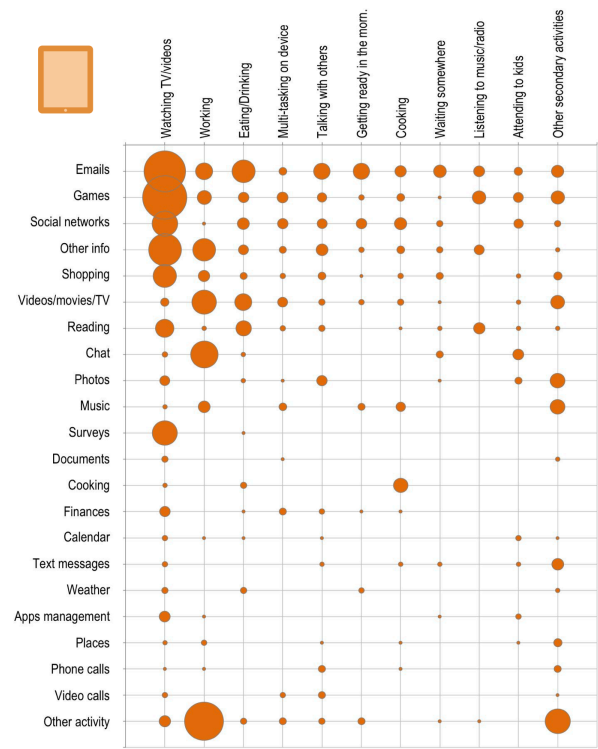


Figure 10. Tablet activities by secondary activities.

shows that we watch together. It's easier to make sure we don't miss things on the show.” When participants used their smartphone while driving, they were primarily used for making or receiving phone calls, but some also interacted with text messages and emails, or listened to music; e.g., “I wanted to catch up on my favorite podcasts while on a road.” While working, participants used their smartphone for text messaging, but also for email and social networking. Finally, while eating or drinking, smartphone use was limited to text messages, checking up on emails and social networks, and phone calls.

Tablet Secondary Activities

When tablet activities took place together with other activities, tablets were primarily used while watching TV, “I was browsing the Internet while sitting on the couch in the living room and watching TV”, followed by working, eating/drinking, or talking with others (see Table 13).

When relating secondary activities to activities on tablets, as seen in Figure 10, several insights emerged. First,

while watching TV, participants were engaged in a wide variety of activities on their tablet, mostly unrelated to the content on TV; playing games, checking email, and looking up information were particularly frequent; *“I was watching TV and remembered that my friend told me about a good book to read and I wanted to add it to my cart before I forgot”*. Second, when participants used their tablets while working, they mostly used chat, watched videos, looked up information, and checked emails; e.g., *“I watched a football game on my iPad, as I can't access that website at work”*. Finally, while eating, participants mostly used their tablets for checking email, watching videos, and reading.

Secondary Activities Comparison

When comparing smartphone and tablet secondary activities, it is important to note that both mobile device types are equally likely to be used while doing something else. However, the nature of the secondary activities differed significantly. While smartphones were used while doing a large variety of different things (i.e., watching TV/videos, driving, working, eating/drinking, device multi-tasking, and talking with others), secondary activities during tablet use were more limited (i.e., watching TV/videos, working, and eating/drinking). In particular, participants were 2.5 times more likely to watch TV/videos and 2 times more likely to be working while using their tablet compared to their smartphone (see Table 12 and Table 13).

CONCLUSION

Research presented in this paper highlights results from a large-scale retrospective daily diary study exploring the use of smartphones and tablets within the general U.S. adult population. It contributes an understanding of most frequent mobile device activities and contexts of use, as well as comparisons between smartphones and tablets.

Key differences between the use of smartphones and tablets identified through this research underscore the need to differentiate design solutions for the two device types due to their unique uses and contexts. While smartphone use was focused on communicating through text messages and emails, tablet use showed larger diversity. On the other hand, the context in which use occurred was more varied for smartphones than tablets, which were almost only used at home.

Smartphones, when used outside the home, were found to be most frequently used in cars. The amount of self-reported use of smartphones in cars was quite surprising given the publicity about the dangers of being distracted by device use while driving. While this study did not provide insight into details (such as whether hands-free devices were used), it does highlight the unique needs in this context. Indeed, these findings provide support to explore novel design solutions for in-car technology use.

Results also indicated that total mobile device use was greater for participants who owned both devices, as compared to those who owned either a smartphone or a tablet. This finding challenged expectations that use of one device would be cannibalized by a second device. It is possible this higher use by multi-device owners is a

consequence of traditional desktop activities shifting to mobile devices. Alternatively, specialized needs previously not supported by technology may now be gaining traction on mobile devices, or perhaps those who own several devices are more enthusiastic about technology and may use these devices more frequently. This trend toward multi-device ownership highlights the need for new solutions that prioritize transitions between devices and their concurrent use. Further research is needed to thoroughly understand how use shifts between device types and how the introduction of a new device may impact use.

The current research on tablet use both replicated and highlighted differences to previous findings by Müller et al., 2012. Overall, top tablet activities show little change, with the top four activities remaining in the same order of frequency. While past research found tablets were used more frequently during weekdays, the shift towards higher weekend use identified in this research may indicate tablets are now more integrated into daily life. This research replicated insights regarding tablet use locations, in addition to secondary activities people were engaged in while using their tablet. As the tablet market continues to evolve, future research needs to monitor potential changes and explore how different device and user characteristics impact use, such as device sizes, device sharing, and Internet access methods.

We should acknowledge certain limitations of the present study. As is typical for diary studies, data collection may have suffered from biases due to required self-report and recall; these biases were minimized by incorporating techniques to aid recollection and documentation. As the diary included open-ended questions, the level of detail in the participants' responses varied; however, it allowed for a more thorough understanding. In addition, while the diary method provided data on frequencies of use, it did not enable the tracking of activity durations for a more complete understanding of device use. However, the benefit of collecting both rich details of device use, as well as quantitative data on use frequencies, outweighed its limitations compared to other methods (such as logs analysis). Finally, while there was a greater representation of female participants in the sample, a comparison of device use by gender showed no notable differences. To further contribute to a holistic understanding of mobile device use, future research needs to explore approaches that allow for the combination of tracking device use with collecting rich details from the participant.

While this research has furthered the understanding of everyday smartphone and tablet use, in an ecosystem of constant technology innovations, further research is needed. The proliferation of larger-screen smartphones, for example, has the potential to impact the use of tablets and even non-mobile devices. The introduction of smartwatches and other wearables may, in turn, change the use of phones. Further, as more devices become part of daily life, interactions across devices may become more frequent. Given this, the study of device use continues to be of interest for understanding the changes in device ownership and use over time.

REFERENCES

- Badam, S. K., Chandrasegaran, S., Elmqvist, N., & Ramani, K. (2014). Tracing and Sketching Performance Using Blunt-tipped Styli on Direct-touch Tablets. In *Proc. AVI '14* (pp. 193–200). ACM.
- Barkhuus, L., & Polichar, V. E. (2011). Empowerment Through Seamfulness: Smart Phones in Everyday Life. *Pers Ubiquit Comput*, *15*(6), 629–639.
- Bryfczynski, S., Pargas, R. P., Cooper, M., & Klymkowsky, M. (2012). Analyzing and Visualizing Student Work with BeSocratic. In *Proc. ACM-SE '12* (pp. 349–350). ACM.
- Buttfield-Addison, P., Lueg, C., Ellis, L., & Manning, J. (2012). "Everything Goes into or out of the iPad": The iPad, Information Scraps and Personal Information Management. In *Proc. OzCHI '12* (pp. 61–67). ACM.
- Church, K., Cousin, A., & Oliver, N. (2012). I Wanted to Settle a Bet!: Understanding Why and How People Use Mobile Search in Social Settings. In *Proc. MobileHCI '12* (pp. 393–402). ACM.
- Church, K., & Oliver, N. (2011). Understanding Mobile Web and Mobile Search Use in Today's Dynamic Mobile Landscape. In *Proc. MobileHCI '11* (pp. 67–76). ACM.
- Do, T. M. T., Blom, J., & Gatica-Perez, D. (2011). Smartphone Usage in the Wild: A Large-scale Analysis of Applications and Context. In *Proc. ICMI '11* (pp. 353–360). ACM.
- Fagen, W., & Kamin, S. (2013). Measuring Increased Engagement Using Tablet PCs in a Code Review Class. In *Proc. SIGCSE '13* (pp. 465–470). ACM.
- Gustarini, M., Ickin, S., & Wac, K. (2013). Evaluation of Challenges in Human Subject Studies "In-the-wild" Using Subjects' Personal Smartphones. In *Proc. UbiComp '13 Adjunct* (pp. 1447–1456). ACM.
- Hang, A., De Luca, A., Hartmann, J., & Hussmann, H. (2013). Oh App, Where Art Thou?: On App Launching Habits of Smartphone Users. In *Proc. MobileHCI '13* (pp. 392–395). ACM.
- Hourcade, J. P., Williams, S. R., Miller, E. A., Huebner, K. E., & Liang, L. J. (2013). Evaluation of Tablet Apps to Encourage Social Interaction in Children with Autism. In *Proc. CHI '13* (pp. 3197–3206). ACM.
- Jacobs, M. L., Clawson, J., & Mynatt, E. D. (2014). My Journey Compass: A Preliminary Investigation of a Mobile Tool for Cancer Patients. In *Proc. CHI '14* (pp. 663–672). ACM.
- Jahnke, I., Svendsen, N. V., Johansen, S. K., & Zander, P.-O. (2014). The Dream About the Magic Silver Bullet: The Complexity of Designing for Tablet-Mediated Learning. In *Proc. GROUP '14* (pp. 100–110). ACM. 4
- Kjeldskov, J., & Paay, J. (2012). A Longitudinal Review of Mobile HCI Research Methods. In *Proc. MobileHCI '12* (pp. 69–78). ACM.
- Kleimola, J., Laine, M., Litvinova, E., & Vuorimaa, P. (2013). TouchModifier: Enriched Multi-touch Gestures for Tablet. In *Proc. ITS '13* (pp. 445–448). ACM.
- Lee, U., Lee, J., Ko, M., Lee, C., Kim, Y., Yang, S., ... Song, J. (2014). Hooked on Smartphones: An Exploratory Study on Smartphone Overuse Among College Students. In *Proc. CHI '14* (pp. 2327–2336). ACM.
- Li, J., & Alem, L. (2013). Supporting Distributed Collaborations Between Mobile Health Workers and Expert Clinicians in Home Care. In *Ext. Abstracts CHI '13* (pp. 493–498). ACM.
- Lin, A. C., Chang, M.-H., Chen, M. Y., Yu, T., Chou, L., Tsai, D.-J., & Wang, J. (2013). Mobility Patterns of Doctors Using Electronic Health Records on iPads. In *Proc. BCB '13* (pp. 933–939). ACM.
- Lu, Y., Wang, X., & Ma, Y. (2013). Comparing User Experience in a News Website Across Three Devices: iPhone, iPad, and Desktop. In *Proc. ASIST '13* (pp. 142:1–142:4). American Society for Information Science.
- McDonald, P., Mohebbi, M., & Slatkin, B. (2012). *Comparing Google Consumer Surveys to Existing Probability and Non-Probability Based Internet Surveys, 2nd version*.
- Mohd Shukri, S. R., & Howes, A. (2014). How Do Children Adapt Strategies when Drawing on a Tablet? In *Ext. Abstracts CHI '14* (pp. 1177–1182). ACM.
- Müller, H., Gove, J., & Webb, J. (2012). Understanding Tablet Use: A Multi-method Exploration. In *Proc. MobileHCI '12* (pp. 1–10). ACM.
- Nielsen. (2012a). How US Smartphone and Tablet Owners Use their Device for Shopping. Retrieved from <http://goo.gl/MQr3Z6>
- Nielsen. (2012b). The U.S. Digital Consumer Report. Retrieved from <http://goo.gl/uET4UG>
- Nielsen. (2013). The Mobile Consumer. Retrieved from <http://goo.gl/xv27mk>
- Nylander, S., Lundquist, T., & Brännström, A. (2009). At Home and with Computer Access: Why and Where People Use Cell Phones to Access the Internet. In *Proc. CHI '09* (pp. 1639–1642). ACM.
- Patil, S., Norcie, G., Kapadia, A., & Lee, A. J. (2012). Reasons, Rewards, Regrets: Privacy Considerations in Location Sharing As an Interactive Practice. In *Proc. SOUPS '12* (pp. 5:1–5:15). ACM.
- Pew Research. (2011). Smartphone Adoption and Usage. Retrieved from <http://goo.gl/hzccjd>
- Pew Research. (2012). A Snapshot of E-reader and Tablet Owners. Retrieved from <http://goo.gl/3JUz5p>
- Pew Research. (2013a). Smartphone Ownership 2013. Retrieved from <http://goo.gl/ygQi5Z>

- Pew Research. (2013b). Tablet Ownership 2013. Retrieved from <http://goo.gl/ukE7Xw>
- Pew Research. (2014). Device Ownership Over Time. Retrieved from <http://goo.gl/VruAmx>
- Pew Research. (2015). U.S. Smartphone Use in 2015. Retrieved from <http://goo.gl/twU7Wo>
- Song, Y., Ma, H., Wang, H., & Wang, K. (2013). Exploring and Exploiting User Search Behavior on Mobile and Tablet Devices to Improve Search Relevance. In *Proc. WWW '13* (pp. 1201–1212). International World Wide Web Conferences Steering Committee.
- Stawarz, K., Cox, A. L., Bird, J., & Benedyk, R. (2013). “I’d Sit at Home and Do Work Emails”: How Tablets Affect the Work-life Balance of Office Workers. In *Ext. Abstracts CHI '13* (pp. 1383–1388). ACM.
- Tossell, C., Kortum, P., Rahmati, A., Shepard, C., & Zhong, L. (2012). Characterizing Web Use on Smartphones. In *Proc. CHI '12* (pp. 2769–2778). ACM.