

Advertising in Young Children's Apps: A Content Analysis

Marisa Meyer,* Victoria Adkins, MSW,† Nalingna Yuan, MS,* Heidi M. Weeks, PhD,‡
Yung-Ju Chang, PhD,§ Jenny Radesky, MD*

ABSTRACT: *Objective:* Young children use mobile devices on average 1 hour/day, but no studies have examined the prevalence of advertising in children's apps. The objective of this study was to describe the advertising content of popular children's apps. *Methods:* To create a coding scheme, we downloaded and played 39 apps played by children aged 12 months to 5 years in a pilot study of a mobile sensing app; 2 researchers played each app, took detailed notes on the design of advertisements, and iteratively refined the codebook (interrater reliability 0.96). Codes were then applied to the 96 most downloaded free and paid apps in the 5 And Under category on the Google Play app store. *Results:* Of the 135 apps reviewed, 129 (95%) contained at least 1 type of advertising. These included use of commercial characters (42%); full-app teasers (46%); advertising videos interrupting play (e.g., pop-ups [35%] or to unlock play items [16%]); in-app purchases (30%); prompts to rate the app (28%) or share on social media (14%); distracting ads such as banners across the screen (17%) or hidden ads with misleading symbols such as "\$" or camouflaged as gameplay items (7%). Advertising was significantly more prevalent in free apps (100% vs 88% of paid apps), but occurred at similar rates in apps labeled as "educational" versus other categories. *Conclusion:* In this exploratory study, we found high rates of mobile advertising through manipulative and disruptive methods. These results have implications for advertising regulation, parent media choices, and apps' educational value.

(*J Dev Behav Pediatr* 00:1–8, 2018) **Index terms:** mobile devices, apps, advertising, digital media, early childhood.

Television advertising to young children in the United States has been regulated by the Federal Communications Commission since the 1970s, based on concerns that children under age 8 years are not able to critically evaluate advertisements or differentiate them from media programming.¹ However, these regulations were informed by research on television advertising, which occurs in predictable segments through linear, dramatized advertisements. Yet, the nature of children's digital

media exposure has changed dramatically since the advent of mobile devices. Children under 8 years of age now spend about 1 hour/day using mobile devices, displacing time they used to spend watching TV.² Mobile-based and application ("app")-based advertising is more personalized, on-demand, and embedded within interactive digital play experiences but may be harder to quantify and regulate because of these design characteristics.

Prior research on apps marketed to young children has been limited to the design of educational content. Hirsh-Pasek et al.³ expressed concern about low-quality content and distracting visual and sound effects in popular apps, outlining approaches to app design that could support children's learning from interactive media. They emphasized the importance of designing enhancements and interactive elements that support learning goals, rather than irrelevant or extraneous visual or sound effects, but remarked that many commercially available "educational" apps are not designed appropriately for how young children learn. Another content analysis of 183 apps marketed as educational literacy games showed that most taught only rote skills and had no input from developmental experts.⁴ Although advertisements likely distract from the learning goals of children's apps by drawing children's attention or engagement to irrelevant stimuli, no studies have examined the commercial or advertising content of apps frequently played by young children.

In addition to influencing the educational potential of apps, in-app advertising is also potentially relevant to young children's health and well-being. Early television-based advertising regulations were based in part upon research showing associations between TV advertising and

From the *Division of Developmental Behavioral Pediatrics, Department of Pediatrics, University of Michigan Medical School, Ann Arbor, MI; †Child Health Evaluation and Research Center, Department of Pediatrics, University of Michigan Medical School, Ann Arbor, MI; ‡Department of Nutritional Sciences, University of Michigan School of Public Health, Ann Arbor, MI; §Department of Computer Science, National Chiao Tung University, Hsinchu, Taiwan.

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Address for reprints: Jenny Radesky, MD, Department of Pediatrics, University of Michigan Medical School, 300 North Ingalls Street, Room 1107, Ann Arbor, MI 48109; e-mail: jradesky@med.umich.edu.

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unhealthy food preferences.⁵ In addition, developmental scholars have been concerned that commercial influences constrain children's play and creativity, leading to more scripted and stereotyped play schemas that mimic media content.⁶ It has not been studied whether food or toy advertising occurs in children's apps, nor is the prevalence of commercial characters in popular children's apps known.

In-app advertising to young children also has potential ethical relevance, since prior research shows that children under age 6 to 8 years cannot distinguish between media content and advertising.⁷ Advertisements embedded within interactive games may appear to be part of the game play and therefore may be more difficult for young children to avoid (e.g., not being able to "X" out of a pop-up ad or clicking on an ad pop-up thinking it is part of the game) or distinguish from game-related interactive features.

Finally, privacy concerns are a novel aspect of mobile and app-based advertising. Mobile advertising collects data from users, including information about preferences, online behavior, and other device-based information, such as contacts and location.⁸ The practice of behavioral advertising utilizes this information to inform the content of mobile advertisements presented to users. The Children's Online Privacy Protection Act (COPPA) was passed in 1998 to allow the Federal Trade Commission to restrict the collection of personal information from children aged 13 years or younger in an attempt to safeguard children from manipulative, online privacy invasion. Recent backend analysis of children's apps on Google Play showed that most do not adhere to COPPA principles.⁹ However, no research or regulations have focused on the design of app-based advertisements, for example, whether advertising approaches are appropriate for the developmental abilities of young children (i.e., to recognize advertising and persuasive intent) or how advertising is being integrated with the persuasive design features (i.e., collecting tokens and rewards) highly prevalent in children's apps and games.

This study aims to address these gaps in research and policy by evaluating the prevalence of different advertising approaches in popular apps played by young children (5 years and under). Using a grounded theory approach, our objective was to develop a reliable coding scheme from 39 apps played by children under 5 years in a pilot mobile device tracking study, which we then applied to the 96 most commonly installed free and paid apps from the Google Play app store marketed for children aged 5 years and younger.

METHODS

Study Design

We conducted a content analysis of 135 apps marketed to or played by children under 5 years of age. We analyzed apps from 2 sources—children's apps captured as part of a study of family mobile device use, in addition to the most commonly installed apps from the Google Play store—with the goal of describing both real-world and national patterns of early childhood app usage. Although marketing to school-

aged children and adolescents is an important topic of study, we chose 5 years and under because these were the ages captured by our initial mobile device tracking study and the target of the "5 and Under" category in popular app stores. The University of Michigan Medical School Institutional Review Board approved the family mobile device tracking study and deemed the content analysis portion of this study exempt from human subjects review.

Coding Scheme Development: Mobile Device Tracking Study

Children's apps were first identified through mobile device tracking performed as part of a larger pilot study. Between October 2016 and March 2018, 58 parent-child dyads were enrolled in an adaptive pilot study testing Minuku, a prototype mobile sensing app for Android devices, and Moment[®], a commercially available tracking app for iPhones and iPads. Participants were recruited via the University of Michigan research recruitment website, and eligibility criteria included child aged 12 months to 5 years, parent was the biological or custodial parent and lived with the child at least 5 of 7 days of the week, parent English proficiency sufficient to complete questionnaires and provide consent, and parent owned an Android smartphone or iPhone. In the first phase of the pilot study, parents completed written informed consent and provided consent on behalf of their child, installed the tracking app on their phone and any child tablets, and completed surveys in person; in later phases, consent for parent and child participation, app installation, and surveys were all completed online. Parents were compensated \$25 for the initial survey completion and an additional \$25 after 14 days of app tracking completion.

The Minuku app generates data regarding screen on/off status and foreground app every 5 seconds, while the Moment[®] app provides daily estimates of app usage. Output from both apps was summarized to generate a list of apps used on any device (parent phone or family tablet), which was then reviewed to identify apps that might have been played by the study index child. For example, a parent's smartphone app output might include games such as *Two Dots* or *Clash of Clans* (which were deemed unlikely to be played by children under 5), but also *PBS Kids* or *Strawberry Shortcake's Sweet Shop* (which were deemed early childhood-appropriate apps). If, from the app name or Google Play store description, it was unclear whether an app was adult-appropriate or early childhood-appropriate (e.g., *FIFA Mobile*; *Plants vs Zombies*), the app was installed and played by the study team, who determined by consensus whether a 5-year-old child could reasonably understand how to play the app. Based on this process, 35 free apps and 4 paid apps were identified from smartphone and tablet output.

To develop the advertising content coding scheme, 2 researchers independently played 30 apps, recording detailed notes about their experience with advertisements during gameplay and approaches used for making the

user watch or click them. Using these observations, a codebook for advertising content and methods was developed using grounded theory methods (e.g., allowing dominant themes and categories to arise from observations rather than imposing a preconceived framework on observations¹⁰). This iterative process of codebook category development took place during several team meetings. To assess the fit of the codebook, 2 team members applied the codebook to all 30 previous apps as well as 15 additional apps downloaded from the Google Play store (see selection criteria below) using NVivo (QSR International). Reliability between coders showed a kappa of 0.96.

App Store Data Collection

Between December 2017 and March 2017, 2 research assistants recorded the most-downloaded apps in the “Ages 5 and Under” category of the Google Play store. Google Play was chosen rather than iTunes because our research laboratory uses Samsung Galaxy tablets with Android operating systems. Android operating systems are present on over half of US mobile devices,¹¹ and therefore, we felt these results would be generalizable to apps played by US children. In order to assess the apps most likely to be played by young children, free apps with more than 50,000 downloads (median 5–10 million downloads) and paid apps with more than 10,000 downloads (median 50,000–100,000 downloads) in the Ages 5 and Under category were installed onto research tablets. Apps did not have to be marketed as “educational” in order to be included.

For each app, we recorded its app store category and which permissions it requested. The most common game categories were Educational (34%) and Pretend Play (31%). Researchers then applied the advertising content coding scheme to these apps by recording gameplay observations onto a template containing all possible codes, which enabled the team to use the auto-coding feature in NVivo. Coders also took screen shots of illustrative examples or confusing design features so they could be discussed in team meetings (Supplemental Digital Content 1, <http://links.lww.com/JDBP/A188>). For observations not fitting into any of the codes, categories were resolved by consensus.

Data Analysis

For descriptive purposes, we calculated the frequencies of advertising approaches across all 135 apps coded. We then performed bivariate analyses examining the frequency of different advertising approaches by free app (yes vs no) and app store category (educational vs other) using χ^2 tests of association.

RESULTS

Based on observations while playing each app, 6 major categories of commercial content or advertising approaches were noted. These often co-occurred within

the same app or could occur alone (e.g., an app being based on commercial characters such as *LEGO Duplo* or *Wild Kratts* but containing no other advertising). Advertising approaches appeared to show a range of potentially disruptive (i.e., interrupting the child’s gameplay) or persuasive characteristics; we describe them below in the order of highest to lowest prevalence (Table 1).

Advertising Approaches

Commercial Characters

It was common for apps to contain commercial characters (65, 48%), including characters from popular cartoon and toy franchises. Many apps featured commercial characters as the objects of gameplay. For example, *LEGO Duplo Town* centers on constructing a LEGO community, made up of houses, restaurants, and a park, in which LEGO characters perform appropriate actions (such as eating when put at a table, or playing on the teeter-totter when placed on it). In *Coloring Book for Hello Kitty*, the coloring pages are all drawings of Hello Kitty.

In other apps, commercial characters narrated and/or directed the gameplay. For example, in *Paw Patrol: Air and Sea Adventures*, Ryder provides a brief introduction to the game, describes the steps players should take to complete a level, and reminds players of different actions to complete a task if the user is inactive for a period of time. Additionally, the “pups” will provide commentary throughout the game, often giggling and congratulating the player for collecting a “pup treat” or for completing the level. Alternatively, some app characters showed facial expressions of disappointment when the player was not successful or did not choose locked items. Thus, the commercial characters not only were the object of gameplay but also had interactions with the user that could be characterized as social pressure or validation.

Full-App Teasers

In 46% of apps played (67% of free apps), there were prompts to upgrade to the full version of the app. The full version was often promoted as being “ad-free,” either removing the banner ads that hung on the periphery of the screen throughout gameplay or removing pop-up ads that disrupted gameplay. In other cases, the full app would allow the child to unlock more levels or gameplay items. For example, in *My Caterpillar*, the full app allows the caterpillar to play with more balloons or toys from the toy box, which appear whited out and inaccessible in the free app. However, the manner in which the full version of apps was promoted varied between apps: in some, it was simply indicated by a button at the top of the app’s home screen; in apps like *Balloon Pop*, the user is offered fancier balloons but then is reminded with a sound effect and written text that those balloons are only available in the full app.

Ad Videos Interrupting Play

In a subset of apps, advertising videos (for apps, to promote in-app purchases, or for other products) were

Table 1. Advertising Approaches Documented in 135 Apps Marketed to or Played by Children Aged 5 Years and Younger

Advertising Code Category	Frequency, N (%)
Any advertising	129 (95.0)
Use of commercial characters	65 (48.2)
Full-app teasers: Offers/reminders to buy “full” version of app to avoid ads, have access to more characters or levels, and make gameplay easier or design that will not let child succeed unless they buy full version	62 (45.9)
Ad video interrupting play	
Pop-up ad automatically appears without clicking anywhere, when idle, or when 1 level ends and before the other begins	47 (34.8)
Prompts to watch ad videos or try out other apps to unlock play items or levels	21 (15.6)
In-app purchases to buy tokens, lives, or items to level up, make play easier, or have access to more characters/levels	40 (29.6)
Prompts to share	
Rating on app store	38 (28.2)
On social media	19 (14.1)
Distracting and deceptive ads	
Banner across top, bottom, or sides of screen	23 (17.0)
Camouflaged ads (e.g., a bouncing present that when clicked takes child to ad video)	9 (6.7)

observed to suddenly interrupt play or appear when 1 level ends and before the other begins (35% of all apps, 54% of free apps). Some pop-up advertisements were not able to be closed out of immediately, and others forced the player to watch the entirety of the video advertisement before being able to close out of it. Moreover, if the player did not tap exactly on the X, the player would have tapped a part of the advertisement, which would take the player to the app’s page in the Google Play store. Other pop-up advertisements were interactive and forced the player to engage in a demonstration version of the advertised app before the X button would appear to close out of the app. In some apps, such as *Kids Animal Jigsaw Puzzle*, pop-up advertisements took up roughly as much time as gameplay, since advertisements appeared every time the player completed a puzzle and returned to the homepage and while trying to open a new puzzle.

When advertisements did not pop up spontaneously, “video” icons often appeared in gameplay items, intended to prompt users to watch ad videos in exchange for more coins or to gain items that would make game play easier. For example, in *Masha and The Bear Vet Clinic*, when the player was obtaining medicine and supplies to treat sick animals, they could choose faster or more effective items by watching a video advertisement, as denoted by the video icon.

In-App Purchases

In-app purchases, which allowed users to buy extra lives, gain access to more characters or locations, or obtain items that make gameplay easier, were present in 30% of all apps and 41% of all free apps. In-app purchases for game play items were observed in *Hello Kitty Lunchbox*, as the player could buy more decorated items to customize the lunchbox and more food types to in-

clude in *Hello Kitty’s* lunch. In-app purchases to obtain more gameplay time (which are otherwise difficult to obtain through game tokens) were observed in games such as *Panda Pop* and *Pengle*. In *Clawbert*, coins and jewels can be purchased to help eggs hatch faster or to refill the game machine rather than waiting 1 to 2 hours for it to refill itself. In *Masha and the Bear Educational Games*, most mini-games offered are locked, and players cannot access them without purchasing them. It was notable that many in-app purchases were encouraged or promoted by familiar, commercial characters. In *Barbie Magical Fashion*, Barbie, the narrator, specifically encourages users to use items (dresses, shoes, accessories) that have the “locked” icon and need to be purchased. In *Rescue Bots*, the player is only provided with 2 free robots. The player is unable to tackle all the disasters without buying the other Bots, and a video is provided depicting all the Bots’ abilities.

Of particular concern was the practice seen in *Strawberry Shortcake Bake Shop*. In the app, players were presented with 2 options for tools: a free standard tool and a locked (in-app purchase) modern tool, and Strawberry Shortcake always states how much better the locked tool is. In this case, the researcher purchased locked tools in order to compare ease of gameplay between free and purchased items and found that purchased tools were notably faster. For example, while cutting a cake with the free wooden knife, the player needed to move the knife in and out across the cake and it was difficult to finish; however, with the purchased metal knife, the cake was cut in 1 quick swipe. Moreover, the storyline of the *Strawberry Shortcake Bake Shop* involves the player creating a dessert for 1 of Strawberry Shortcake’s friends. When an order is successfully filled, the player receives a star; however, after

a few levels, the player must make an in-app purchase in order to fulfill orders. If the player does not make a purchase and makes the wrong dessert, Strawberry Shortcake comments, “we didn’t fill this order, so this dessert can be just for you.”

Prompts to Share Information

Many apps contained prompts for the user to rate the app on Google Play (28% of all apps and 34% of free) and prompts to share their progress or score on social media sites such as Facebook (14%). Rating prompts were either a button on the homepage or interrupted gameplay through a dialogue box requesting an app rating. In *My Baby Care*, a pop-up rating prompt appeared recurrently after taking care of a couple of babies, the equivalent to playing a few levels of the game.

Social media prompts occurred in the form of buttons or pop-ups that prompt the user to share their progress on social media, sometimes in reward for coins or items. In *Candy Crush*, the player is asked, immediately after opening the app, to connect to Facebook to share their progress with friends across devices through a button right below the “Play” button. Additionally, social media buttons appear on the scoreboard and in pop-up messages praising the child in several apps (e.g., in *Animals*, a pop-up stating “The kid excellence award is granted! Press the social network button to claim the award—tell the world about this whiz kid’s achievements!”).

The most common permissions requested by apps were notifications (100%) and files/photo storage (53.3%). Seventeen (12.6%) apps requested phone permission (e.g., *Dr. Panda* apps, *My Town Daycare*, *Masha and the Bear* apps), 11 (8.1%) apps requested microphone permission (e.g., *Disney NOW*, *YouTube Kids*), likely for the purpose of voice-activated searching, and 9 apps (6.7%) requested camera permission, likely to take photos during gameplay (e.g., *Daniel Tiger’s Gruffic Feelings*, *Strawberry Shortcake Dress Up*). Although collecting data on child location is a potential COPPA violation, 6 apps (4.4%) requested location permission (*Love2Learn*, *Edukitty*, and *Masha and the Bear* apps). Contacts permission was requested by some mixed-audiences apps, such as *Jelly Jump* and *Panda Pop*, and also by the child-directed apps *Chuggington Ready to Learn*, *Masha and the Bear Vet Clinic*, *Masha and the Bear House Cleaning Game for Girls*, and *Blaze and the Monster Machines*. Permissions requests typically appeared as a small standard dialog box during app installation but did not specifically ask for the parent’s consent.

Distracting and Deceptive Ads

Overt advertising consisted of banner ads (17% of all apps; 27% of free apps), which usually covered the sides or top and/or bottom of the screen during game play. Banner ads were often for other apps but could also be for adult-appropriate apps such as *Wish* (a shopping app), Samsung, sporting goods, or tax return preparers. In 1 app, the coder noted banner ads for the following adult-appropriate products: Chicago Theatre Week sponsored

by *Choose Chicago*, “10 Bipolar Facts to Learn: Search Treatments” sponsored by *Health Living Today*, and *Instagram*. When the ads were tapped on, the player’s screen switched to the app’s page in the Google Play store, to facilitate downloading. Coders frequently reported ads for adult-appropriate apps such as *Pocket Politics* (which features a cartoon of the President wanting to press a “nukes” button) and *FastLane* (a car shooting game). In both cases, the user had to watch the app demonstration before the X would appear to close the advertisement.

Although some apps had a button on the home screen advertising “More Apps” made by the same developer, apps would occasionally contain buttons with misleading symbols such as “\$” or a teddy bear, which when clicked would bring up a video for other apps, toys (e.g., baby dolls), or food (e.g., Lunchables). Some apps also contained ads camouflaged in gameplay items, which when clicked take the user to an ad video (7%). As observed in *Talking Tom*, a present drops from the ceiling into the background; when tapped on, assuming the present would be a game, the player is instead prompted to “watch videos and win.” In *Builder Game*, characters regularly showed thought bubbles indicating what the player should do next; in many cases, these were games that could only be unlocked by watching an ad video.

Comparison of Paid to Free Apps

As shown in Table 2, in comparison to the paid apps, free apps contained more in-app advertising that disrupted the gameplay experience. Free apps contained more full-screen pop-up video advertisements that forced the player to stop gameplay, banner advertisements, hidden or disguised advertisements, prompts to connect to social media, and features involving unlocking items through watching advertisements. Similar levels of commercial characters were observed in both types of apps.

Comparison of “Educational” Apps to Other App Categories

As shown in Table 3, some advertising approaches were less prevalent in apps labeled as Educational in Google Play, although advertising was present in 1% to 47% of Educational apps.

DISCUSSION

This study is the first to examine advertising practices to which young children are exposed when playing with mobile and interactive media, which has become increasingly prevalent over the past 10 years. We found, particularly among free apps, a high prevalence of advertising using distracting features, potentially manipulative approaches, and content that did not appear to be age-appropriate.

Prior research has examined the quality of educational and literacy apps but not the quality of extraneous design features, such as advertising content. Because irrelevant

Table 2. Frequency of Advertising Approaches Documented in Free Vs Paid Apps

Advertising Code Category	Frequency, N (%), Free Apps (n = 85)	Frequency, N (%), Paid Apps (n = 50)	<i>p</i>
Any advertising	85 (100)	44 (88)	0.000
Commercial characters	38 (44.7)	27 (54.0)	0.17
Full-app teasers	57 (67.1)	5 (10.0)	<0.0001
Ad video interrupting play			
Pop-up ads	46 (54.1)	1 (2.0)	<0.0001
Watch ads to unlock items/levels	21 (24.7)	0 (0.0)	<0.0001
In-app purchases	35 (41.2)	5 (10.0)	<0.0001
Prompts to share			
Rating on app store	29 (34.1)	9 (18.0)	0.001
On social media	17 (20.0)	2 (4.0)	0.0005
Distracting and deceptive ads			
Banner ads	23 (27.1)	0 (0.0)	<0.0001
Camouflaged ads	9 (10.6)	0 (0.0)	<0.0001

stimuli can detract from learning from interactive media,¹² our findings raise concern that commercially available apps may have lower educational value due to a high prevalence of distracting ads. Many laboratory-based studies documenting learning from apps in young children have used specially designed apps,¹³ not apps that are commercially available. By studying the apps most downloaded from the app store, as well as apps played on family mobile devices, we were able to illustrate what children are actually playing—and thus what ads they are exposed to—rather than the apps that are highest rated or recommended by early childhood specialists.^{3,14}

A notable finding is that free apps, which may be more often downloaded and played by lower-income children,¹⁵ had a significantly higher prevalence of advertising and pop-up features that disrupted gameplay.

TV advertising regulations limit the number of commercial breaks during viewing segments, but no restrictions exist for mobile advertising. With more distracting features and advertising exposure, and therefore lower educational value, it is possible that disparities in the quality of app usage may contribute to a new digital quality divide.

Some features of mobile advertising observed in this study were similar to those children might view on television (e.g., a video advertisement for food or toys); however, we also documented advertising practices that used persuasive methods not typically found in TV advertising. By embedding ad videos within gamified features, such as coin/token collection or ability to advance to the next level, children might be persuaded to consume more advertising, and interrupt their play, more than

Table 3. Frequency of Advertising Approaches Documented in Apps Labeled as Educational in Google Play Vs Other Categories^a

Advertising Code Category	Frequency, N (%), Educational (n = 46)	Frequency, N (%), Other Category (n = 89)	<i>p</i>
Any advertising	43 (93.5)	86 (96.6)	0.40
Commercial characters	12 (26.1)	45 (50.6)	<0.0001
Full-app teasers	21 (45.7)	41 (46.1)	0.01
Ad video interrupting play			
Pop-up ads	12 (26.1)	35 (39.3)	0.0008
Watch ads to unlock items/levels	6 (13.0)	15 (16.9)	0.05
In-app purchases	7 (15.2)	33 (37.1)	<0.0001
Prompts to share			
Rating on app store	11 (23.9)	27 (30.3)	0.009
On social media	3 (6.5)	16 (18.0)	0.003
Distracting and deceptive ads			
Banner ads	7 (15.2)	16 (18.0)	0.06
Camouflaged ads	2 (1.3)	7 (7.9)	0.1

^aOther Google Play categories include Games, Pretend Play, Casual, Puzzle, Creativity, Arcade, Music and Video, Action and Adventure, Brain Games, and Entertainment.

expected. In addition, due to weaknesses in attention control and impulse inhibition, young children may be more susceptible to ads with highly salient (e.g., larger, sparkling) or novel features (e.g., hidden within a present) and may be less likely to wait for the X to appear to minimize a pop-up ad.

While it is expected that free apps would have more offers to upgrade to a paid, full app version or make in-app purchases, the manner in which these options were promoted was potentially unethical for young children. For example, in-app purchases were often not only advertised clearly to children (e.g., by a row of locked games or items) but were also encouraged by familiar characters in the app. Because children are known to develop trusting, emotional parasocial relationships with media characters and pay more attention to and learn better from familiar characters,¹⁶ we suggest that this is a misuse of parasocial relationships. In some cases, app characters showed disapproval of the user or an important mission (such as rescuing characters) could not be accomplished without a purchase, which may also lead children to feel an emotionally charged need to make purchases. The Federal Communications Commission has long banned “host selling” on children’s television as an unfair practice, so similar regulations should be developed for apps.

Prior policy has focused on restricting advertising when children are under 8 years of age, since children lack the cognitive skills to understand the difference between a TV program and advertisement at this age and are not aware when their preferences are being influenced by advertisements.⁷ In other words, they lack a meta-awareness about advertising and are unable to critically reflect upon their reactions to it. When advertisements are combined with rewards, both cognitive and emotional processes respond to persuasion.¹⁷ In the case of the gamified ads we documented—those involving watching ads to collect tokens or gameplay items—children under 6 years may be especially susceptible to this approach because of their responsiveness to positive reinforcers.

Given these ethical concerns, our findings have relevance for design and policy. The ethics of the persuasive design and marketing practices of technologies designed for children have been discussed by European agencies (www.childrensdesignguide.org) but not formally in the United States. When persuasive technology was first studied in the 1990s, programmers discussed a code of ethics holding developers responsible when their design intentionally manipulated the behavior of users in a manner counter to the user’s best interests; essentially that designers should “never seek to persuade a person...of something they themselves would not consent to be persuaded to do.”¹⁸ They noted that, contrary to interpersonal communication, users of persuasive technologies struggle to distinguish exaggerated and/or false information from truthful information embedded in these technologies and “tend to trust the information

computers deliver to them.” This effect is likely to be even stronger in young children, who cannot understand the motivations of the app’s designer. Thus, a serious discussion of how to balance the needs of advertisers and the rights of children is needed.

Of note, when we made in-app purchases in selected cases, it was apparent that the free option took much more effort and a longer time to use, which is similar to the phenomenon of “grinding” used in video games—considered an unethical “dark pattern” of design—to make the game challenging or boring enough to encourage more in-game purchases.¹⁹

From a policy standpoint, consumer protection agencies may wish to discuss legal implications of these findings and pursue reevaluation of regulations regarding marketing, privacy, and persuasive design in digital media marketed to young children. The American Academy of Pediatrics recommends elimination of advertising in apps marketed to children aged 5 years and under.¹⁴ In addition to COPPA, current statutes include Section 5 of the Federal Trade Commission Act, which seeks to prevent deceptive advertising and marketing practices, defined as “a representation, omission, or practice that is likely to mislead the consumer acting reasonably in the circumstances, to the consumer’s detriment.”¹ It is likely that persuasive, gamified advertising practices in children’s apps would fit under this designation when children are the intended audiences. However, mixed-audience apps such as *Pengle* and *Candy Crush* may be more difficult to regulate.

The Federal Trade Commission may need to investigate whether permissions (e.g., *Masha and the Bear* requests access to location and contacts), sharing on social media, or prompting the child to rate the app are COPPA violations, since they may allow sharing of personal information. In addition, child advocates recommend easier parent access to and control over children’s online personal information and restricting the types of ads that can be displayed in children’s apps.²⁰

Finally, increasing media literacy of both parents and children might be helpful in protecting consumers from deceptive or unfair advertising practices, although no programs have yet been proven effective for these purposes. Media literacy programs in elementary, middle, and high schools are available (e.g., through Common Sense Media) but not yet widely adopted. From a practical standpoint, pediatric providers and early educators can encourage parents to play apps together with children to help them understand advertising¹⁴ and uninstall apps with excessive ads or manipulative design.

Several limitations of this study are worthy of mention. We only studied apps we presumed were played by children under 5 years on family mobile devices (although our passive sensing methods could not rule out a sibling using the device), or apps available in the 5 and Under section of Google Play. We therefore cannot make conclusions about app-based advertising to older children. In addition, our observations represent a snapshot

in time, and many apps are constantly going on and off the market and receiving updates, and changes to advertising approaches may be made. Therefore, a similar content analysis during a different timeframe may have yielded different results. We did not install from iTunes but did check that similar apps were available in both stores. However, the Apple App Store Review Guidelines state that “apps must not include links out of the app, purchasing opportunities, or other distractions to kids unless reserved for a designated area behind a parental gate;” it is unknown whether iOS apps adhere to these guidelines, but the current results may therefore not be generalizable to Apple App Store downloads. However, because Android is the most common operating system in US homes,¹¹ we believe these findings are generalizable to families’ experiences.

Our results suggest that app stores could play a crucial role in making higher-quality apps more easily accessible to parents and children (i.e., highlighted and prioritized on the top of their webpage or app store, where children are more likely to click them). It is important that Google Play and iTunes be transparent with families about the apps they offer and not misrepresent that apps meet certain privacy or educational criteria, which may lead to a false sense of security among parents.

These findings have several implications for future research. More needs to be known about whether children understand mobile advertising, at what age critical thinking about persuasive design develops, and how parents can help children build digital literacy. Although shared media engagement and active parent mediation are recommended,¹⁴ it is not known whether this might improve digital literacy or reduce children’s exposure to mobile advertising. Future directions for research focusing on commercialization in children’s apps include applying similar coding schemes to apps played by children in ongoing cohort studies to examine associations with child behavior, play interests, overall media usage, and displacement of other activities.

In summary, as technology companies currently reconsider their design choices for the purposes of protecting user rights and privacy and empowering their consumers, children’s apps should be considered as an important aspect of this cultural and business model change. By redesigning the systems in which children and parents seek out digital media products and experiences, technology companies have the potential to achieve sustainable progress through human-centered—not advertising-centered—design principles.

REFERENCES

1. Commission UFT. Advertising to kids and the FTC: a regulatory retrospective that advises the present. 2004. Available at: https://www.ftc.gov/sites/default/files/documents/public_statements/advertising-kids-and-ftc-regulatory-retrospective-advises-present/040802adstokids.pdf. Accessed March 15, 2018.
2. Rideout V. The common sense census: media use by kids age zero to eight. San Francisco, CA: Common Sense Media; 2017.
3. Hirsh-Pasek K, Zosh JM, Golinkoff RM, et al. Putting education in “educational” apps lessons from the science of learning. *Psychol Sci Public Interest*. 2015;16:3–34.
4. Guernsey L, Levine MH. *Tap, Click, Read: Growing Readers in a World of Screens*. San Francisco, CA: John Wiley & Sons; 2015.
5. Strasburger VC. Children, adolescents, and advertising. *Pediatrics*. 2006;118:2563–2569.
6. Carlsson-Paige N. *Taking Back Childhood: Helping Your Kids Thrive in a Fast-Paced, Media-Saturated, Violence-Filled World*. New York, NY: Hudson Street Press; 2008.
7. John DR. Consumer socialization of children: a retrospective look at twenty-five years of research. *J Consum Res*. 1999;26:183–213.
8. Montgomery KC, Chester J, Milosevic T. Children’s privacy in the big data era: research opportunities. *Pediatrics*. 2017;140(suppl 2):S117–S121.
9. Reyes I, Wijesekera P, Reardon J, et al. “Won’t somebody think of the children?” examining COPPA compliance at scale. *Proc Privacy Enhancing Tech*. 2018;2018:63–83.
10. Perrin JM. Qualitative research and ambulatory pediatrics. *Acad Pediatr*. 2005;5:129.
11. Company N. Smartphone owners are as diverse as their devices. 2015. Available at: <http://www.nielsen.com/us/en/insights/news/2015/smartphone-owners-are-as-diverse-as-their-devices.html>. Accessed April 10, 2018.
12. Bus AG, Takacs ZK, Kegel CA. Affordances and limitations of electronic storybooks for young children’s emergent literacy. *Dev Rev*. 2015;35:79–97.
13. Kirkorian HL, Choi K, Pempek TA. Toddlers’ word learning from contingent and noncontingent video on touch screens. *Child Dev*. 2016;87:405–413.
14. Radesky J, Christakis D, Hill D, et al. Media and young minds. *Pediatrics*. 2016;138:e20162591.
15. Radesky JS, Eisenberg S, Kistin CJ, et al. Overstimulated consumers or next-generation learners? Parent tensions about child mobile technology use. *Ann Fam Med*. 2016;14:503–508.
16. Brunick KL, Putnam MM, McGarry LE, et al. Children’s future parasocial relationships with media characters: the age of intelligent characters. *J Child Media*. 2016;10:181–190.
17. Nairn A, Fine C. Who’s messing with my mind? The implications of dual-process models for the ethics of advertising to children. *Int J Advert*. 2008;27:447–470.
18. Berdichevsky D, Neuenschwander E. Toward an ethics of persuasive technology. *Commun ACM*. 1999;42:51–58.
19. Zagal JP, Björk S, Lewis C. Dark patterns in the design of games. Paper presented at: Foundations of Digital Games 2013; May 14, 2013; Crete, Greece.
20. Johnson AF. *Inside the Kids’ Privacy Zone*. 2017. Available at: <https://www.common sense media.org/kids-action/blog/new-report-inside-the-kids-privacy-zone>. Accessed February 7, 2018.