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YouTube for young children: what are infants and toddlers watching on the most popular video-sharing app?

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Background: Infants and toddlers engage with digital media about 1–3 h per day with a growing proportion of time spent on YouTube.

Aim: Examined content of YouTube videos viewed by children 0–35.9 months of age and predictors of YouTube content characteristics.

Methods: We completed a secondary analysis of data from the 2020 Common Sense "YouTube and Kids" study. Parents were surveyed about demographics and YouTube viewing history. We developed a novel coding scheme to characterize educational quality and comprehension-aiding approaches (i.e., labels, pacing) in 426 videos watched by 47 children. Videos were previously coded for violence and consumerism. Bivariate analyses compared video-level predictors of higher quality educational content. Multivariable analyses examined child and family predictors of YouTube video content, adjusted for FDR.

Results: Only 19% of videos were age-appropriate, 27% were slow paced, 27% included physical violence, and 48% included consumerism. The game genre was associated with faster pace, more physical violence, more scariness, and more consumerism vs. all other videos. The informational genre was associated with more learning goals, slower pace, and less physical violence vs. all other videos. Child age 0–11.9 months vs. 24–35.9 months was associated with more age-inappropriate and violent content.

Conclusion: Physical violence and consumerism were prevalent among YouTube videos viewed by this sample, with infants being exposed to more age-inappropriate and violent content compared with toddlers. Caregivers may wish to select videos in the informational genre which tended to include more high-quality indicators and avoid gaming videos and monitor young infant video content.

KEYWORDS

YouTube, infants, digital media, parents, content analysis

Introduction

YouTube currently represents the largest share of young children's screen viewing, with young children 0–8 years of age spending over an hour per day on this video-sharing platform (Rideout and Robb, 2020). Over 80% of parents with a child less than 12 years of age report that their child watches YouTube (Smith et al., 2018). Among infants and toddlers, media use

averages 40 min to 3 h per day (Zimmerman et al., 2007; Kabali et al., 2015; Rideout, 2017). Videos and apps directed to this age group are abundant (Radesky et al., 2020; Meyer et al., 2021); yet, prolonged or non-educational media use in the infant and toddler years is strongly linked with developmental delays (Madigan et al., 2020; Wiltshire et al., 2021). Accordingly, the National Institutes of Health Strategic Plan has emphasized early childhood screen media use as a research priority (2021–2025). However, there is a paucity of research examining content for this specific age group in the most-used streaming video app, YouTube.

Indeed, a growing proportion of screen media time is spent on YouTube, with 17% of children under two accessing online videos as of 2020 (Levine et al., 2019; Rideout and Robb, 2020). Prior research on infant/toddler media use has focused on television (TV) and DVDs, which have been heavily marketed to them in prior decades, but YouTube has received less study. YouTube differs from traditional TV or DVDs in many key ways, including the presence of user-generated videos, marketing content, and algorithms that may drive children's viewing patterns (Alruwaily et al., 2020; Radesky et al., 2020). These characteristics may make it harder for families to find high-quality, educational videos on this platform. Furthermore, the algorithm itself has lacked transparency (Covington et al., 2016). It may be possible that when families view videos with more educational characteristics, the algorithm may present more videos with similar characteristics (Covington et al., 2016). Given that content quality is an important driver of young children's developmental outcomes (Madigan et al., 2020), more needs to be known about what infants and toddlers specifically are viewing on YouTube.

Young children often demonstrate less learning after viewing a video as compared with a face-to-face demonstration. This difference in how infants are able to learn from screens as compared with a face-to-face demonstration is termed the "video deficit effect" (Zack et al., 2009). For infants and toddlers, design of digital media is particularly important to overcome the cognitive constraints (video deficit effects) when learning information from tablets or TV (Barr, 2010). Previous content analyses of infant DVDs and TV programs have therefore examined comprehension-aiding approaches within videos to help overcome this video deficit effect, with a theoretical grounding in the development of young children's visual attention (Vaala et al., 2010). Such comprehension-aiding strategies can help guide young children toward important aspects of the content (Vaala et al., 2010). Examples of these strategies include: using child-directed speech, leveraging joint attention with pointing or verbalizations, using labels, and repetition. Additionally, slow-paced design may allow more opportunity for young children to process the content delivered in videos, while fast-paced design may have implications for children's hyperactive behavior (Zimmerman and Christakis, 2007; Lillard and Peterson, 2011). Similarly, speech that is slower and includes motherese, defined as a speech pattern with sing-song prosody that emphasizes vowels, may allow for language to be better-understood (Golinkoff et al., 2015). In prior work examining content analyses of TVs and DVDs marketed toward families with infants and toddlers, joint attention occurred about 15% of the time, visual depiction using labels occurred about 22% of the time, and child-directed speech occurred about 9% of the time (Goodrich et al., 2009; Vaala et al., 2010). These types of comprehension-aiding approaches have not been examined on YouTube for infants and toddlers, yet this information could provide context on the educational quality of YouTube videos.

Another way in which YouTube differs from child-directed TV or DVDs includes the higher prevalence of violence and advertisements which are embedded within YouTube videos (Radesky et al., 2020). Indeed, 61% of parents reported that their child encountered content that was unsuitable for children on YouTube (Smith et al., 2018; Radesky et al., 2020). However, no studies have examined markers or characteristics of YouTube videos with higher quality to help guide parents toward video content that is more supportive of young children's learning. For example, if higher-quality videos have greater view counts or belong to different video genres, parents could use these indicators to guide their young child's viewing behavior on this platform.

Lastly, prior work has suggested that family and child characteristics might shape their media viewing habits for TV (Thompson et al., 2013; Radesky et al., 2022). Specifically, certain types of TV content such as Baby Einstein DVDs have been previously marketed toward low-income families as being educational without substantive evidence base to support those claims (DeLoache et al., 2010). Indeed, many families have indicated they select and choose to utilize digital media with young children because of their desire to provide them with educational opportunities (Radesky et al., 2016a,b). Similar to TV marketing practices, the YouTube algorithm may suggest specific types of content tailored to or marketed toward certain family and child characteristics. Prior work has found that lower family socioeconomic status was associated with longer YouTube duration and greater likelihood of using YouTube main as compared with YouTube Kids (Radesky et al., 2022). As YouTube's algorithm lacks transparency, more needs to be known about how family and child characteristics relate to the content they are offered. For instance, it has been proposed that young children may be more likely to view YouTube when sharing a device with an older sibling (Radesky et al., 2022). In one low-income sample, device ownership was prevalent among children 0–4 years of age, with about 44% having their own mobile device or tablet (Kabali et al., 2015). However, it is unknown what the implications of early childhood device ownership might be, and how to counsel families. Therefore, more needs to be known about contextual factors such as family structure and device ownership and how these relate to children's encounters with inappropriate content on YouTube.

Given that non-educational use of media in infancy and toddlerhood is associated with language delays, social-emotional delays (McArthur et al., 2022), and sleep problems (Janssen et al., 2020), we focused our content analysis on young children from 0–35.9 months of age. We aimed to:

1) Examine the content, educational quality, and comprehension-aiding approaches for videos that infants and toddlers have watched on YouTube. We hypothesize that overall educational quality and comprehension-aiding approaches are low in YouTube videos.
2) Test video-level characteristics (view count, genre) that predict educational quality of YouTube videos. We hypothesize that there are view counts are lower for YouTube videos with more educational characteristics and that certain genres such as

TABLE 1 Coding scheme description and Cohen's Kappa reliability.

	Description	Reliability
Age-appropriate	Developmentally-appropriate content for young child (0–2.99y) and specifically developed for infants and toddlers. Routine nursery rhymes, songs with positive messaging, Sesame Street, or Dora the Explorer are all examples of age-appropriate content	1.00
Labels	Label (in sentence with elaboration) matches a visual depiction, the name/title of an object is stated and matched with a visual depiction. (Audible and visual)	0.79–1.00
Joint attention	Presence of orienting approaches such as pointing to promote attention	0.74–1.00
Learning goal	Content is goal-oriented with learning. These include: someone teaching how to draw, reading a children's story to the audience, social-emotional learning such as sharing, teaching kindness/empathy, numbers and letters, and shapes learning. These might be more explicit with teaching	1.00
Fast pace	Fast cuts with multiple camera changes or new concepts introduced, generally faster than once every 20 s	0.64–0.78
Motherese	Speaks in a manner that places emphasis on the consonants (slower, emphatic speech) in a way that caregivers might speak to infants/young children	0.78–0.90
Child-directed speech	Narrator or character speaks directly to the child or asks a question directly to the child, in a way that is developmentally-appropriate	0.65–0.78
Violence (previously coded)	Presence of physical violence with weapons, gore, or personal injury	0.78–0.93
Scary content (previously coded)	Frightening themes such as horror, spookiness, or jump-scare games	0.82–1.00
Consumerism (previously coded)	Branded content, unboxing videos, calls to purchase items	0.69–0.92

Reliability range as there were multiple coders.

music and informational genres will predict higher educational quality of YouTube videos.

3) Assess associations between family- and child-level characteristics and educational quality of YouTube videos viewed by infants and toddlers. We hypothesize that less parent education, younger parent age, and child owning device predict lower educational quality of YouTube videos.

Methods

Study sample

We analyzed a subsample of data collected from the 2020 Common Sense Census (Radesky et al., 2020), which included a nationally representative sample of children 0–8 years of age. Of the 1,140 children in the Census study, 191 watched the main YouTube platform (i.e., not YouTube Kids) at least once per week and submitted their viewing history for analysis. Parents provided electronic informed consent to participate and the University of Michigan IRB found the study to be exempt from review. Caregivers submitted the most recent ten YouTube video URL links viewed by their child by copying and pasting from the history section of YouTube. For the current study, we examined a sub-sample of 47 infants and toddlers 0–35.9 months of age. Of the 470 videos they viewed, 20 were duplicates, 21 were no longer available, and 3 were not coded due to being in a foreign language, leaving 426 videos that were coded using our current coding scheme on educational quality. Of note, there is variability in the total number of videos for video content variables, depending on when they were coded and which YouTube videos were available on the YouTube platform at the time. For instance, the previously-coded videos such as genre included a different total number of videos given that some videos became unavailable when the infant and toddler coding schemes were developed.

Coding scheme development

We developed a coding scheme based upon prior work examining educational content and quality of infant and toddler TVs and DVDs (Goodrich et al., 2009; Vaala et al., 2010) however, we allowed for iterative additions of novel codes that were pertinent to YouTube content. Codes were refined in weekly meetings and review of videos. Over 20% of videos were double coded against a gold-standard coding scheme and differences were resolved between coders systematically through discussion. Coder's inter-rater reliability was calculated using weighted Kappa with goal >0.70 and discrepancies in coding were resolved by consensus.

As described in Table 1, codes comprised: age-appropriate content (how developmentally-appropriate the content was for a child of this age group); labels (label of a word matches a visual depiction); joint attention (character on YouTube directs infant attention by pointing, gesturing, or by verbal means such as saying 'look at that'); learning goal (content is goal-oriented with learning, examples including: explicit teaching such as social-emotional learning with sharing, reading a children's story, content with numbers and letters/shapes); fast pace (fast cuts with multiple camera changes every 20 s or new flashing images), motherese (speech that places emphasis on consonants with slower, emphatic speech in a way that caregivers might speak to infants/young children), and child-directed speech (YouTube character directly addresses a child and asks a question).

These codes have been identified in prior work around infant and toddler DVDs and TV as being components relevant to visual comprehension-aiding and learning (Goodrich et al., 2009; Vaala et al., 2010). Reliability for fast pace was slightly less than 0.70, possibly due to within-video variability of pace, though we defined this as video cuts once every 20 s. Content of advertisements was not coded.

Previously coded content and video characteristics

YouTube videos had previously been coded for negative content according to a reliable coding scheme based on Common Sense Media criteria. These included violence (presence of physical violence with weapons, gore, or personal injury), scary content (frightening themes such as horror, spookiness, or jump-scares), and consumerism (branded content, unboxing videos and calls to purchase items). Additionally, videos were previously classified by genre. These genres included: story-based, music-based, DIY (do-it-yourself), informational, reality, games/challenges, toys, compilations (videos showing clips of highlights or surprising moments from various places), and information such as news or science. Data regarding video duration and view count were abstracted from the YouTube interface at the time of initial coding (June 2020). Additional information about the coding schemes and classification of genres can be found in the primary Common Sense Media "YouTube and Kids" report (Radesky et al., 2020).

Child and family characteristics

Caregivers reported demographic information and data which included: child gender, child age, parent gender, caregiver age, caregiver education, household income. Caregiver race/ethnicity was categorized as White non-Hispanic, Black non-Hispanic, Hispanic, and multiracial. Number of children in the household was dichotomized into presence of siblings vs. only child. In the primary YouTube Common Sense Media study, child age was reported as a categorical variable: 0–11.9 months, 12–23.9 months, 24–35.9 months.

Analysis

Univariate analyses

Univariate analyses quantified the demographic information of our sample and frequency of different content codes across all 426 unique videos.

Video-level, bivariate analyses

To identify video characteristics that were associated with infant-toddler content codes, we examined bivariate associations between (1) view count and (2) video genre with the presence of each content code (labels, joint attention, learning goal, fast pace, motherese, child-directed speech, violence, scary content, and consumerism). Because of the multiple categories of genre, we chose to conduct pair-wise *t*-tests to compare each individual genre with all the other genres combined. We included Mann–Whitney U tests to compare high-quality indicators with YouTube views.

Child-level, multivariable analyses

For each child, we created a proportion score for each of the content codes, indicating the proportion of videos they watched that included those characteristics. For instance, each child watched approximately 10 videos and if 2 of the videos were coded as age-appropriate, we created a proportion score of 0.2 for age-appropriate videos. The proportion score therefore accounted for occasional missing videos among some children though the vast majority of children had complete data. We created multivariable models examining associations between demographic characteristics (child age, gender, caregiver age, caregiver education, caregiver income, caregiver age, child device ownership, and siblings were included as independent variables in each model) and proportion of videos that each child watched containing different content codes (labels, joint attention, learning goal, fast pace, motherese, child-directed speech, violence, scary content, and consumerism). We created separate models with each of the proportion scores as the outcome variable. For all analyses, we adjusted for multiple comparisons with a False Discovery Rate of 0.05. All analyses were completed using SAS 9.4.

Results

As shown in Table 2, 32% of children were 0–11.9 months old, 30% were 12–23.9 months old, 38% were 24–35.9 months old, 53% were male and 26% had their own tablet device. Of the caregivers, 60% were fathers. Caregivers were on average 34 years old. Regarding racial/ethnic diversity, 72% of caregivers identified as white, non-Hispanic, 13% Black, non-Hispanic, and 13% white, Hispanic. In terms of education, most caregivers had a bachelor's degree or higher (68%).

As shown in Table 2, common video genres viewed by infants and young children included: music (31%), reality (25%), games (21%), story (17%), and toys (10%). Most videos were not age-appropriate (81%), though many contained labels (40%), some contained joint attention features (18%), few included a developmentally-appropriate learning goal (6%), and most were fast-paced (73%). About a quarter of videos contained physical violence (27%), and about half of the videos contained consumerism (48%).

View count was higher for videos with high-quality indicators such as: labels (19.3 million vs. 4.2 million, $p < 0.0001$), joint attention (17.0 million vs. 6.2 million views, $p < 0.0001$), motherese (18.4 million vs. 7.2 million views, $p < 0.004$). However, view counts were higher for fast-paced videos (13.6 million vs. 1.5 million views, $p < 0.0001$). These data are shown in Appendix A.

Additional bivariate analyses are presented in Tables 3A,B. In general, the music genre was associated with less physical violence, scariness, and consumerism as compared with all other videos. The DIY genre was associated with more presence of labels, slower pace, and less physical violence as compared with all other videos. The game genre was associated with less presence of labels, less joint attention, fewer learning goals, faster pace, more physical violence, more scariness, and more consumerism as compared with all other videos. The informational genre was associated with more learning goals, more child-directed speech, slower pace, and less physical violence as compared with all other videos. The toy genre was associated with more consumerism as compared with all other videos.

TABLE 2 Child demographic characteristics and video characteristics.

Demographic information	*n* = 47 (% or SD)
Child age	
0–11.9 months	15 (32%)
12–23.9 months	14 (30%)
24–35.9 months	18 (38%)
Child gender	
Male	25 (53%)
Female	22 (47%)
Parent age (years)	34.0 (SD = 4.8)
Parent gender	
Male	28 (60%)
Female	19 (40%)
Parent education	
High school or less	7 (15%)
Some college	8 (17%)
Bachelor's degree or higher	32 (68%)
Parent race/ethnicity	
White, non-Hispanic	34 (72%)
Black, non-Hispanic	6 (13%)
Hispanic	6 (13%)
Two or more races, non-Hispanic	1 (2%)
Child has their own device	12 (26%)
Video characteristics	
Genre (videos may fall into multiple genres), *n* = 441	
Story	77 (17%)
Music	135 (31%)
DIY	31 (7%)
Reality	109 (25%)
Games	91 (21%)
Satisfying	6 (1%)
Compilation	15 (3%)
Informational	32 (7%)
Toys	46 (10%)
Age-appropriate, *n* = 426	81 (19%)
Labels, *n* = 426	171 (40%)
Joint attention, *n* = 426	77 (18%)
Learning goal, *n* = 426	25 (6%)
Slow pacing, *n* = 426	116 (27%)
Motherese, *n* = 426	40 (9%)
Child-directed speech, *n* = 426	34 (8%)
Physical violence, *n* = 414	111 (27%)
Scary content, *n* = 411	61 (15%)
Consumerism, *n* = 410	196 (48%)

Multivariable analyses including covariates of child age, child gender, caregiver age, caregiver education, child owning their device, caregiver income, and siblings in the home are shown in Tables 4A,B. Child younger age (0–11.9 months vs. 24–35.9 months) was associated with viewing less age-appropriate content ($\beta = -33.6$, 95% CI [−56.0, −11.3], $p = 0.005$) and with viewing more violent content ($\beta = 27.1$, 95% CI [6.4, 47.9], $p = 0.01$).

Discussion

As of 2020, YouTube has represented the greatest share of young children's digital content viewing time and has distinct affordances from previous network TV and DVD content viewed by infants and toddlers, such as user-generated content and recommendation algorithms. Well-planned and developmentally-appropriate videos can promote social-emotional, language, and academic skills in young children (Fisch et al., 1999; Barr et al., 2010; Rasmussen et al., 2016). However, we found these types of videos to be uncommon in our sample of videos watched by infants and toddlers, with less than 6% of all videos containing learning goals. Rather, infants and toddlers encountered frequent violence and commercialism in this sample of videos. Though comprehension-aiding approaches such as child-directed speech and joint attention were common, they were used to direct infants and toddlers toward low-quality content.

Though educational quality overall in this sample of YouTube videos was low, more highly-viewed videos contained more comprehension-aiding approaches, were generally more age-appropriate, and contained less violent, scary, or consumerist content. Caregivers may be selecting videos that are generally more high-quality, or the YouTube algorithm has made these videos slightly more popular. The vast majority of these popular videos were nursery rhyme compilations. However, it also should be noted that videos containing violent or scary content included average view counts which were still quite high (in the millions). In the primary Common Sense Media "YouTube and Kids" study, most caregivers indicated that they co-viewed (i.e., watched videos with their children together) sometimes or frequently (Radesky et al., 2020). This prior work suggests that caregivers may try to select videos they perceive to be more educational and popular or possibly the YouTube algorithm may be creating a feedback loop once parents engage in educational content. On the other hand, in the same Common Sense Media "YouTube and Kids" study, about 10% of caregivers indicated they were surprised by some of the videos their child had watched, aligning with one naturalistic study finding that co-viewing occurs infrequently at home (Domoff et al., 2018). For families who may not be able to co-view with their children, avoiding genres such as video gaming may prevent unintended exposures to physical violence, scary content, and consumerism.

The formal features of YouTube videos, such as their fast pace, may have an impact on how infants and toddlers process their content visually and cognitively. Visual attention during infancy—alerting and orienting to stimuli are shaped by neurobiology and interactions with the environment (Colombo, 2001). Video pacing may drive some of these alerting responses. In particular, fast paced videos can be more challenging for young children to learn from because it is harder for young children to know what to focus on and orient to. Prior work has proposed that such fast cuts may be more stimulating for young children, and entrain young children to expect more intense visual input (Christakis, 2009). In one previous study of 4 years olds, fast pacing in an experimental design was associated with less optimal orientation to the video (Cooper et al., 2009). In another study, when

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TABLE 3 Bivariate associations between video categories and video characteristics.

(A)	Presence of labels	Joint attention	Learning goal	Fast pace	Motherese
Age-appropriate (81)	68% (55)	35% (28)	21% (17)	61% (49)	21% (17)
Not age-appropriate (345)	34% (116)	14% (49)	2% (8)	76% (260)	7% (23)
	***p* < 0.0001**	***p* < 0.0001**	***p* < 0.0001**	***p* = 0.006**	**p < 0.0001**
Story (72)	39% (28)	21% (15)	8% (6)	85% (61)	11% (8)
All other genres (354)	40% (143)	18% (62)	5% (19)	70% (248)	9% (32)
	p = 0.81	*p* = 0.50	*p* = 0.33	***p* = 0.012**	*p* = 0.58
Music (128)	42% (54)	14% (18)	7% (9)	70% (90)	8% (10)
All other genres (298)	39% (117)	20% (59)	5% (16)	74% (219)	10% (30)
	p = 0.57	*p* = 0.16	*p* = 0.50	*p* = 0.47	*p* = 0.46
DIY (31)	74% (23)	19% (6)	0% (0)	32% (10)	13% (4)
All other genres (395)	38% (148)	18% (71)	6% (25)	76% (299)	9% (36)
	***p* < 0.0001**	*p* = 0.85	*p* = 0.15	***p* < 0.0001**	*p* = 0.49
Reality (109)	50% (54)	37% (40)	6% (7)	82% (89)	14% (15)
All other genres (317)	37% (117)	12% (37)	6% (18)	70% (220)	8% (25)
	p = 0.02	***p* < 0.0001**	*p* = 0.78	*p* = 0.015	*p* = 0.07
Games (89)	26% (23)	7% (6)	0% (0)	89% (79)	2% (2)
All other genres (337)	44% (148)	21% (71)	7% (25)	69% (230)	11% (38)
	***p* = 0.002**	***p* = 0.002**	***p* = 0.008**	***p* = 0.0001**	***p* = 0.009**
Compilation (15)	13% (2)	7% (1)	7% (1)	80% (12)	0% (0)
All other genres (411)	41% (169)	19% (76)	6% (24)	72% (297)	10% (40)
	p = 0.031	*p* = 0.24	*p* = 0.89	*p* = 0.52	*p* = 0.20
Informational (30)	37% (11)	13% (4)	23% (7)	33% (10)	20% (6)
All other genres (395)	40% (160)	18% (73)	5% (18)	76% (299)	9% (34)
	p = 0.69	*p* = 0.48	***p* < 0.0001**	***p* < 0.0001**	*p* = 0.04
Toys (46)	65% (30)	44% (20)	7% (3)	80% (37)	15% (7)
All other genres (380)	37% (141)	15% (57)	6% (22)	72% (272)	9% (33)
	***p* = 0.00024**	***p* < 0.0001**	*p* = 0.84	*p* = 0.21	*p* = 0.15

(B)	Child-directed speech	Physical violence	Scariness	Consumerism
Age-appropriate (81)	19% (15)	4% (3)	1% (1)	16% (12)
Not age-appropriate (345)	6% (19)	33% (106)	13% (41)	57% (182)
	p = 0.0001	**p < 0.0001**	**p = 0.001**	**p < 0.0001**
Story (72)	7% (5)	45% (34)	22% (16)	28% (20)
Other genre (354)	8% (29)	23% (77)	8% (27)	52% (176)
	p = 0.72	**p < 0.0001**	**p = 0.002**	**p = 0.0001**
Music (128)	6% (7)	8% (9)	1% (1)	11% (13)
Other genre (298)	9% (27)	34% (102)	14% (42)	62% (183)
	p = 0.21	**p < 0.0001**	**p = 0.0002**	**p < 0.0001**
DIY (31)	19% (6)	3% (1)	3% (1)	53% (16)
Other genre (395)	7% (28)	29% (110)	11% (42)	47% (180)
	p = 0.02	**p = 0.003**	*p* = 0.19	*p* = 0.53
Reality (109)	11% (12)	20% (21)	12% (13)	66% (71)
Other genre (317)	7% (22)	29% (90)	10% (30)	41% (125)
	p = 0.18	*p* = 0.051	*p* = 0.76	**p < 0.0001**
Games (89)	0% (0)	64% (58)	19% (17)	89% (80)
Other genre (337)	10% (34)	16% (53)	8% (26)	36% (116)
	p = 0.002	**p < 0.0001**	**p = 0.0005**	**p < 0.0001**
Compilation (15)	0% (0)	43% (6)	15% (2)	15% (2)
Other genre (411)	8% (34)	26% (105)	10% (41)	49% (194)
	p = 0.25	*p* = 0.17	*p* = 0.69	*p* = 0.02
Informational (30)	23% (7)	0% (0)	7% (2)	67% (20)
Other genre (396)	7% (27)	29% (111)	11% (41)	46% (176)
	p = 0.001	**p = 0.0006**	*p* = 0.35	*p* = 0.03
Toys (46)	20% (9)	7% (3)	2% (1)	76% (35)
Other genre (380)	7% (25)	28% (108)	11% (42)	42% (161)
	p = 0.002	**p = 0.001**	*p* = 0.04	**p < 0.0001**

With FDR correction to account for a false discovery rate of 0.05. Significant results are bolded.

TABLE 4 Multivariable associations between child and parent demographic factors and video characteristics.

(A)	Dependent video characteristics β (SE)				
Independent predictors	Age-appropriate	Labels	Joint attention	Learning goal	Fast pace
Child age					
0–11.9 mo	−33.6 (11.2), $p = 0.005$	−14.5 (11.7), $p = 0.22$	−13.1 (8.9), $p = 0.15$	−8.7 (5.9), $p = 0.15$	11.7 (11.9), $p = 0.31$
12–23.9 mo	−16.4 (11.0), $p = 0.14$	1.0 (11.5), $p = 0.93$	−14.5 (8.8), $p = 0.11$	−5.8 (5.8), $p = 0.33$	8.0 (11.2), $p = 0.48$
24–35.9 mo (ref)	–	–	–	–	–
Child gender					
Female	−0.8 (9.1), $p = 0.93$	9.0 (9.6), $p = 0.35$	0.003 (7.3), $p = 0.99$	−0.6 (4.8), $p = 0.90$	5.4 (9.3), $p = 0.57$
Male (ref)	–	–	–	–	–
Parent age	−0.4 (1.0), $p = 0.67$	1.8 (1.0), $p = 0.09$	1.3 (0.8), $p = 0.11$	−0.3 (0.5), $p = 0.62$	1.5 (1.0), $p = 0.13$
Parent edu					
HS/some college	−22.7 (11.6), $p = 0.048$	−18.1 (11.8), $p = 0.13$	−3.8 (9.0), $p = 0.67$	−0.07 (5.9), $p = 0.99$	15.1 (11.4), $p = 0.19$
College (ref)	–	–	–	–	–
Child own device					−15.9 (11.3),
No	10.2 (11.0), $p = 0.36$	6.2 (11.6), $p = 0.60$	14.6 (8.9), $p = 0.11$	0.4 (5.9), $p = 0.95$	$p = 0.17$
Yes (ref)	–	–	–	–	–
Income	−1.5 (1.3), $p = 0.26$	−1.4 (1.4), $p = 0.31$	−0.7 (1.1), $p = 0.51$	0.4 (0.7), $p = 0.60$	2.0 (1.4), $p = 0.15$
Siblings in home	−3.4 (10.1), $p = 0.73$	3.9 (10.6), $p = 0.71$	0.7 (8.1), $p = 0.94$	−6.9 (5.4), $p = 0.21$	14.3 (10.3), $p = 0.17$
Only child (ref)	–	–	–	–	–

(B)	Dependent video characteristics β (SE)				
Independent predictors	Motherese	Child-directed speech	Violence	Scary content	Consumerism
Child age					
0–11.9 mo	−9.0 (6.7), $p = 0.19$	−5.9 (6.2), $p = 0.35$	27.1 (10.4), $p = 0.01$	−0.3 (5.7), $p = 0.96$	16.5 (13.1), $p = 0.21$
12–23.9 mo	−7.7 (6.5), $p = 0.25$	−5.6 (6.1), $p = 0.36$	20.3 (10.2), $p = 0.05$	0.1 (5.7), $p = 0.99$	17.5 (12.9), $p = 0.18$
24–35.9 mo (ref)	–	–	–	–	
Child gender					
Female	−2.9 (5.4), $p = 0.60$	6.1 (5.1), $p = 0.24$	7.7 (8.5), $p = 0.37$	3.1 (4.7), $p = 0.51$	−1.1 (10.7), $p = 0.92$
Male (ref)	–	–	-	–	–
Parent age	0.7 (0.6), $p = 0.23$	−0.1 (0.5), $p = 0.91$	−1.6 (0.9), $p = 0.09$	0.1 (0.5), $p = 0.85$	0.8 (1.1), $p = 0.50$
Parent edu					
HS/some college	−5.7 (6.7), $p = 0.40$	0.6 (6.2), $p = 0.91$	11.7 (10.4), $p = 0.27$	0.1 (5.8), $p = 0.98$	20.1 (13.1), $p = 0.13$
College (ref)	–		–	–	–
Child own device					
No	−2.1 (6.6), $p = 0.76$	5.1 (6.1), $p = 0.41$	−21.5 (10.3), $p = 0.04$	−4.9 (5.8), $p = 0.40$	−3.3 (13.0), $p = 0.80$
Yes (ref)	–	–	–	–	–
Income	−0.4 (−0.8), $p = 0.58$	−0.3 (0.7), $p = 0.70$	1.5 (1.2), $p = 0.23$	0.7 (0.7), $p = 0.32$	−0.4 (1.6), $p = 0.82$
Siblings in home	0.6 (6.0), $p = 0.92$	−2.1 (5.6), $p = 0.72$	−7.3 (9.4), $p = 0.44$	−1.1 (5.3), $p = 0.83$	−0.7 (11.8), $p = 0.95$
Only child (ref)	–	–	–	–	–

All covariates below (independent predictors) have been included in the models. With FDR correction to account for a false discovery rate of 0.05. Significant results are bolded.

4 years old children immediately viewed a fast-paced cartoon vs. a slow-paced educational cartoon, they exhibited weaker executive functioning in a lab-based task (Lillard and Peterson, 2011). Lastly, another study of 4 years olds found fast pacing and realism might both impact inattention (Kostyrka-Allchorne et al., 2019).

Additionally, because young children's visual attention is still developing, prior work has focused on comprehension-aiding approaches embedded in videos which direct infants and toddlers to the content (Meltzoff, 1988; Cooper et al., 2009; Goodrich et al., 2009), and which are designed to make it easier to learn language (i.e., motherese). These comprehension-aiding approaches were used fairly frequently with rates similar to or with greater frequency than those found in infant TV/DVDs (Vaala et al., 2010). However, these comprehension-aiding approaches often directed children to attend to violent and consumerist content rather than educational content.

Our study found that the youngest infants (0–11.9 months as compared with 24–35.9 months) were more frequently exposed to age-inappropriate and violent content, which is consistent with one

prior study examining the content of infant TV exposures (Barr et al., 2010). It is possible that caregivers inadvertently included video links of a sibling's YouTube viewing history, which is a limitation of this study. However, our multivariable modeling controlled for the presence of siblings in the home, and this did not alter our findings. Prior work has found that infants typically attend to TV content about 5% of the time (Anderson and Pempek, 2005), therefore caregivers may perceive that the content is less important during infancy. However, in one low-income sample, caregivers self-reported fewer verbalizations directed toward infants when infants were viewing adult-oriented content as compared with educational content (Mendelsohn et al., 2008). Toddlers and preschoolers may view less of this violent or age-inappropriate content as they may have stronger preferences about what they view. Caregivers may be more inclined to select videos that are more age-appropriate as they perceive their child has more ability to learn from the content (Kirkorian, 2018). It is also possible that the YouTube algorithm may be personalizing digital content based upon a child's viewing history, creating a feedback loop. More needs to be known about how the YouTube algorithm may be directing caregivers toward certain video options and how caregivers of the youngest infants (0–12 months of age) select YouTube content.

Physical violence was present in 27% of these videos and it was the youngest infants in our sample (0–11.9 months) who were viewing more of these videos. The developmental implications of violent content for very young infants is unclear, as infants younger than 18 months of age have difficulty transferring information from a screen to the real world, though infants as young as 14 months can imitate from TV screens (Meltzoff, 1988; Barr et al., 2007; Zack et al., 2009; Barr, 2010). It is possible that for such infants younger than 14 months of age, violent content may appear as more fast-paced cuts. In prior work, greater exposure to violent TV and non-violent entertainment TV at 1–3 years of age was associated with greater symptoms of inattention and hyperactivity five years later, as compared with educational content (Zimmerman and Christakis, 2007). However, the same associations were not true when children were exposed to this content at age 4–5 years (Zimmerman and Christakis, 2007). One prior randomized control trial has found reductions in externalizing symptoms for preschool boys when violent TV content was replaced with age-appropriate content (Christakis et al., 2013). These studies suggest a period of heightened susceptibility to violent content around 1–3 years of age. Violent and fast-paced content may shape children's attention even for the youngest children who may not fully understand what is occurring on the screen.

Consumerist content was prevalent in this sample of YouTube videos. Young children less than 8 years of age still have difficulty recognizing traditional advertising (Kunkel et al., 2004; Alruwaily et al., 2020). In previous work examining advertising content on YouTube, advertising was often embedded into the video itself and also leveraged parasocial relationships where the main YouTube character delivered the commercial content, termed host-selling (Alruwaily et al., 2020). Given these qualities, it may be challenging for young children to recognize videos on YouTube being advertisements. Though infants and preverbal toddlers have desires and preferences, they cannot yet negotiate with their caregivers at the store for certain products (Valkenburg and Cantor, 2002). For preverbal children, advertisements may have a stronger impact on their caregivers or siblings. Two to three-year olds may be more susceptible to the influences of advertising due to their stronger preferences and expressive language abilities (Valkenburg and Cantor, 2002). Prior work has found that when caregivers denied children's requests for products, children who were more heavy viewers of advertisements argued about the purchase twice as frequently compared with lighter viewers of advertisements (Calvert, 2008). Future work should examine the immediate effects of advertising content on infant, toddler, and parenting behaviors.

This study is not without limitations. Our sample size was small and these data were collected during the COVID-19 pandemic which may have shaped the types and quantity of videos viewed by young children. We only coded 10 videos viewed per participant, but our prior work (Radesky et al., 2020) suggests that children generally view the same video genres over time, so this is likely an adequate sampling approach. Additionally, previous work examining infant DVDs and TV programs have coded fewer videos and have not linked content with infant and family characteristics (Goodrich et al., 2009; Vaala et al., 2010). Prior work has found that digital media exposure was higher during pandemic times and caregivers may have had less supervision over their children's viewing habits during this period of time (Dore et al., 2021; Eales et al., 2021). Therefore, our results may not be generalizable outside of the pandemic time frame. Future work may consider including a larger sample of infants and toddlers and examining the context of how infants and toddlers view YouTube. Additionally, it would be important to examine associations between YouTube content viewed by infants and toddlers and longitudinal associations with developmental outcomes.

To our knowledge, this is the first study to examine YouTube content among young infants and toddlers and characterize associations between video characteristics and family characteristics. We found that videos with low educational quality, fast pacing, violent, and consumerist content were highly prevalent on YouTube for toddlers and infants. Caregivers may wish to pre-select videos for their young children including genres such as music or informational content and avoiding content such as gaming or compilation videos. Lastly, even for young infants, selecting YouTube videos that are age-appropriate and educational remains important, given associations between non-educational media use and developmental delays. YouTube may consider age-appropriate grouping of videos for specific age groups and elevating content that is more age-appropriate in their algorithm.

Data availability statement

This study involved a secondary analysis of a subsample of data collected from the 2020 Common Sense Census (Radesky et al., 2020). Further questions should be directed to TM, chungti@med.umich.edu.

Ethics statement

The studies involving humans were approved by University of Michigan, IRB exempt status. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and institutional requirements.

Author contributions

DH: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. TB: Conceptualization, Writing – original draft, Writing – review & editing. JS: Writing – review & editing, Formal analysis, Methodology. MR: Methodology, Writing – review & editing, Conceptualization, Data curation, Investigation, Project administration, Supervision. JR: Conceptualization, Methodology, Project administration, Supervision, Writing – review & editing, Formal analysis, Funding acquisition, Writing – original draft. TM: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing, Investigation.

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Conflict of interest

JR is a paid consultant and on the board of directors for Melissa & Doug Toys LLC and receives research funding from Common Sense Media. MR was employed at Common Sense Media during the production of this research and is currently employed by Google. TM is a paid consultant for PBS Kids.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Appendix A

TABLE A1 Video view characteristics and association with view counts.

Videos characteristics	View count in millions of views median (IQR)	*p*-value for Mann–Whitney U test
Labels not present	4.2 (0.9–18.9)	**<0.0001**
Labels present	19.3 (3.0–76.6)	
Joint attention absent	6.2 (1.0–26.7)	**<0.0001**
Joint attention present	17.0 (3.8–76.6)	
Learning goal absent	19.3 (7.9–133.7)	**0.006**
Learning goal present	7.3 (1.3–30.9)	
Slow-paced content	1.5 (0.1–9.7)	**<0.0001**
Fast-paced content	13.6 (2.6–47.4)	
Motherese absent	7.2 (1.1–30.8)	**0.004**
Motherese present	18.4 (4.3–103.7)	
Child-directed speech absent	7.4 (1.2–29.1)	**0.01**
Child-directed speech present	34.2 (3.0–111.2)	
Physical violence not present	8.7 (1.3–46.5)	0.05
Physical violence present	4.5 (1.1–15.7)	
Scary content absent	8.5 (1.4–39.3)	**0.007**
Some scary content	2.2 (0.5–14.0)	
More prevalent scary content	4.3 (1.1–4.3)	
Consumerism absent	14.3 (1.8–57.9)	**<0.0001**
Consumerism present	3.6 (0.9–15.6)	

With FDR correction to account for a false discovery rate of 0.05. Significant results are bolded.