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'A New You, That's Who': an evaluation of short videos on puberty and human reproduction

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ABSTRACT Learning basic information about puberty and human reproduction can alleviate concerns about the transition to adolescence and provide a foundation for later learning about more advanced reproductive health topics, such as family planning. Parents and children alike believe educational videos make these topics more engaging, and socio-cultural theory suggests such videos can effectively promote learning. To that end, we tested the efficacy of a series of reproductive health education videos called '*A New You, That's Who*', with a sample of 80 11-year-old children in a research laboratory setting. The series was designed with socio-cultural theory learning principles in mind and consisted of three 5-min animated music videos focused on puberty, reproductive anatomy, and menstruation. Children were randomly assigned to watch the '*A New You, That's Who*' videos or a control set of videos on the scientific method. Children who watched the treatment videos out-performed peers in the control group on a measure reproductive health knowledge. However, there were no differences in attitudes towards puberty between conditions. The videos provide effective ways to learn factual information about puberty and human reproduction, and may be valuable tools to supplement social-emotional lessons provided at home, at school, or in other real-world settings.

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Introduction

By age 11, most children begin showing signs of puberty, with girls typically achieving pubertal milestones earlier than boys (Walvoord, 2010). It is optimal for parents, teachers, and health educators to provide both boys and girls basic information about human reproduction topics (e.g., puberty, reproductive anatomy, menstruation) in advance of major pubertal milestones (Goldman, 2011; Zimvrakaki and Athanasiou, 2004). Empowered with this knowledge, children are better intellectually and emotionally prepared for dramatic changes happening to their bodies (Winn et al. 1995). As children mature throughout adolescence, they can continue building upon their foundational reproductive health knowledge, which can lead to stronger learning about more advanced human reproduction topics, such as family planning (Goldman, 2011; UNESCO, 2009; LeCroy et al. 2018; Stubbs, 2016). Unfortunately, children's reproductive health knowledge usually falls far below recommended educational benchmarks—at least in the Midwestern U.S. where the present data were collected—(Hurwitz et al. 2017), and youth in early adolescence are rarely the focus of educational intervention (LeCroy et al. 2018).

Learning about puberty and reproductive health can be sensitive topics for children. However, past research indicates that children recognize the importance of learning foundational reproductive health information (Zimvrakaki and Athanasiou, 2004) and believe learning tools, such as educational films, might help to elevate their level of knowledge around these topics (Haglund, 2006). Such videos might be able to supplement and extend the educational experiences parents and teachers are able to provide (Fisher, 1986; UNESCO, 2009). After all, there is extensive research showing that school-age children can learn lessons about science and health topics from curriculum-based media (Fisch, 2004) and that educational films can help to alleviate anxiety around health issues (Wartella et al. 2014). To that end, in the present study, we tested the efficacy of *A New You, That's Who*, a series of three 5-minute animated music videos designed to teach youth in early adolescence about puberty, reproductive anatomy, and menstruation. Focusing on a sample of 11-year-old children living in the greater metropolitan area of a major Midwestern U.S. city, we aimed to determine whether these videos could positively impact children's knowledge about and attitudes towards puberty and human reproduction.

Foundational reproductive health knowledge

U.S.-focused learning standards developed by the Sexuality Information and Education Council of the United States (SIECUS, 2004) and affiliated Future of Sex Initiative (FoSE, 2012), as well as international standards by the United Nations Organization for Education, Science, and Culture (UNESCO, 2009) agree that, by age 12, children should master a variety of reproductive health topics. For example, children in this age range should be familiar with puberty and associated social, emotional, and physiological (including hormonal) changes (FoSE, 2012; SIECUS, 2004; UNESCO, 2009). Likewise, the UNESCO (2009) standards stipulate that children should have basic understanding of reproductive anatomy and physiology, including sperm production and related hormonal processes. Moreover, UNESCO (2009) specifies that, by age 12, both boys and girls should be able to describe menarche, the menstrual cycle, and the hormones regulating this cycle. In the U.S., children's knowledge of these topics typically falls below these benchmarks (Hurwitz et al. 2017), which may be because many educational programs in the U.S. focus primarily on AIDS/sexually transmitted infections, and contraception or abstinence, at the exclusion of other topics (Schmidt et al. 2015).

Puberty. Although young adolescents have greater knowledge (Winn et al. 1995) and are more likely to have received school-based education (Hurwitz et al. 2016a) about puberty relative to other reproductive health topics, their knowledge about puberty is nonetheless relatively low. Only about two-thirds of young adolescents in the U.S. have learned about puberty in school (Hurwitz et al. 2016a). Some youth in early adolescence are not even familiar with the term "puberty" (KRC Research and Consulting, 1991a; Hurwitz et al. 2017) or assume only children of their own sex go through puberty (Hurwitz et al. 2017). By age 10, most children have some knowledge of changes that occur during the transition from childhood to adulthood (even if "puberty" is an unknown word). Familiarity with secondary sexual developments (i.e., pubertal developments not directly linked to human reproduction, such as increased body odor) is much higher than primary sexual developments (i.e., changes to reproductive organs) (Hurwitz et al. 2017). Some gender differences seem to exist, with boys eagerly anticipating pubertal developments, and girls tending to be more apprehensive (KRC Research and Consulting, 1991a; Hurwitz et al. 2017). Both boys and girls sometimes desire reassurance that the timing and individual nature of their transition to puberty is "normal" (Forrest et al. 2004; Stubbs, 2016).

Reproductive anatomy and physiology. Only 20% of U.S. government-endorsed pregnancy prevention educational programs cover reproductive anatomy and physiology (Schmidt et al. 2015). Perhaps as a result, some children report not learning the technical terms for human genitalia in elementary school (Sex Education Forum, 2016). Most children, however, who have received at least some sexual education are able to list some reproductive anatomy vocabulary words (e.g., uterus; fallopian tube), but their mental models of the full male and female reproductive systems are often limited (Zimvrakaki and Athanasiou, 2004). To illustrate, they might be able to name an organ but not know where it is located or what function it serves (Gartrell and Mosbacher, 1984). In some cases, children may be more familiar with or comfortable using slang terminology than technical labels for reproductive anatomy (Forrest et al. 2004; Burrows et al. 2017). In a similar vein, children also are largely unfamiliar with hormonal processes underlying puberty (KRC Research and Consulting, 1991a). Discussing reproductive anatomy can make prepubescent children squeamish, which in turn can inhibit learning (Zimvrakaki and Athanasiou, 2004).

Menstruation. Unsurprisingly, knowledge about menstruation is higher among girls than boys at this age, although most research has focused on girls. Boys have a vague idea that menstruation involves bleeding (KRC Research and Consulting, 1991a). Many girls understand menstruation is the result of an unfertilized ovum, but their knowledge about particulars—such as what specifically exits the female body—is hazy (Stubbs, 2008). Premenarchal girls are often uneasy about menarche and menstruation generally (KRC Research and Consulting, 1991a; Brooks-Gunn and Ruble, 1982; Stubbs, 2008), in large part due to negative messaging around menstrual "symptoms" (e.g., cramping) in many sexual education texts and in the popular media (Stubbs, 2016).

Media as a tool to support learning

It is not surprising that children believe educational videos or films might be a useful tool for addressing gaps in knowledge about human reproduction (Haglund, 2006; KRC Research and

Consulting, 1991a), given that there is a nearly 50-year history demonstrating that children can learn from curriculum-based videos (Fisch, 2004). Although many theoretical frameworks have been used to predict and interpret causal mechanisms, in this project, we consider educational media's potential through a socio-cultural lens (see Wartella et al. 2016; Watkins, 1985). Two principles from Vygotsky's (1930–1934/1978) socio-cultural theory are particularly germane to the present study: a) humans use *sign systems*, such as texts or artwork, to convey or gain information; and b) learning occurs as students move through a *zone or proximal development*, closing gaps between what they already know and what they can accomplish or learn through mentored guidance. Psychologists and learning scientists have expanded upon Vygotsky's thinking. For example, Bruner (1964) proposed that humans encode and process information using *enactive* (motor-based), *iconic* (image-based), or *symbolic* (language-based) representation. Bruner (1964) considers these modes of representation, particularly symbolic representation, analogous to Vygotsky's (1930–1934/1978) notion of sign systems. As an extension of the second principle of socio-cultural theory identified above (i.e., about the zone of proximal development), today members of the education community refer to Vygotsky's mentored guidance as *scaffolding* (Wood et al. 1976).

Further extending this line of thinking, others have argued that television can be an informative sign system that supplements or replaces lessons from teachers (Watkins, 1985) by scaffolding learning (McElhaney et al. 2015) and presenting information in a fashion that students can encode through iconic and symbolic modes of representation (Calvert, 1999). As with other sign systems, children learn to "read" television's formal features (i.e., salient audiovisual production techniques; Calvert, 1999; Watkins, 1985), which, in turn, draw their attention to the screen for lessons and signal that content might be age appropriate (Huston et al. 2007; Anderson and Kirkorian, 2015). For example, audio cues like music and rhyming (in limited amounts) can attract children's attention (Anderson and Lorch, 1983; Anderson and Kirkorian, 2015; Calvert, 1999). Children even might attend to song lyrics during moments when they look away from the screen (Anderson and Lorch, 1983; Anderson and Kirkorian, 2015), although this may not translate to stronger learning (Calvert, 2001). Additionally, animation might indicate content is child-friendly, consequently eliciting greater attention and learning (Huston et al. 2007; Anderson and Kirkorian, 2015). Calvert (1999) has referred to the mix of audiovisual formal features as a representational system—one that provides both visual and verbal streams of input aligned with children's iconic and symbolic representational thought. For these reasons, formal features can help children learn and later recall information presented in videos (Calvert, 1999).

For life science learning specifically, animated videos also can create a zone of proximal development and scaffold learning by showing phenomena otherwise inaccessible to children (Fisch, 2004; McElhaney et al. 2015), such as the inside of the human body. Such imagery can help make concepts about the body seem more concrete, which can help students refine their mental models of life science concepts (McElhaney et al. 2015). Moreover, life sciences visualizations can depict simplified versions of real-life phenomena, omitting structures irrelevant to lessons (Buckley and Quellmalz, 2013). This helps students focus on the most important aspects of a visual and reduces extraneous cognitive load (i.e., thought and attention dedicated to processing unimportant details) (McElhaney et al. 2015). Videos also can zoom in, or use highlighting or other visual cues to focus on important aspects of phenomena, while drawing attention away from less relevant features (Dalacosta et al. 2009; McElhaney et al. 2015). Children have intuition and some amount of background knowledge about human reproduction that they bring to the experience of viewing educational videos on these topics (Hurwitz et al. 2017), and, through the techniques described in this paragraph, videos can scaffold children through a zone of proximal development and help them refine their nascent mental models.

Other production techniques can further scaffold learning. Repetition helps reinforce messages and provides children with lower levels of prior knowledge with more than one opportunity to learn new lessons (Fisch, 2004; Fisch et al. 2005). Moreover, repeating content across different segments of videos can help children encode information in a more abstract, context-free manner, facilitating later recall (Fisch, 2004; Fisch et al. 2005). Additionally, videos also can create a zone of proximal development in the form of *layering*, or strategically placing advanced lessons amid other content the target audience would find very accessible (Bickham et al. 2012). In other words, videos can include both easier and more challenging concepts in a way that encourages children to extend themselves to acquire the more difficult content.

Beyond socio-cultural theory, additional empirical evidence suggests certain production decisions make video content more appealing, consequently eliciting greater attention and learning from children (Fisch, 2004). Themes children find personally relevant are appealing (Fisch, 2004) and allow them to more easily assimilate new information into existing frameworks of understanding (McElhaney et al. 2015). Age-appropriate humor and likeable characters also enhance appeal (Fisch, 2004; KRC Research and Consulting, 1991a). To that end, children's media typically features protagonists who are slightly older than the target audience (Chen, 1980; Fisch, 2004), homophilous or highly similar to the target audience (Chen, 1980; Anderson and Kirkorian, 2015), or simply cute/whimsical, like Pokémon's Pikachu (Allison, 2004). When such characters model strategies for coping with challenging health-related situations, children may feel reduced anxiety about (Wartella et al. 2014) and increased self-efficacy towards (Bandura, 2001) their own abilities to face these situations.

Despite the wealth of theory- and evidence-backed strategies for developing effective videos to teach about human reproduction, existing educational materials used in schools have been criticized for being dry, sterile, and unappealing (Fields, 2008). In some cases, separate videos target boys and girls, with videos targeting boys tending to convey a more positive tone (Fields, 2008). Videos with higher production quality often are created by consumer product companies and include advertisements for the companies' branded goods, such as feminine hygiene products, toothpaste, and deodorant (Stubbs, 2008). Across videos of varied production quality, some researchers have criticized materials for failing to provide sufficiently detailed, comprehensive, and holistic depictions of reproductive processes (Fields, 2008), although these critiques are not universal (Havens and Swenson, 1989).

Current study

Applying many of the socio-cultural and production design principles described above, *A New You, That's Who* videos were developed to promote understanding about and comfort with foundational reproductive health topics. The series consists of three 5-minute music videos, focused on puberty, reproductive anatomy, and menstruation. This evaluation aimed to determine whether the videos could promote stronger understanding about (RQ1) and more positive attitudes towards (RQ2) puberty and reproductive health among youth in early adolescence.

Table 1 Participant demographics

	All ($N = 80$)	Treatment ($n = 40$)	Control ($n = 40$)
Female	53%	53%	53%
Age in years-*M (SD)*	11.31 (0.71)	11.32 (0.66)	11.30 (0.76)
Child Race-Ethnicity			
African-American/Black	9%	3%	15%
Asian	6%	10%	3%
Caucasian	71%	83%	60%
Hispanic	5%	0%	10%
Other/mixed	6%	0%	13%
Household size -*M (SD)*	4.24 (1.03)	4.12 (.99)	4.35 (1.07)
Household income			
$49,999 or less	10%	5%	15%
$50,000 to $149,999	53%	49%	58%
$150,000 or more	37%	46%	28%
Highest parent education			
Less than college	8%	5%	10%
Bachelor's	30%	30%	30%
Master's	34%	30%	38%
Higher graduate degree	29%	35%	23%
Parent marital status			
Married	86%	90%	83%
Cohabiting	4%	5%	3%
Single	5%	0%	10%
Widowed, divorced, or separated	4%	5%	5%

Note: Percentages of families reporting each demographic characteristic, or means and standard deviations as appropriate. There were no significant differences between the treatment and control group.

LBH, ARL, and EW have served as independent research partners for the *A New You, That's Who* production team since 2013, and led two prior research studies to inform production. In winter 2014, we conducted a qualitative study designed to provide a needs assessment for reproductive health education in our local community and to update a rather dated literature on children's knowledge about and attitudes towards puberty and other reproductive health topics (Hurwitz et al. 2017). Drawing from those insights, the literature reviewed above, and additional scientific input from TKW and the Oncofertility Consortium, Peabody Award-winning animator EP led a team of Northwestern University student animators and partnered with Parents' Choice Award-winning musician Robert M. Charde to develop the videos. The videos were further refined to enhance comprehensibility and appeal, based on formative evaluation feedback (Hurwitz et al. 2016b). The present study evaluates the efficacy of the final videos.

Method

Sample. In a suburb outside of a major city in the Midwestern U. S., 82 children were recruited through a database of families who agreed to engage in research, as well as through flyers, Craigslist and Facebook postings, and personal referrals. Data from two children were dropped: One stopped the videos midway through testing, and the other appeared to answer the written measures without reading the questions. The final sample of 80 (42 girls) ranged in age from 8.25 to 12.39 years ($M = 11.31$, $SD = 0.71$). Parents identified children as Caucasian (71%), African American/Black (9%), Asian (6%) and Hispanic (5%), with the remainder choosing "other" or not providing race-ethnicity information. Eighty-three percent of the children had one or more siblings ($M = 1.20$ siblings, $SD = 0.85$).

Family income varied greatly, with 10% of families reporting household incomes of under $50,000, 53% between $50,000 and $149,999, and 36% earning $150,000 or more. The remainder did not provide income information. Primary caregivers' education ranged from 13% with less than a college education, 40% with Bachelor's degrees, 33% with Master's degrees, and 14% with higher levels of graduate education, with the remaining not specifying education. Likewise, 16% of children had secondary caregivers with less than a college education, 30% with Bachelor's degrees, 23% with Master's degrees, and 21% had higher levels of graduate education. Most parents were married (86%), with 4% cohabiting with partners, 5% single, and 4% widowed, divorced or separated.

Children were randomly assigned to either a treatment ($n = 40$) or control condition ($n = 40$). As shown in Table 1, there were no significant differences in background characteristics between the two conditions.

Stimuli. The treatment group watched the three *A New You, That's Who* (*New You)* videos. The full set of videos are freely available here: http://reprotopia.northwestern.edu/projects/new-you-thats-who. Each video consists of an approximately five-minute song about puberty, anatomy, or menstruation, accompanied by supportive animation. Some educational content is repeated across videos. For example, all videos explained hormonal processes underlying puberty and human reproduction, a topic for which children's prior knowledge may be especially low (KRC Research and Consulting, 1991a). Since the primary objective of these videos was to focus on puberty, reproductive anatomy, and menstruation, only one video alluded at all to the development of romantic feelings in a single very brief segment. In that video, EP aimed to be inclusive by showing protagonist's romantic object in silhouette without any gender markers, conscious of critiques that other educational materials and curricula promote heteronormativity (Fields, 2008; Gegenfurtner and Gebhardt, 2017). Also in contrast to other reproductive health education videos, which tend to be replete with advertisements and provide separate content for each sex (Fields, 2008), these videos contain no commercial content, and two out of three divided focus evenly between males and females.

The production team employed many design techniques aligned with socio-cultural theory (see Watkins, 1985) and other recommended best practices (e.g., Fisch, 2004). Despite the mature subject matter, the use of animation and music signaled to children that they were the videos' target audience (Huston et al. 2007). The videos judiciously employed rhyming to further attract attention (Anderson and Lorch, 1983). Because of the many audiovisual cues suggesting the videos were age-appropriate, the production team could create a zone of proximal development through layering (see Bickham et al. 2012). The videos featured vocabulary slightly more advanced (e.g., uterus) and considerably more advanced (e.g., progesterone) than what previous research suggests children in the target age range would be familiar with (Hurwitz et al. 2017) that in another context might have seemed too challenging or mature. As shown in Fig. 1, segments began with an orienting, wide-angle shot of the body, and then focused on specific areas, as per prior work (Dalacosta et al. 2009). Animations only showed phenomena concurrently described in the lyrics to avoid distracting or confusing children (Buckley and Quellmalz, 2013; McElhaney et al. 2015). To enhance appeal, the videos alternatingly featured characters depicted as whimsical anthropomorphized gonads (see Allison, 2004), prepubescent children roughly the same age as the sample (Chen, 1980), and postpubescent adolescents who had transitioned through puberty and were slightly older than the target

audiene (Chen, 1980; Fisch, 2004), as shown in Fig. 2. The videos also attempted to appeal to children by incorporating humor (Fisch, 2004), as shown in Fig. 3.

The control group watched a set of commercial videos by *BrainPOP* on the scientific method, critical reasoning, and statistics. *BrainPOP* produces educational videos and related learning resources on a host of topics for children in grades 3 and above (BrainPOP, 2017), and counts about 25% of U.S. elementary and middle schools among its international subscriber base (Schoology and BrainPOP, 2017). The *BrainPOP* videos used in this study were comparable in length to the *New You* videos, but contained no music or information about human reproduction or the human body. They took place in a science laboratory, spaceship, and grocery store, respectively. We showed these videos to the control group so that the time both groups spent in the research space between pretest and posttest was comparable. This allowed us to rule out the possibility that any changes observed in the study could be attributed to the treatment group having more time to become acclimated to the testing space and to reflect on any answers they provided at pretest.

Procedure. Children, accompanied by a parent, completed study sessions in our university research space. At the beginning of each session, parents consented and children assented to participate. Afterwards, all children completed icebreaker games and then were queried verbally about their prior knowledge and experience learning about puberty and menstruation. We did not probe for children's knowledge about reproductive anatomy, because our prior research (Hurwitz et al. 2017) and research by others (Zimvrakaki and Athanasiou, 2004) suggested that children struggle to express their knowledge of the male and female reproductive system without visual aids, such as reproductive anatomy diagrams. We did not wish to provide such aids at pretest for fear of contaminating our posttest results. Put another way, we were concerned that, if shown anatomy diagrams at pretest, children's posttest scores might in part reflect incidental learning from those diagrams.

Following the completion of the pretest activities, children screened their assigned video (either the *New You* or control videos). Afterwards, all children answered written multiple-choice questions reflecting their reproductive health knowledge, along with three Likert-type items on their attitudes towards puberty. While children were engaged in these activities, parents completed a short questionnaire that included additional questions on children's experience learning about reproductive

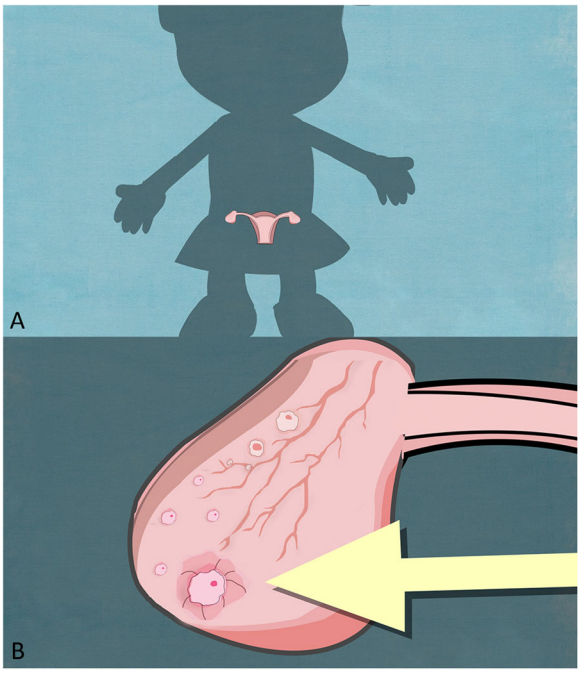

Fig. 1 Screenshots from the *A New You, That's Who* video on menstruation: (**a**) an orienting wide-angle animation focused on the female reproductive system, followed by (**b**) a narrow shot of the follicles in an ovary. This figure is covered by the Creative Commons Attribution 4.0 International License. Reproduced with permission of Eric Patrick; copyright © Eric Patrick, all rights reserved

Fig. 3 Screenshot from the *A New You, That's Who* video on puberty: The male character with exaggerated acne and facial hair to illustrate secondary sexual developments and provide humor. This figure is covered by the Creative Commons Attribution 4.0 International License. Reproduced with permission of Eric Patrick; copyright © Eric Patrick, all rights reserved

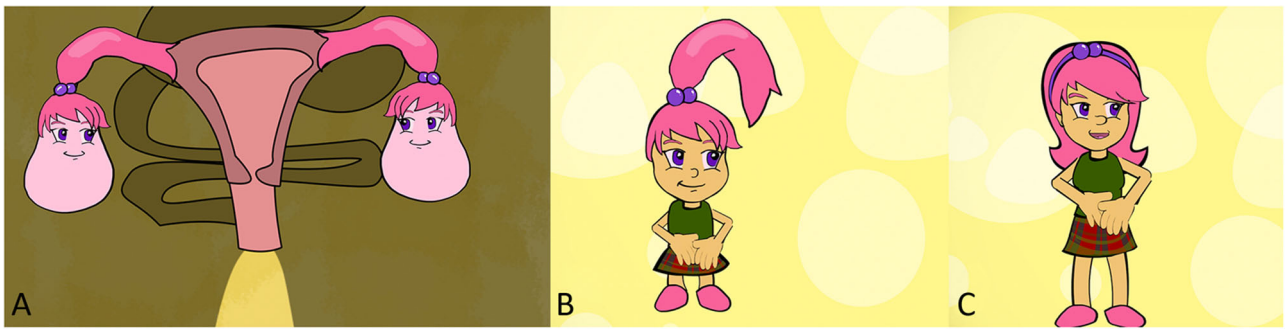

Fig. 2 Screenshots from the *A New You, That's Who* video on puberty: The female character depicted as (**a**) ovaries, (**b**) a prepubescent child, and (**c**) an adolescent. This figure is covered by the Creative Commons Attribution 4.0 International License. Reproduced with permission of Eric Patrick; copyright © Eric Patrick, all rights reserved

Table 2 Correlations

	1	2	3	4	5	6	7	8	9
Child gender	1								
Child age	.1522	1							
Parent education	−.0108	−.0592	1						
Race	.1488	.1694	−.0325	1					
Income (adjusted for family size)	−.0465	.0292	.2361*	−.2287*	1				
Marital status	−.0164	−.2132	.0392	−.4510**	.0566	1			
Pretest score	.2071	.3584**	.2181	.1872	.0964	−.2235*	1		
Reproductive health score	−.1380	.1638	.1493	−.2216	.1959	.3550**	−.0265	1	
Puberty attitude score	−.3937**	−.0051	.0167	−.0052	.0188	−.1197	−.0363	.0780	1

Note. Bivariate correlations of all study variables. Parent education is the highest available when data were provided for more than one parent. We dichotomized child race (Caucasian and Asian vs. all other races) and marital status (married vs. not). Income used in these analyses was adjusted for household size (i.e., for each participant, we divided reported household income by household size). *$p < .05$; **$p < .01$

health topics, as well as items on family demographics. At the end of the session, parents received $30 and children received a $20 Amazon gift cards. All research activities were approved and deemed ethical by our university Institutional Review Board.

Measures

Reproductive health pretest. Both children and parents provided data that contributed to a pretest composite. Children were asked whether they had previously learned about puberty (81% had) or menstruation (29% had). Children received one point for each topic they had learned about. Then, children provided definitions for each term. For both terms, children's definitions were scored using a three-point scale: One point for describing *what* occurs during puberty/menstruation, one for explaining *why* puberty/menstruation occur, and a third for information about timing (*when*). For example, the following definition of the term menstruation received three points:

> "For women, every month there's an egg and your uterus builds a lining and if there's no sperm, the uterus sheds the lining. That's blood."

For reliability purposes, a quarter of children's responses were double coded. Inter-rater agreement was high: ICC(3,1) = .83 for puberty and .96 for menstruation. The average puberty definition score was 1.56 ($SD = 0.81$) and menstruation score was 0.25 ($SD = 0.58$).

Finally, children rated their knowledge about puberty and menstruation, respectively, using a three-point scale ranging from "not very much" (1) to "a lot" (3). Children received scores of 0 if they indicated earlier they were unfamiliar with either topic. Children's average level of knowledge about puberty was 2.02 ($SD = 0.78$) and menstruation was 0.49 ($SD = 0.91$). Again, based on prior work, we did not believe it would be fruitful to query about reproductive anatomy verbally without visual aids (Zimvrakaki and Athanasiou, 2004; Hurwitz et al. 2017), and therefore did not cover this topic in the child portion of our pretest.

Parents also provided questionnaire data about children's reproductive health knowledge and education. Using a five-point scale ranging from "nothing at all" (1) to "almost everything there is to know" (5), parents indicated how much they believed their children knew about puberty and other reproductive health topics ($M = 3.31$, $SD = 0.67$). Using a list of 10 potential sources (e.g., teachers, medical providers), parents also checked every source that had provided children with reproductive health information ($M = 3.92$ sources, $SD = 2.14$). Finally, parents noted whether children had learned about any of 11 different reproductive health topics, including knowledge of both male and female reproductive anatomy ($M = 5.29$ topics, $SD = 2.63$).

Using the psych package (Revelle, 2016) in R 3.3.1 (R Core Team, 2016), we conducted an item-cluster analysis on the child and parent measures described above, which suggested they all clustered together (Pattern fit = .93, Cronbach's $\alpha = .72$). Because these indicators were scored on differing scales, we standardized and then averaged measures. Composite pretest scores ranged from −1.45 to 1.45 ($M = 0.02$, $SD = 0.63$).

Reproductive health posttest. As a posttest measure, children's knowledge about reproductive health was assessed via a custom measure created using procedures adapted from Collins (1983). First, LBH watched each video several times, and created a list of every fact shared. For research study credit, a sample of 15 undergraduates then screened the videos and indicated which items from that list could be removed from the videos without compromising their overall message. The research team then created a list of 21 written multiple-choice questions covering points 80% or more of undergraduates believed could not be deleted. For each question, there was one correct and two incorrect choices. Incorrect choices were generated based upon common misconceptions children reported in the research team's prior qualitative work (Hurwitz et al. 2017). As an illustration, one question asked: "What happens to unfertilized human eggs?" Response choices were "a) They're reabsorbed into the human body; b) They leave the female body; and c) They wait forever until a sperm comes to them". The Flesch-Kincaid readability grade level for this measure was 3.7, suggesting it was written at an appropriate level for our sample (all of whom were in 5th or above). The average score on this measure was 13.47 out of 21 potential points ($SD = 3.82$).

Puberty attitudes. As another posttest, children completed three items on their attitudes towards puberty, adapted from the Menstrual Attitude Questionnaire (Brooks-Gunn and Ruble, 1980). Children rated the extent to which they agreed with statements such as, "Puberty is enjoyable." Children could elect responses ranging from "disagree a lot" (1) to "agree a lot" (5), which were represented both in writing and with pictorial smiley face symbols. The Flesch-Kincaid readability grade level for this measure was 5.4. Although this may have been somewhat challenging for below level readers in our sample, the smiley face pictures should have supported comprehension. Because internal consistency was only moderate, (Cronbach's $\alpha = .6$), we computed children's puberty attitude scores as regression-weighted factor scores, which gave more weight to items more predictive of

Table 3 ANCOVA models

Source	*df*	*SS*	*F*	*p*	η^2
Reproductive health knowledge					
Condition	1	346.56	44.33	<.001	0.30
Gender	1	50.51	6.46	0.01	0.04
Income (adjusted for household size)	1	2.1	0.27	0.61	0.001
Pretest scores	1	159.38	20.39	<.001	0.14
Puberty attitudes					
Condition	1	0.05	0.10	0.75	0.001
Gender	1	6.90	12.78	<0.001	0.15
Income (adjusted for household size)	1	0.001	0.002	0.96	0.000
Pretest scores	1	0.09	0.17	0.68	0.002

Note: Analysis of covariance (ANCOVA) models exploring whether reproductive health knowledge and puberty attitudes were predicted by condition assignment, controlling for child gender, family income (adjusted for household size), and pretest scores.

the underlying construct. Children's scores ranged from −1.56 to 1.74 ($M = 0.02$, $SD = 0.78$).

Results

Analytical approach. As shown in Table 2, we first examined the bivariate correlations of the demographic, pretest, and outcome variables. For our main analyses, we examined puberty and human reproduction knowledge, as well as puberty attitudes, using independent samples t-tests to compare the scores of the treatment and control groups. We followed these with analysis of covariance (ANCOVA) models comparing between conditions while also controlling for gender, pretest scores, and household income (see Table 3). Income, parent education, parent marital status, and child race were significantly intercorrelated, and income was the only one of these variables to correlate with either outcome measure. Consequently, we controlled for income, rather than those other variables. For similar reasons, we controlled for child pretest scores rather than age. Results do not change substantially if we control for age rather than pretest (see supplemental Table S1; https://doi.org/10.7910/DVN/MSXKJG).

Reproductive health knowledge. Children in the treatment condition significantly outperformed those in the control group on the reproductive health knowledge posttest. On average, children in the treatment condition received scores of 15.67 out of 21 on this measure ($SD = 2.40$ points), while children in the control condition received scores of 11.27 ($SD = 3.73$), $t(78) = 6.27$, $p < 0.001$, $\eta^2 = 0.33$, Cohen's $d = 1.43$. Table 3 displays the results of the ANCOVA model, which incorporate pretest and demographic controls. Importantly, the difference between the treatment and control group remained significant in this model. There also was a main effect of pretest scores, with pretest scores positively predicting posttest scores, and of gender, with boys ($M = 14.02$, $SD = 3.7$) significantly outperforming girls ($M = 12.98$, $SD = 3.9$). Household income was not a significant predictor.

Puberty attitudes. Condition did not predict puberty attitude scores ($M_{\text{treatment}} = 0.002$, $SD = 0.86$ vs. $M_{\text{control}} = -0.01$, $SD = 0.69$, $t(78) = 0.22$, $p = .82$, $\eta^2 < .001$, Cohen's $d = 0.02$). In the ANCOVA model, condition still did not significantly predict attitudes, as shown in Table 3. There was, however, a main effect of gender, with boys ($M = .33$, $SD = .72$) having a significantly more positive attitude than girls ($M = -.28$, $SD = .71$). Puberty attitudes were not related to pretest scores or household income.

Discussion

The *A New You, That's Who* videos were highly effective at scaffolding children's learning about puberty and human reproduction, but did not have an impact on puberty-related attitudes. Below, we discuss each of these findings in greater detail.

Positive impact on puberty and reproductive health knowledge. The videos had a statistically significant and large effect on children's topical knowledge (Cohen, 1988). The overall effect found in the present study was about 3–5 times greater than the average effect for educational videos on health and science knowledge (Mares and Pan, 2013), and for parent- (Widman et al. 2016) or teacher-directed sexual education lessons (Fonner et al. 2014). Because weak foundational knowledge about puberty and human can make it more challenging for children to later grasp more advanced reproductive health concepts (UNESCO, 2009), it is encouraging that these free videos successfully promoted learning in these areas in the context of this study.

In all likelihood, the videos facilitated strong learning by conveying new information in a manner aligned with sociocultural theory (e.g., Watkins, 1985) and with children's natural iconic and symbolic representational thought (Calvert, 1999), and in a way that reflected accumulated empirical evidence about optimal video design (e.g., Fisch, 2004). The use of music with lyrics that occasionally rhymed may have signaled to children they should pay attention to the videos, which in turn may have facilitated learning (Anderson and Lorch, 1983). This contradicts previous research, which did not document learning gains for educational information delivered via song (Calvert, 2001). It may be, in this case, the host of visual animation techniques and touches of humor reinforced the lyrics in way that uniquely promoted learning (Fisch, 2004). Most video segments began with a wide angle shot of the human body and then focused on the organ or other element being concurrently described in the song lyrics (Dalacosta et al. 2009), never showing extraneous physiology (Buckley and Quellmalz, 2013). Together, these visual techniques may have helped children to develop accurate iconic representations of relevant processes. Additionally, the animation style may have signaled to children that the videos were targeting them (Huston et al. 2007), allowing the production team to create a zone of proximal develop by layering in advanced reproductive health vocabulary (Bickham et al. 2012). It also probably helped that the lyrics repeated vocabulary and other advanced concepts within and across videos (Fisch, 2004). Future research may help disentangle which production element or combination of elements was most responsible for the positive results.

Lack of support for puberty attitudinal change. The videos did not impact children's puberty attitudes. While educational video excels at promoting an understanding of concrete physical

phenomena that can be shown visually and vocabulary that can be used in context, theoretical work suggests it is less successful at promoting abstract ideas (Fisch, 2004), such as the notion that puberty is not something to fear. Indeed, other studies looking at learning from video about other topics have found small to negligible effects on students' attitudes (e.g., Jennings, 2013). Videos that have been successful in this regard showed characters who engaged in relatively lengthy modeling sequences (e.g., undergoing a full medical procedure), and, in some cases, researchers prompted children to practice modeled behaviors (e.g., Klingman et al. 1984). Although the *New You* videos did show prepubescent characters quickly grow into postpubescent bodies, these depictions were brief, and the characters were relatively passive during these moments of transition. Characters may have needed to engage in more active behaviors that children could strive to emulate to prompt attitudinal changes. Longer exposure also may have been necessary to counter the myriad negative messages children, especially girls, may have already received about pubertal developments elsewhere (Stubbs, 2016). Alternatively, it is also possible our three-item attitude measure was insensitive to change following short video exposure.

Nonetheless, there may be more of a need for videos that promote factual knowledge than impact attitudes. Because of the sensitive nature of these topics, parents and experts alike advocate for parents to be children's first teachers in this area (American Academy of Pediatrics, 2001; KRC Research and Consulting, 1991b). Parents may be best equipped to discuss the social-emotional aspects of transitioning to puberty (KRC Research and Consulting, 1991b). Videos in turn might be more appropriate for delivering high level information about hormonal and physiological processes, technical areas parents or even educators might have lower comfort teaching (Fisher, 1986; UNESCO, 2009; Zimvrakaki and Athanasiou, 2004).

Limitations and future directions. This was an efficacy evaluation conducted with a convenience sample in a university research space with few distractors and with learning assessed immediately after video exposure. It is possible children may have been more attentive in this setting than a school environment. Several children imagined classroom peer dynamics might lead their classmates to make jokes about the content. It also may be that children or families with low levels of comfort or knowledge about these topics opted not to enroll in this study, and effects could be lower for such a population (LeCroy et al. 2018). Conversely, it is also possible learning from the videos would have been even stronger in a naturalistic setting, as teachers or parents could have made opportunities to scaffold children's learning (Takeuchi and Stevens, 2011). Our testing protocol did not allow children to pause the videos to take notes or to re-watch tricky segments, and it also did not provide time for parents or researchers to help clarify any points presented in the videos. Other research suggests that learning from science visuals is stronger when students learn in a classroom over multiple class periods and when they have some control over video pacing (McElhaney et al. 2015). Future research should assess these videos in a more naturalistic setting and using a more rigorous control (e.g., exposing children to a competitor video series). To provide an even stronger test of the robustness and meaningfulness of children's learning, it also would be helpful for future researchers to assess children's retention of what they have learned after a delay.

Nonetheless, based on these promising findings, the video development team has begun considering ways to make the video series even more comprehensive. To that end, the team created new discussion prompts to accompany the videos and intends to create a robust suite of supplementary materials for teachers. The team also has discussed creating videos focused on additional topics. The existing videos largely focused on the biology and biochemistry underlying pubertal processes, but there is a need for related educational content on other topics, such as the biology of sexual orientation and identity, and the characteristics of healthy romantic relationships (Forrest et al. 2004; Gegenfurtner and Gebhardt, 2017; Stubbs, 2016).

Conclusion

A New You, That's Who videos are promising free tools for providing foundational knowledge about puberty and reproductive health. The information conveyed in these videos is important for preparing children for eventual advanced reproductive health lessons (LeCroy et al. 2018; UNESCO, 2009; Zimvrakaki and Athanasiou, 2004; Stubbs, 2016). Additional support from parents and teachers may serve to further enhance learning from these videos (Takeuchi and Stevens, 2011; McElhaney et al. 2015), and address any social-emotional concerns children may have about puberty.

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Data availability

The dataset generated during and analyzed during the current study are available in the Dataverse repository: https://doi.org/10.7910/DVN/MSXKJG.

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Additional information

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