Social network determinants of screen time among adolescents

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ABSTRACT

This research investigates the screen-based media consumption of adolescents in their social context, using social contagion theory to understand how screen-based media consumption is affected by an individual's social environment. To assess the possibility of person-to-person spread and the social network determinants of screen-based media consumption behavior, analyses were performed on the social networks of adolescents. First, the social networks of adolescents were assessed for the degree of clustering of similar screen-based media behavior between friends. Second, regression analyses assess the extent to which these associations may be attributed to friendship selection or to social influence processes. Results show that high screen-based media consumption rates are strongly correlated with high screen-based media consumption rates in one's friends. This association extends up to six degrees of separation. Implications for understanding how adolescents make decisions about how to consume media are discussed.

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1. Introduction

More than half of parents say that their adolescent children get too much screen time (Pew Research Center, 2013), and scholarly work has disagreed about the extent to which screen-based media consumption is beneficial or detrimental. A recent report from the Royal Society of Pediatricians concluded that there is little evidence of harm from screen time, but that more and better studies of its effects are needed (Viner, Davie, & Firth, 2019). Indeed, two recent open letters published in *The Guardian* took far different views of the concern over screen time. One letter (Palmer, S. [on behalf of all signatories], 25 December, 2016) described a view of children's health being undermined by a lack of control over screen-based media consumption. A follow-up letter (Etchells, P. [on behalf of all signatories], 6 January, 2017) challenged this view. Importantly, however, both letters called for increased research into the causes and consequences of screen-based media consumption for children. A study suggests that moderate uses of screen-based media may be beneficial, and that particularly low or high levels of such media consumption are negatively associated with mental well-being (Przybylski & Weinstein, 2017). Research that advances our understanding of how and why adolescents make decisions about how much screen-based media to consume helps inform these discussions. Research focused on the determinants of screen-based media consumption have considered individual factors, such as race, sex, and age (Katz, Blumler, & Gurecitch, 1974; McQuail, 2005; Papacharissi & Mendelson, 2007), and structural factors, such as the availability of media and competition between media sources (Barrett, 1999; Cooper, 1993). Relatively understudied has been the role that the social environ-

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ment to which an individual is exposed plays in affecting screen-based media consumption decisions.

Some studies have shown that high levels of screen time among adolescents is associated with various health and behavioral effects, such as decreased academic performance (Anand, 2007). Other research demonstrates that media consumption at more moderate levels is often associated with positive outcomes, including for social relationships. Research has demonstrated that playing video games in groups can increase cooperative behavior outside of the video game setting (Velez, Mahood, Ewoldsen, & Moyer-Gusé, 2014). Exposure to television may also have impacts on social feelings, as people report watching television programs to combat loneliness and to develop feelings of belonging (Derrick, Gabriel, & Hugenberg, 2009). A recent study showed that the relationship between media consumption and feelings of depression may be complex and non-linear (Scherr, 2018). For a review of work that shows the benefits of screen-based media consumption for children and adolescents, see Chassiakos, Radesky, Christakis, Moreno, and Cross (2016). For both policymakers and academics, it is important to understand when and why adolescents consume screen-based media at varying levels in the first place.

1.1. Determinants of adolescent media exposure

Media exposure has many determinants. Previous studies have grouped the determinants of media exposure into two broad categories — individual factors and structural factors (Cooper & Tang, 2009). Individual demographics have been shown, sometimes through the lens of the uses and gratifications approach as demographics are related to satisfaction of particular needs through media, to affect rates of media consumption (Katz et al., 1974; McQuail, 2005; Papacharissi & Mendelson, 2007). These studies have shown that individual characteristics such as age, gender and socioeconomic status influence rates of media usage (Albarran & Umphrey, 1993; Kang, 2002). Structural factors, such as audience availability, access to media sources, and competition among media sources, also affect rates of media exposure (Barrett, 1999; Cooper, 1993). While research into the interaction between individual factors and structural factors is relatively uncommon, some scholars have attempted to combine the two sets of explanations to better understand their shared and separate influences (Cooper & Tang, 2009).

The cultural context in which media are consumed may substantially impact the rate of media consumption. Studies have shown the cultural context is related the amount of time spent consuming screen-based media and the purposes for which such media are used (Larson & Verma, 1999; Zohoori, 1988). Cultural context may be differences across the globe or may be differences within a society depending on the culture within a society. For example, research has shown that immigrant families may use media as a way of establishing a new identity and acculturating to a new cultural context (Elias & Lemish, 2008; Moon & Park, 2007). Cultural context has also been shown to impact the amount of time spent watching television, time spent on the Internet, and how parents mediate such behavior (Martínez de Morentin, Cortés, Medrano, & Apodaca, 2014). However, a recent study (Scherr, Mares, Bartsch, & Götz, 2018) shows that cultural differences may not be as important for explaining differences in children's responses to media as are socialization processes, particularly parental approval. As such, it is particularly important to investigate how family and peer socialization may impact how children respond to media.

Scholarly research has also investigated the important role that the social context of an individual has for media consumption. Televisions are frequently located in a central location such as the family room, which facilitates consumption in a shared space. As such, media are frequently consumed socially, often with family members (Pasquier, Buzzi, d'Haenaens, & Sjöberg, 1998). Due to the often-social nature of this behavior, media consumption patterns among adolescents are frequently informed by the media usage of parents and siblings. This may facilitate positive family dynamics, such as facilitating bonds between family members (Pasquier et al., 1998). Indeed, research has investigated the important role that parents may play in mediating the consumption of screen-based media. This research has shown that how parents mediate may have impacts on the attitudes that adolescents have toward their parents and may result in increased viewing with friends (Nathanson, 2002). Parents engage in similar mediation activities surrounding video games as they do when mediating television consumption (Nikken & Jansz, 2007; Shin & Huh, 2011).

The social context of media consumption extends outside of the family. Media consumption is a topic of conversation among friends (Suess et al., 1998), as friends are likely to use media together, talk about media they have consumed (either communally or separately), and provide a sense of group identity to the relationship. Further, Fletcher (2006) shows that the amount of television viewed is associated with the average rate of television consumption of classmates at school. The social context of media consumption highlights the important role that media has for social relationships, for both friends and family (Livingstone, 2002). Family context may play in important role in how children are socialized to respond to media, particularly as related to emotional expression (Scherr et al., 2018). Work on YouTube has shown that co-viewing and social interaction are important determinants of video consumption (Haridakis & Hanson, 2009), suggesting that similar processes may impact the consumption of online videos.

1.2. Social contagion theory

A growing literature explores the important role that a broad set of social contacts may play for a variety of behaviors. Studies have investigated a wide range of phenomena in which the behaviors of social contacts in the focal individual's social network affects her behavior, such as smoking, obesity, voter turnout, alcohol consumption, suicide, online ratings, and the adoption of social media applications (Christakis & Fowler, 2009). These studies indicate that a wide variety of behaviors and attitudes cluster in social networks, and that social influence is

responsible, at least in part, for the clustering. Though the precise mechanisms through which behavior and attitudes may spread through social networks may vary depending on the context of what is being studied, these studies have shown that (a) people's behaviors and attitudes tend to cluster in their social networks such that people are connected to social contacts who are relatively similar to them, and (b) the clustering is often due, at least in part, to social influence.

Research has yet to investigate how the social environment surrounding adolescents' decisions about how much television to watch or how long to spend playing video games using these techniques. One way in which adolescents may make such decisions is through observation of the attitudes toward such behaviors, or observing the actual behaviors, of those around them. Although social learning theory (Bandura, 1977) is complex and is not directly tested in this paper, the basic tenets of the theory show one pathway through which the social environment may impact decisions surrounding media consumption. Social learning theory posits that through the observation of others we learn from the behavior of models. Models, who may be parents, teachers, friends, siblings, or others, are people whose behavior we observe and evaluate. We observe not only the behavior of others, but also the consequences of the behavior. Later, we may imitate this behavior, particularly if the model is seen to experience positive consequences from the behavior.

The uses and gratifications approach to media consumption demonstrates one reason that such imitation may take place. This approach shows that people have social relationships in mind when they make media consumption decisions (Katz, Blumler, & Gurecitch, 1973). Indeed, people have long reported that they either make plans to watch television or play video games with another person or because of an expectation of a future interaction (Rubin, 1983). As people make consumption decisions anticipating future social interactions, they may decide to consume media in order to facilitate conversation and build social bonds.

According to social learning theory, individuals copy or imitate the behavior of those around them. Such imitation may produce a resulting correlation in behavior through multiple processes or mechanisms. For example, an individual may imitate a friend's video game playing behavior (e.g., playing a particular game for a long period of time), imitation of another behavior that takes up time that could otherwise have been spent playing video games (e.g., playing basketball), or changing the social norms surrounding the behavior in question — in this case, perhaps, norms surrounding how long it is acceptable to play video games in a single setting. Importantly, many psychological mechanisms may produce behavior that, broadly construed, is consistent with imitation. In its most pure form, imitation may be simply copying. More broadly construed, however, imitation may be a result of copying the behavior of others who appear to receive real or social rewards for their behavior. Although the examples below use the lens of social learning theory to explain how a psychological process may produce correlated behavior between friends,

other processes consistent with the broad interpretation of imitation may produce similar resulting relationships.

As one example of an alternative psychological process that may produce correlated behavior between friends, consider socialization. That is, media consumers may choose what and how much media to consume based on past social interactions in which media was discussed or the expectation that future interactions in which media will be discussed are likely to occur. In these circumstances, people may decide to consume media in order to facilitate social interactions and to create stronger social bonds. This explanation suggests that media consumers are more strategic in why they tend to behave like those around them, but results in a similar imitation process.

In doing so, they may create or maintain social relationships with similar others, causing clustering in their social networks. This leads to the first pair of hypotheses:

H1a. Social networks of participants will exhibit significant clustering of television consumption behavior in which social network friends, friends of friends, and so on, will show correlated behavior.

H1b. Social networks of participants will exhibit significant clustering of video game playing in which social network friends, friends of friends, and so on, will show correlated behavior.

The results of H1 inform whether participants exhibit similar behavior and the distance, in terms of the degrees of separation between individuals, in the network that influence may travel. An association in the behavior of friends in a social network may be the result of three mechanisms: (1) influence, in which a participant's behavior produces behavioral change in that participant's friends (2) homophilic selection, in which a participant selects friends based on common behavioral attributes, and (3) confounding, in which participants are exposed to the same external stimulus that causes their behavior to become more correlated over time (e.g., the availability of a television provider in the community in which connected individuals live) (Christakis & Fowler, 2013). Fully accounting for these alternative explanations in an observational study is difficult, but through the use of various control variables (as described in detail below) researchers may attempt to limit the impact that homophilic selection and confounds from a shared environment may have. This leads to the second pair of hypotheses:

H2a. Participants whose social network neighbors (friends) consume television at a high rate will be more likely to also consume television at a high rate after controlling for homophilic selection and confounding.

H2b. Participants whose social network neighbors (friends) play video games at a high rate will be more likely to also play video games at a high rate after controlling for homophilic selection and confounding.

The likelihood that social influence, rather than some other network process, is responsible for clustering may be examined by investigating whether different types of friendships exhibit different levels of social influence. We may intuitively theorize that closer friends will be more

likely to be influential than are mere acquaintances. This suggests that variation in the type of friendship relationship may impact the likelihood that a friendship shows social influence. For example, imagine that Dylan thinks of Logan as a friend, but Logan does not think of Dylan as a friend (a non-reciprocated friendship). In this case, Logan's actions would be influential for Dylan, as in Dylan's mind Logan is a good model, but the reverse would be less likely to be true.

When friendships are not reciprocated, the participant who does not perceive a friendship in the relationship may be less likely to be influenced by the behavior of their social contact. In this case the social contact is less likely to be perceived as a good model, and the participant is less likely to change their behavior to be similar to the model's behavior. This leads to the third pair of hypotheses:

H3a.   Participants whose social contact perceives a friendship, but the participant does not (friend-perceived friendship), will show less evidence of social influence than the full set of friendships for consuming television at a high rate, after controlling for homophilic selection and confounding.

H3b.   Participants whose social contact perceives a friendship, but the participant does not (friend-perceived friendship), will show less evidence of social influence than the full set of friendships for playing video games at a high rate, after controlling for homophilic selection and confounding.

In relationships where both the participant and the social contact perceive a friendship (mutual friendships) social influence is very likely. For example, if Logan thinks of Dylan as a friend and Dylan reciprocates (a mutual friendship) this is likely to be a relatively strong relationship. In this type of relationship, both Dylan and Logan would be likely to think of one another as good models and Dylan and Logan's actions would be likely to be influential for one another. Mutual friendships are likely to show the strongest evidence of social influence among friendships if social influence is responsible for similarity in behavior. This leads to the fourth hypothesis:

H4a.   Participants who perceive a friendship that is reciprocated (a mutual friendship) will show more evidence of social influence than the full set of friendships for consuming television at a high rate, after controlling for homophilic selection and confounding.

H4b.   Participants whose social contact perceives a friendship, but the participant does not (friend-perceived friendship), will show more evidence of social influence than the full set of friendships for playing video games at a high rate, after controlling for homophilic selection and confounding.

2. Methods

2.1. Participants and data

Participants were a nationally representative sample of 90,118 American students from 142 schools in Grades 7–12

involved in the National Longitudinal Study of Adolescent Health (Add Health) (Harris, 2009). Table 1 shows summary statistics of the sample. A subset of the full sample was chosen for in-depth "in-home" follow-up interviews in Wave I (1994–1995; N = 20,745) and Wave II (1996, N = 14,738). Participants were interviewed in their own home by interviewers for the National Opinion Research Center. The overall response rate was 79% for Wave I, and 89% for Wave II. Among the set chosen for in-home interviews, some schools were chosen for full network sampling. In these schools all participants were invited to complete the in-home interview and completed a survey module that included social network measures, yielding a sample of 5,913 individuals who completed both Wave I and Wave II follow-up surveys that included social network measures. Two questions were used to measure screen-based media consumption behavior: (1) "How many hours a week do you watch television?", and (2) "How many hours a week do you play video or computer games?" (participants were able to answer any integer number of hours). In Wave I, participants watched an average of 16.6 h of television per week and played an average of 2.7 h of video or computer games per week. In Wave II, participants watched an average of 15 h of television per week and played an average of 2.5 h of video or computer games per week. Rather than combine the two measures into one measure, they are analyzed separately.

To identify social networks, some schools were selected for full network sampling. In such schools, each student was asked to identify his or her friends within that school. Participants in such schools nominated up to 5 female and 5 male friends from the roster of students from their school. Each nomination was treated as a directed link from the participant to the named friend. Participants could only nominate friends who were also in the study, such as fellow classmates from their school. If participants nominated fewer than the number of friends indicated all friendships that were nominated are included in the analysis (e.g., if a participant nominated 2 male and 4 female friends, that participant would be included in the analyses with 6 nominated friendships rather than the limit of 10 nominated friendships).

All statistical analyses were conducted in R. Code to replicate the results is available by contacting the author. Missing data were imputed using the Amelia II package in R (Honaker, King, & Blackwell, 2011). For all regression analyses, 10 data sets were created in which missing data are imputed in each. Regressions are performed across all 10 of the imputed data sets and then recombined using the rules set forth in King, Honaker, Joseph, and Scheve (2001).

2.2. Statistical analyses

The two screen-based media consumption measures are significantly correlated in both Wave I and Wave II for the overall sample. The correlation between hours of watching television in Wave I and Wave II is 0.39 ($p < 0.01$) and the correlation between hours of playing video games in Wave I and Wave II is 0.33 ($p < 0.01$). In Wave I, the correlation between hours of watching television and hours of playing video or computer games is 0.29 ($p < 0.01$) and

Table 1
Descriptive statistics of main variables in Wave I and Wave II.

	Wave I				Wave II			
	M	SD	Min	Max	M	SD	Min	Max
Participant hours of TV watched	15.86	14.9	0	162	14.72	13.91	0	162
Participant hours of video games played	2.73	6.04	0	95	2.47	5.76	0	90
Participant hours of videos watched	4.37	6.68	0	96	4.13	6.22	0	96
Participant hours listening to the radio	17.16	20.14	0	99	15.98	17.59	0	99
Number of times nominated as a friend	0.71	1.49	0	15	0.72	1.5	0	15
Total number of social contacts	2.19	2.13	1	18	2.19	2.13	1	18
Participant controls TV time					0.82	0.38	0	1
Participant female	51%	–	0	1				
Participant age	15.81	1.59	11	21				
Household income (1,000s of dollars)	46.06	52.21	0	999				
Mother's education	5.45	2.4	0	9				
Hispanic	17%	–	0	1				
Black	23%	–	0	1				
Asian	7%	–	0	1				

in Wave II the correlation is 0.27 ($p < 0.01$). Clearly there is substantial stability in media consumption within an individual over time, as well as correlation between different forms of media consumption within an individual. Note, however, that the correlations are not so high that they are clearly a single construct — those who consume television at the highest rates are not necessarily the same participants as those who consume video games at the highest rates.

To test for correlated behavior between friends in the network within a Wave I used a permutation test. This is accomplished by generating 1,000 networks in which the network structure is preserved and the overall prevalence of the screen-based media consumption behavior remains stable, but the assignment of behavior is randomized. By comparing the observed correlation between the participant's behavior and the friend's behavior to this random baseline, the significance of the relationship may be established. Using the networks with random assignment of behavior to participants, a null distribution of values for the relationship between friends' media consumption is constructed. Using this distribution, the estimated standard errors for 95% confidence intervals may be calculated (Christakis & Fowler, 2013). The 25th (<2.5%) and 975th (>2.5%) values from the ordered set of values from the randomly generated networks may be interpreted as the 95% confidence interval of the null distribution of the correlation in behavior between friends. This type of significance testing accounts for the interdependence between connected individuals in a network and has been widely used to test for clustering (Christakis & Fowler, 2013).

The permutation test described above provides a baseline measurement of clustering, but does not help to distinguish the likely causal process that produced the clustering. Distinguishing between the three processes that may be responsible for such clustering discussed above (influence, homophilic selection, and confounding) requires repeated measures of the variable of interest and longitudinal measures of friendships (Carrington, Scott, & Wasserman, 2005; Fowler & Christakis, 2008). Regression analyses of participants' screen-based media consumption in Wave II as a function of the participants' age, gender, race, ethnicity, household income, mother's education,

screen-based media consumption in Wave I, and screen-based media consumption of their nominated friends in Wave II and Wave I enable analysis net of homophilic selection and confounding. The inclusion of variables for friends' screen-based media consumption in Wave I helps to control for homophilic selection (Carrington et al., 2005). Inclusion of the friend's screen-based media consumption in the previous wave has been shown to control for the likelihood that a participant selects a friend based on similarity in the characteristic of interest (Fowler & Christakis, 2008). By including the screen-based media consumption of nominated friends in Wave I the regression model identifies associations between the participant's screen-based media consumption and that of the participant's social contact net of the association exhibited in Wave I. Inclusion of measures of both the participant and the participant's friend's media consumption behaviors for other forms of media (watching videos and listening to the radio) in Wave II control for similarity in media consumption behavior more generally between the participant and the friend in the wave. Research has shown that parental rules about television watching significantly impact how much time adolescents spend watching television and playing video games (Ramirez et al., 2011). To control for this, a measure of whether or not the participant controls the amount of television they are allowed to watch in Wave II is included. This was measured with a question that read, "Do your parents let you make your own decisions about how much television you watch?" with response options of "yes" (coded 1) and "no" (0). Similarly, research has shown that feelings of loneliness may be associated with higher rates of screen-based media consumption (Derrick et al., 2009; Scherr, 2018; Viner et al., 2019). To control for this, measures of a participant's loneliness and feelings of depression from Wave II are included. To measure loneliness and depression, participants were asked how frequently they had felt various emotions. For loneliness, the statement read, "You felt lonely" and for depression the statement read, "You felt depressed." For both items response options were "never or rarely" (coded 0), "sometimes" (1), "a lot of the time" (2), "most of the time or all of the time" (3). In each model, the coefficient at Wave II (e.g., "friend hours of video game playing, Wave II") reflected the effect of social influ-

ence of the friend's behavior controlling for confounding variables in the model.

Linear regression models[1] in which the hours of television consumption and hours of video game playing in the participant as the dependent variable are estimated using generalized estimating equation (GEE) models[2]. Each observation is the participant-friend dyad and a given participant may be present in multiple observations. By conducting the analysis in this way, the results indicate how behavioral change in one individual affects another — that is any effects observed are per-friend effects. Therefore, it is important to remember that because the key independent variables are measured as the number of hours engaged in the given activity that the resulting coefficients relate to the change in behavior in the individual per-friend-hour. The GEE modeling process accounts for multiple observations of the same individual across individual-friend dyads (Bollen & Stine, 1990). Because the models estimated below are similar in scope and use similar data, I present both the raw results and note whether the statistically significant result passes a Bonferroni correction. For each of the sets of models (television viewing and video game playing) I present four models, and thus use a Bonferroni-corrected p-value (α of $0.05/4 = 0.0125$).

In addition to the control variables described above, I include a number of other control variables. These include the number of hours of radio listened to, as measured by the response to the question, "How many hours a week do you listen to the radio?" and recorded as the integer number of hours. Similarly, the number of hours watching videos was measured by the response to the question, "How many hours a week do you watch videos?" and responses were recorded in the as the integer number of hours. Demographic controls are also included. These include age as calculated by the difference in years between the date of the interview and the participant's birthdate and the participant's gender as confirmed by the interviewer. Participant race was measured using the question, "What is your race? You may give more than one answer." Response options included "white", "black or African American", "American Indian or Native American", "Asian or Pacific Islander", and "other". Participants are coded as identifying to all racial groups to which they indicated identifying with that race. Household income was measured by asking a parent of the participant, "About how much total income, before taxes did your family receive in 1994? Include your own income, the income of everyone else in your household, and income from welfare benefits, dividends, and all other sources" with response options as the integer number of thousands of dollars. Similarly, the parent's education was measured by asking a parent, "How far did you go in school?" with response options of "never went to school" (coded as 0), "8th grade or less" (1), "more than 8th grade, but did not graduate from high school" (2), "went to a business,

trade, or vocational school instead of high school" (3), "high school graduate" (4), "completed a GED" (5), "went to a business, trade or vocational school after high school" (6), "went to college, but did not graduate" (7), "graduated from a college or university" (8), "professional training beyond a 4-year college or university" (9).

3. Results

3.1. Influence of friends on hours spent watching television

Hypothesis 1 predicted that both hours of television consumption (H1a) and hours of video game playing (H1b) would show evidence of network clustering in which individuals would show correlated behavior with friends, friends of friends, and so on, within a wave. To test this hypothesis the permutation method described above was used. Fig. 1 shows the results of the network permutation test for television viewing and video game playing. The results show that television viewing shows evidence of clustering for six degrees of separation (friend's, friend's, friend's, friend's, friend) in both Wave I and Wave II. For instance, in Wave II, the correlation in hours of television watching between friends is 0.086 (95% CI: 0.076–0.114). For video game playing the correlation between a participant's and a friend's hours of video game playing is significant for up to 3 degrees of separation in Wave I and up to two degrees of separation in Wave II. These results support both H1a and H1b. H1 supports that the network exhibits evidence of similar behavior between connected individuals, but the permutation test does not control for social selection or confounding.

To test H2 the regression approach described above was used on the full set of friendships. Table 2 shows the results from the regression analyses on the full set of friendships. The results show that the number of hours that a friend watches television is positively associated with the number of hours a participant watches television (B = 0.05, $p = 0.002$), which supports H2a. For video games, the results show that the number of hours that a friend plays video games is positively associated with the number of hours a participant plays video games (B = 0.19, $p < 0.001$), which supports H2b.

To test H3 the regression approach described above was used on the set of friendships in which the friend had nominated the participant as a friend, but the participant did not nominated the friend as a friend (alter-perceived friendships). Table 3 contains the results from the regression analyses on this set of friendships. The results show that the number of hours an alter-perceived friend watches television is positively associated with the number of hours a participant watches television (B = 0.06, $p < 0.001$), which does not support H3a. In fact, the point estimate for the alter-perceived friendships is higher than that of the full set of friendships, although it is worth noting that the confidence intervals overlap considerably. For video game playing, the results show that the number of hours that an alter-perceived friend plays video games is significantly related to the number of hours the participant plays video games (B = 0.07, $p < 0.001$), which supports H3b.

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[1] I note that non-linear specifications were explored, but do not improve model fit. As such, I present linear specifications for their relative ease of interpretation.

[2] Each participant-friend pair represents a separate observation and account for multiple observations per participant by clustering standard errors on the participant.
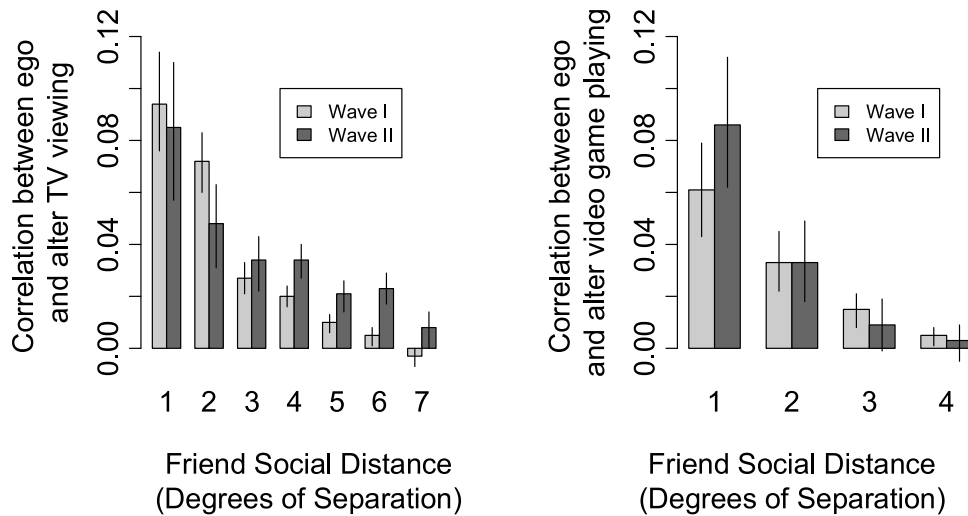
Fig. 1. Evidence of clustering in television viewing and video game playing.
Note: Fig. 1 shows the percent correlation between a participant's hours of watching television with a friend's hours of watching television (left panel) and a participant's hours of playing video games with a friend's hours of playing video games. Vertical bars denote 95% confidence intervals. Friend social distance (degree of separation) measures the shortest path through the network that the participant could reach another member of the network (distance 1 = friend, distance 2 = friend of friend, distance 3 = friend of a friend's friend, etc.).

Table 2
Media consumption among all friendships.

	Participant hours of TV consumption, Wave II			Participant hours of video game playing, Wave II		
	B	SE	p	B	SE	p
Friend hours of TV consumption, Wave II	0.05	0.02	<0.01	0.01	0.01	0.25
Friend hours of TV consumption, Wave I	0.03	0.01	0.03			
Participant hours of TV consumption, Wave I	0.32	0.02	<0.01			
Participant hours of TV consumption, Wave II				0.04	0.01	<0.01
Friend hours of video game playing, Wave II	0.01	0.03	0.86	0.19	0.04	<0.01
Friend hours of video game playing, Wave I				−0.01	0.01	0.57
Participant hours of video game playing, Wave I				0.29	0.04	<0.01
Participant hours of video game playing, Wave II	0.22	0.06	<0.01			
Friend hours of watching videos, Wave II	−0.08	0.04	0.03	−0.04	0.01	0.01
Participant hours of watching videos, Wave II	0.68	0.09	<0.01	0.09	0.03	<0.01
Friend hours of listening to radio, Wave II	−0.04	0.01	<0.01	<0.01	<0.01	0.54
Participant hours of listening to radio, Wave II	0.12	0.02	<0.01	0.02	0.01	0.07
Participant controls TV time	0.03	0.42	0.93	0.15	0.17	0.37
Participant female	−1.16	0.39	<0.01	−1.08	0.14	<0.01
Participant age	−0.40	0.13	<0.01	−0.04	0.05	0.45
Household income	−0.01	<0.01	<0.01	>−0.01	<0.01	0.38
Mother's education	−0.12	0.09	0.21	−0.03	0.03	0.38
Hispanic	0.93	0.59	0.12	−0.14	0.20	0.47
Black	2.83	0.70	<0.01	0.05	0.26	0.83
Asian	1.03	0.68	0.13	0.40	0.30	0.17
Participant loneliness	0.23	0.33	0.49	−0.02	0.13	0.89
Participant depression	−0.04	0.33	0.89	−0.03	0.12	0.84
Constant	11.60	2.75	<0.01	1.36	1.25	0.28
Deviance	687,121.3			116,034.8		
Null deviance	1,044,085.0			152,664.1		
N	5,913			5,913		

Note: The dependent variables are time spent consuming media (television and video games) and are regressed on friend time spent consuming media in Wave I and Wave II controlling for time spent consuming media by the participant in Wave 1, participant sex, age, race, ethnicity, household income, and mother's education, the participant's ability to control the amount of television watched in Wave II, participant's reported feelings of loneliness and depression, and media consumption behavior (video game playing, watching videos and listening to the radio) by both the participant and the participant's nominated friends in Wave II. The sample in these models is the full set of friendships.

To test H4 the regression approach described above was used on the set of friendships in which the friend and the participant nominated one another as friends (mutual friendships). Table 4 shows the results from the regression analyses on this set of friendships. The results show that the number of hours a mutual friend watches tele-

Table 3
Media consumption among friend-perceived friendships.

	Participant hours of TV consumption, Wave II			Participant hours of video game playing, Wave II		
	B	SE	p	B	SE	p
Friend hours of TV consumption, Wave II	0.06	0.02	<0.01	>−0.01	0.01	0.92
Friend hours of TV consumption, Wave I	0.06	0.02	<0.01			
Participant hours of TV consumption, Wave I	0.26	0.02	<0.01			
Participant hours of TV consumption, Wave II				0.02	0.01	0.07
Friend hours of video game playing, Wave II	−0.05	0.04	0.19	0.07	0.02	0.01
Friend hours of video game playing, Wave I				0.05	0.02	0.02
Participant hours of video game playing, Wave I				0.32	0.03	<0.01
Participant hours of video game playing, Wave II	0.05	0.05	0.28			
Friend hours of watching videos, Wave II	0.08	0.06	0.17	0.03	0.02	0.06
Participant hours of watching videos, Wave II	0.61	0.06	<0.01	0.28	0.04	<0.01
Friend hours of listening to radio, Wave II	0.01	0.01	0.39	<0.01	0.01	0.74
Participant hours of listening to radio, Wave II	0.15	0.01	<0.01	0.03	0.01	<0.01
Participant controls TV time	−0.18	0.83	0.83	−0.17	0.25	0.50
Participant female	−0.60	0.60	0.32	−0.60	0.27	0.03
Participant age	−0.38	0.18	0.04	−0.05	0.06	0.40
Household income	>−0.01	<0.01	0.27	−0.01	<0.01	<0.01
Mother's education	0.18	0.11	0.12	0.01	0.05	0.85
Hispanic	0.76	0.54	0.15	−0.21	0.27	0.43
Black	1.38	0.80	0.09	0.22	0.32	0.49
Asian	0.09	0.66	0.99	−0.18	0.33	0.59
Participant loneliness	2.01	0.81	0.01	0.57	0.22	0.01
Participant depression	−1.25	0.71	0.08	−0.57	0.18	<0.01
Constant	7.02	20.23	0.73	0.89	2.50	0.72
Deviance	265,313.3			58,763.7		
Null deviance	400,410.0			81,722.5		
N	2,909			2,909		

Note: The dependent variables are time spent consuming media (television and video games) and are regressed on friend time spent consuming media in Wave I and Wave II controlling for time spent consuming media by the participant in Wave 1, participant sex, age, race, ethnicity, household income, and mother's education, the participant's ability to control the amount of television watched in Wave II, participant's reported feelings of loneliness and depression, and media consumption behavior (video game playing, watching videos and listening to the radio) by both the participant and the participant's nominated friends in Wave II. The sample in these models is the set of friendships in which the friend perceived a friendship, but the participant did not.

vision is not significantly related to the number of hours the participant watches television (B = 0.02, p = 0.46), which does not support H4a. For video game playing, the results show the number of hours a mutual friend has played video games is positively associated with the number of hours the participant played video games (B = 0.24, p < 0.001), which supports H4b. I note that all statistically significant results remain significant when using the Bonferroni-adjusted significance level.

4. Discussion

4.1. Research implications

This research shows that screen-based media consumption clusters in social networks. For both television viewing and video game playing, the results of the statistical analyses demonstrated that high rates of both activities showed evidence of correlated behavior between connected individuals. For television viewing, the association extended up to six degrees of separation, while for video game playing the association extended up to three degrees of separation. However, the two behaviors showed different levels of support for the idea that the observed associations in the network were due to social influence.

For television viewing, the regression analyses showed mixed support for the idea that the observed correlation

in behavior might be attributed to social influence. These analyses showed support for social influence playing a role in clustering among all friends (support for H2a). However, when other types of friendships were examined, the patterns of results did not suggest that social influence was the most likely cause of the associated behavior between friends (lack of support for H3a and H4a). For video game playing the results were consistent with what would be expected if social influence were to be at least partly responsible for video game playing decisions. For television consumption, the results are consistent with homophily, or the tendency for people with similar rates of television consumption patterns to become friends.

The observational nature of the data used in this study make it difficult to make claims about causality or about mechanisms. Although the panel data enable the modeling of change in behavior over time, and the inclusion of multiple variables from previous waves for both participants and their friends account for homophily to some degree, the patterns observed may still be due to participants with shared characteristics becoming friends. However, the pattern of results across friendships for video game playing does provide some evidence about the mechanisms through which behavior may spread between connected individuals. For video game playing, the strongest association between friends is for those who are in mutual friendships. For television viewing, the type of friendship

Table 4
Media consumption among mutual friendships.

	Participant hours of TV consumption, Wave II			Participant hours of video game playing, Wave II		
	B	SE	p	B	SE	p
Friend hours of TV consumption, Wave II	0.02	0.03	0.46	>0.01	0.01	0.99
Friend hours of TV consumption, Wave I	0.06	0.03	0.04			
Participant hours of TV consumption, Wave I	0.35	0.04	<0.01			
Participant hours of TV consumption, Wave II				0.05	0.02	<0.01
Friend hours of video game playing, Wave II	>0.01	0.07	0.97	0.40	0.10	<0.01
Friend hours of video game playing, Wave I				−0.04	0.03	0.10
Participant hours of video game playing, Wave I				0.24	0.07	<0.01
Participant hours of video game playing, Wave II	0.18	0.08	0.03			
Friend hours of watching videos, Wave II	−0.10	0.06	0.10	−0.03	0.03	0.40
Participant hours of watching videos, Wave II	0.58	0.09	<0.01	0.09	0.06	0.16
Friend hours of listening to radio, Wave II	−0.01	0.02	0.75	>−0.01	0.01	0.91
Participant hours of listening to radio, Wave II	0.14	0.03	<0.01	0.04	0.02	0.05
Participant controls TV time	1.14	0.85	0.18	−0.41	0.53	0.44
Participant female	−2.12	0.62	<0.01	−0.89	0.31	<0.01
Participant age	−0.36	0.23	0.11	0.02	0.13	0.87
Household income	−0.01	0.01	0.50	>−0.01	<0.01	0.52
Mother's education	−0.48	0.16	<0.01	−0.12	0.07	0.09
Hispanic	1.09	1.25	0.39	−0.23	0.59	0.70
Black	3.11	1.42	0.03	−0.30	0.69	0.66
Asian	2.53	1.09	0.02	0.02	0.54	0.98
Participant loneliness	0.21	0.54	0.70	0.52	0.33	0.11
Participant depression	0.39	0.53	0.46	−0.52	0.25	0.04
Constant	11.25	4.66	0.02	0.78	2.63	0.77
Deviance	112,603.0			30,799.0		
Null deviance	192,588.6			42,711.4		
N	1,279			1,279		

Note: The dependent variables are time spent consuming media (television and video games) and are regressed on friend time spent consuming media in Wave I and Wave II controlling for time spent consuming media by the participant in Wave 1, participant sex, age, race, ethnicity, household income, and mother's education, the participant's ability to control the amount of television watched in Wave II, participant's reported feelings of loneliness and depression, and media consumption behavior (video game playing, watching videos and listening to the radio) by both the participant and the participant's nominated friends in Wave II. The sample in these models is the set of friendships in which both the participant and the friend perceived a friendship.

does not seem to have much bearing on the extent to which friends show correlated behavior, as the degree of association is similar across all friendship types. This suggests that different social network processes may account for the degree of clustering for video game playing and television consumption.

Although the literature sometimes treats screen-time across screen-related activities as a similar construct, this research suggests that for understanding social influence as a cause for high rates of media consumption, the type of media may matter substantially. These findings are generally consistent with previous research that has shown that screen-based media consumption both facilitates and is a result of social interaction (e.g., Fletcher, 2006; Livingstone, 2002; Pasquier et al., 1998; Suess et al., 1998). However, it seems that social interaction is likely to cause a change in behavior for video game playing, but for television viewing less so. Some of the particular aspects that differentiate video games from television may explain why video games produce relatively strong social influence effects.

Video game play is, by its nature, a more active experience in general, and frequently a more active social experience, than television viewing (Krcmar & Strizhakova, 2009). Video game players report that social interaction and competition are motivators of game play (Lee, Lee, & Choi, 2012). Many aspects of video games are only possible or are most enjoyable when the game is played with others. Multi-player modes of games by definition need multiple individuals to play at once. This type of functionality in video games might encourage an individual to influence others to play games with them to further enjoy the game. Television programs may work similarly – some television programs may be more enjoyable to watch with others – but television never needs another person in order for aspects of it to function.

Video games may also provide more opportunities for social learning than television viewing does. While both activities would offer the opportunity to learn about the content that a friend consumes, video games provide opportunities for a wider array of social learning. Video games may also be competitive (Vorderer, Hartmann, & Klimmt, 2003), which increases enjoyment of the game. Such competition may also be social, which could create opportunities for social influence. Competition might encourage an individual to play for long periods of time. Research has shown that one aspect of competitive game play is a desire to play for long periods of time (Schuurman, De Moor, & De Marez, 2008). Although there may be competition among friends for aspects of watching television – for example, knowledge about characters in a favorite show – television consumption does not encourage competition in the same way.

This research opens new questions related to how media are consumed in a digital age. Theoretical work has suggested that parents' role in mediating screen-based media with various strategies may impact how adolescents

consume such media (Clark, 2011). Research on parental mediation of Internet use has shown that mediation could impact the type of use, but had little impact on its duration (Lee & Chae, 2007; Lee, 2012). This work suggests that researchers may wish to investigate how parental mediation strategies may impact behavior and outcomes for not only the parents' own adolescent children, but also the social network contacts of those adolescent children. It is possible that the effects of parental mediation affect not only their adolescent children's behavior, but also the behavior of adolescent children's friends or peers. Similarly, parental mediation may impact how adolescents make or maintain friendships. Thus, parental mediation of media use may have impacts on the social lives of their children or on the media consumption behavior of their children's friends.

Outside of the family environment, digital media consumption has previously been shown to be related to social relationships. Social connection is among the primary reasons people report using various forms of social media, such as Instagram (Sheldon & Bryant, 2016), Facebook (Smock, Ellison, Lampe, & Wohn, 2011), Twitter (Chen, 2011), and YouTube (Khan, 2017). Unlike traditional forms of media, such as television and video game playing as examined in this article, social media provide opportunities to consume media and to interact with others directly, as well as to leave a record of both the media consumption and social interaction for others to view. In doing so, the processes through which social influence or social relationship building or maintaining take place may be different than they would be with traditional media. Further, these digital traces may impact the downstream decisions about how, when, and which media to consume.

Further, social media and traditional media may interact in new ways that have to opportunity to interact with social relationships. For example, research has investigated how co-viewing through Twitter may impact the social experience of viewing broadcast media (Pittman & Tefertiller, 2015). Social media may enable viewers of particular media to find others who are similarly interested in such media who are not in the same geographic location (Wohn & Na, 2011). Further, social media may enable further communication regarding the media that are consumed, and this may deepen social relationships, create stronger social bonds, and facilitate social support, perhaps related to the media that have been consumed. The impact of such relationships, which may be quite different from the in-person friendships studied herein, is an area for future research.

4.2. Limitations and future research

It should be noted that the extent to which the current estimation strategy accounts for homophily and confounding is a matter of debate in the social network literature (for a criticism of the current estimation strategy see Cohen-Cole and Fletcher (2008) and O'Malley (2013); but also see Christakis and Fowler (2013) and VanderWeele, Ogburn, and Tchetgen (2012) for a rebuttal). Of particular concern is the possibility that there is an omitted variable that is related to both screen-based media consumption in the

participant and related to the formation of social network relationships. The Add Health data do not include all such measures, so these measures could not be included in the model. The use of lagged dependent variables to account for homophily in observational social network data has been theorized as a mechanism to control for the tendency for similar individuals to form relationships (Carrington et al., 2005). Following up on this work, two simulation studies have shown that, using the same regression technique of using lagged dependent variables for both the ego and the alter, produces unbiased estimates of the causal relationship (Fowler & Christakis, 2008; Fowler, Heaney, Nickerson, Padgett, & Sinclair, 2011). Future research designs should endeavor to further disentangle homophily from social contagion.

As mentioned above, many psychological processes could be responsible for the social patterns observed in the data. Although social contagion and imitation, broadly construed, are likely to be responsible, exactly how adolescents become more similar to their peers is unknown. Future research should investigate this through research designs that enable the researchers to distinguish between various processes through which correlated behavior emerges.

The study is also limited because the data used are somewhat dated. Wave I and Wave II of the Add Health data were collected between 1994 and 1996. Patterns of social network connections between adolescents may have changed in the intervening 20 years, but that is unlikely. The ways in which adolescents consume media surely have changed, but the impacts of those changes on the processes observed here are uncertain. When these data were collected, television was the predominant source of screen-based media among adolescents. While that is still the case, now children and adolescents spend considerably more time consuming media through other platforms, such as computers, tablets and cell phones. A recent report shows that 12–17 year-olds spend approximately 17 h consuming live or time-shifted television per week and an average of about 4.5 h per week using game consoles (The Nielsen Company, 2016). These numbers are quite similar to the averages in the Add Health data. However, the degree to which the patterns of social sharing between friends has changed is not yet known.

Clearly, patterns of media use among adolescents are changing. Future research should investigate whether patterns of clustering and social influence exist for other forms of media usage, such as the usage of smartphones, usage of social networking websites, and the playing of mobile video games. It is noteworthy that even with the changing media landscape, the vast majority of hours spent consuming media comes through watching television. What this research does not address, and what would potentially have an important impact on the results presented here, is that the ways in which media are shared between friends has changed. Due to the advent of DVRs, sharing through social media, and websites that curate video content, understanding how social relationships impact the decisions of how to spend time consuming media may have changed in the intervening years.

5. Conclusion

The results from this study show that social networks play an important role in the rate of screen-based media consumption among adolescents. Policymakers may be interested in such a result as it provides insights into how campaigns surrounding screen time may be improved. Efforts to encourage healthy rates of screen-based media consumption among adolescents may have social effects. That is, individuals enrolled in programs intended to provide alternatives to screen-based media – such as after-school programs – may provide benefits to the friends of those enrolled as well as the children in the program. These results also show that the extent to which screen-based media consumption is socially informed varies considerably by media type. Particularly as the range of sources of screen-based media increases, future work should investigate how and why different forms of media may or may not show contagious adoption and usage.

Conflict of interest

The author declares no conflicts of interest.

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