Media and Communication
Open Access Journal | ISSN: 2183-2439
Volume 4, Issue 3 (2016)

Adolescents in the Digital Age: Effects on Health and Development

Editor
Daniel Romer

COGITATIO

Media and Communication, 2016, Volume 4, Issue 3
Issue: Adolescents in the Digital Age: Effects on Health and Development

Published by Cogitatio Press
Rua Fialho de Almeida 14, 2º Esq.,
1070-129 Lisbon
Portugal

Academic Editor
Daniel Romer, University of Pennsylvania, USA

Managing Editor
António Vieira, Cogitatio Press, Portugal

Available online at: www.cogitatiopress.com/mediaandcommunication

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2016, Volume 4, Issue 3, Pages 1-3
Doi: 10.17645/mac.v4i3.658

Editorial

Introduction to the Issue "Adolescents in the Digital Age: Effects on Health and Development"

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Submitted: 19 April 2016 | Published: 16 June 2016

Abstract
This thematic issue brings together papers by researchers who are studying the ways that today's adolescents interact with their peers, families, and the larger media environment in the digital age. The contributors highlight both the challenges and the opportunities that this new age presents for the healthy development of young people.

Keywords
adolescents; digital communication; healthy development; social networking

Issue
This editorial is part of the issue "Adolescents in the Digital Age: Effects on Health and Development", edited by Dan Romer (University of Pennsylvania, USA).

This thematic issue on the Health and Wellbeing of Adolescents in the Digital Age covers considerable ground regarding the ways that young people use and are influenced by the many forms of digital communication. The dominant theme in news media attention to this topic focuses on the dangers that confront adolescents as they navigate this new terrain. The irony however is that adolescents are using digital media in ways that often exceed the capabilities of adults. They are the first adopters of many of the innovations that appear in this landscape, and they likely feel more comfortable using digital media than adults. Indeed, the new media offer novel ways to communicate that were not even conceivable to parents during their transition to adulthood. At the same time, these new means of communicating have also introduced problems that have often confronted adolescents of the past either in face-to-face interaction or when using more traditional media.

The contributors to this issue address both the opportunities and the problems of the digital age. Katherine Mills (2016) reviews what research has told us about the effects of the new media on adolescent cognitive and social development. With so much information at one's fingertips, there is the fear that adolescents will fail to learn about the world as prior generations have done. However, based on the literature to date, there are no clear indications of adverse effects. Adolescents may now need to learn more about where to find information rather than memorizing the information itself. In addition, evidence appears to be accumulating that communicating through screen media is no less detrimental to social bonding than face-to-face interaction. Indeed, adolescents who frequent social media appear to be less lonely and better adjusted than those who use it less. However, adolescents who use social media to overcome deficits in social competence may benefit less from its use.

The article by Ellen Wartella, Vicky Rideout, Heather Montague, Leanne Beaudoin-Ryan and Alexis Lauricella (2016) presents the results of a recent national survey they conducted to uncover the ways that adolescents use the new media to gather information about their health. With access to this vast resource, it is no surprise that many search for such information. What is perhaps more surprising is that they use this resource less for sensitive topics, such as sexual health, than other topics. They instead seem to prefer adults they know, such as parents and doctors, for such advice. The authors also present findings indicating continuing evidence of a digital divide in the US afflicting low-income youth.

One concern that has arisen in the digital age is the overuse of the internet, especially by young people. Amy Bleakley, Morgan Elliathorpe and Dan Romer (2016) examine the results of a recent national survey in the US regarding the phenomenon of internet addiction. Youth who spend inordinate amounts of time on the internet often report symptoms that appear to reflect an addiction to this behavior. The most recent addition of the Diagnostic and Statistical Manual of the American Psychiatric Association identifies this condition as a form of behavioral addiction that requires further study. Bleakley et al. (2016) find that the youth who report these symptoms tend to have less parental supervision and poorer relationships with parents. They also appear to be more impulsive than other youth, which suggests that the behavior is reflective of an impulse control problem that may well precede the appearance of internet addictive behavior.

Given the ubiquitous presence of adolescents online, the new media may well offer new opportunities for marketers to promote unhealthy products to adolescents. Sally Dunlop, Becky Freeman and Sandra C. Jones (2016) review what is known about the marketing of such products, including sugar-sweetened beverages, tobacco, and alcohol, to adolescents, especially on video sites, such as YouTube. They find that such marketing is widespread and largely unregulated. Opportunities to promote healthier lifestyles online have not yet been realized to the degree needed to counteract these influences.

Megan Moreno, Jon D'Angelo and Jennifer Whitehill (2016) examine the potential for adverse peer influence to proliferate on the internet, primarily through social media. They review what is known about the sharing of profiles and other messages in social media as influences on such unhealthy behaviors as binge drinking. In addition, they show how marketing of products such as alcohol can intersect with the transmission of unhealthy messages through peer networks. Finally, they suggest some ways that future interventions might be developed and tested to counteract these influences.

Another aspect of the digital lives of young people is the extension of offline peer networks into the digital space. Robin Stevens, Jamie Dunaev, Ellen Malven, Amy Bleakley and Shawnika Hull (2016) examine the characteristics of such "digital neighborhoods" with special attention to sexual behavior in Latino and African American youth. The authors highlight what is known about the transmission of sexual norms in online communities and how this opens opportunities for novel interventions to encourage healthy development of sexual behavior.

Lynne Edwards, April Kontostathis and Christina Fisher (2016) examine the highly publicized issue of cyberbullying. They highlight the important characteristics and consequences of this behavior and note the relative lack of attention to youth of color as either perpetrators or victims. Although youth of color appear to be as digitally connected via smartphones as other youth, they do display unique patterns of communication using these devices and appear to experience less cyberbullying victimization. However, what victimization they do experience appears to be associated with comparable levels of adverse mental health outcomes.

One of the consequences of nearly continuous connectivity on digital networks is the potential for distraction while engaged in such attention-dependent activities as driving. M. Kit Delgado, Kathryn J. Wanner and Catherine McDonald (2016) review what is known about this phenomenon, especially in regard to texting while driving, and the hazard it poses to young drivers who are inexperienced and potentially challenged by incomplete development of cognitive control capacities. They suggest some ways that use of smart phones could be integrated into driving that might minimize the risks that they pose.

In an afterword, Dan Romer is joined by Michael Rich (2016), the "Mediatrician" at the Harvard Medical School, in discussing the cross-cutting implications of the papers in this issue. In terms of large-scale national health and well-being indicators, the digital age has not yet had an observable aggregate impact. However, for some subpopulations, there may well be challenges and adverse outcomes. Needless to say, our understanding of the digital age is only in its early stages and much remains to be learned about how nearly continuous access to the vast stores of information on the internet and digital communication without limits affects the development of children and adolescents. It is an exciting, if not concerning, time in history.

Conflict of Interests

The author declares no conflict of interests.

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Media and Communication (ISSN: 2183-2439)
2016, Volume 4, Issue 3, Pages 4-12
Doi: 10.17645/mac.v4i3.516

Review

Possible Effects of Internet Use on Cognitive Development in Adolescence

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Submitted: 24 November 2015 | Accepted: 7 March 2016 | Published: 16 June 2016

Abstract
The rise of digital media use and the ability to be in almost constant connection to the Internet has raised a number of concerns about how Internet use could impact cognitive abilities. In particular, parents and policy makers are concerned with how being 'constantly online' might disrupt social and cognitive development. This review integrates the latest empirical evidence on Internet use with relevant experimental studies to discuss how online behaviors, and the structure of the online environment, might affect the cognitive development of adolescents. Popular concerns are discussed in light of the reviewed evidence, and remaining gaps in knowledge are highlighted.

Keywords
digital media; multitasking; online; social cognition; social media; social networking

Issue
This review is part of the issue "Adolescents in the Digital Age: Effects on Health and Development", edited by Dan Romer (University of Pennsylvania, USA).

1. Introduction

How does Internet use affect the cognitive development of adolescents? Parents and policy makers have increasingly voiced their concerns with the effects of Internet use on the developing generation of adolescents (George & Odgers, 2015). As noted in recent reviews (George & Odgers, 2015; Mills, 2014), there is still a lack of experimental studies examining the impact of Internet use on cognitive development. The current review focuses on the few studies that have examined the possible effects of Internet use on cognitive processes in adolescents and emerging adults, including social cognitive processes.

The question of how Internet use affects cognition is not straightforward enough to be answered by one or even a series of experiments. Internet use can be considered an environmental exposure variable, similar to musical training or malnutrition. However, unlike musical training or malnutrition, Internet use is an environmental factor that almost the entirety of industrialized nations has been exposed to in recent years. This makes it almost impossible to conduct an experiment comparing groups with and without exposure to the Internet. Indeed, one of the main concerns about Internet use is not just how using the Internet can impact cognitive processes such as memory or social understanding, but how having *constant access* to the Internet might impact these cognitive processes.

To properly address the question of how Internet use could affect the cognitive development of adolescents, empirical studies can either utilize measures of actual Internet use or incorporate the distinct features of Internet use into cleverly designed laboratory experiments. These features can be defined as online behaviors, which include (but are not limited to) information gathering and communication. These features can also be conceptualized as structures present in the online environment, which include access to vast stores of information, communication through text, and virtual peer evaluation. This review will integrate empirical evidence from experimental studies including online behaviors or online structures when relevant studies incorporating measures of actual Internet use are lacking.

Investigating the effects of Internet use on cognition in adolescents is warranted given the continued

development of cognitive processes into the twenties (Luna, Marek, Larsen, Tervo-Clemmens, & Chahal, 2015). These cognitive processes include, but are not limited to, working memory capacity, attentional control, and social cognition. Specific concerns about how the Internet might impact adolescent cognitive development include how having near-constant access to information might disrupt memory abilities or the utilization of effortful thinking (Näsi & Koivusilta, 2012), or how the ability to multitask between several online/offline activities could shorten attention spans. While these concerns about altered cognitive abilities are often couched within the idea that 'Internet use could be rewiring developing brains', the current review focuses specifically on cognitive processes rather than neural correlates or neural development.

2. How the Internet Is Being Used Today

To understand how Internet use might affect adolescent cognitive development, it is first necessary to describe just how adolescents are using the Internet. In late 2014 and early 2015, the Pew Research Center surveyed the Internet use of 1,060 American adolescents aged 13 to 17 years (Lenhart, 2015). Of the sample, 92% reported using the Internet daily, with 24% of the sample going online 'almost constantly.' In this survey, teens with mobile devices were more likely to access the Internet frequently than teens without mobile devices, with 94% of teens that access the Internet from mobile devices reporting going online at least daily versus 68% of teens who do not access the Internet from mobile devices (Lenhart, 2015). This most recent national survey of Internet use suggests that teenagers are using the Internet frequently, but are not limited to accessing the Internet from a stationary device.

Adolescents report engaging in a variety of online activities, but many aspects of Internet use, from social networking sites to multiplayer video games, involve communicating with peers. In an interview study of 128 American 13 to 14 year olds, 85% reported using information technologies for communication purposes (Fitton, Ahmedani, Harold, & Shifflet, 2013); a study of 10,930 adolescents spanning 6 European countries found that approximately 70% of adolescents aged 14 to 18 years reported using social networking sites daily (Tsitsika et al., 2014). The primary reason why adolescents use social networking sites is to connect with individuals known offline (Reich, Subrahmanyam, & Espinoza, 2012).

An important but rarely addressed consideration is the multitasking nature of most Internet use. The 2015 *Common Sense Census* report acknowledges that digital media use (which includes Internet use) can occur simultaneously with other activities such as physical activity, household chores, or commuting (Common Sense Media, 2015). Thus, using the Internet does not necessarily displace engagement in other activities. To further complicate matters, socializing online can occur simultaneously with socializing offline, as social media use is also an activity that can be shared among those friends present in the same offline setting (similar to video game play).

Finally, the 2014–2015 Pew Research Center Teen Relationships Survey suggests that Internet use might actually complement, rather than displace time spent communicating face-to-face, as more teens reported spending time with their closest friend at school (83%) or at someone's house (58%) than reported spending time with their closest friend online (55%) (Lenhart, Smith, Anderson, Duggan, & Perrin, 2015). And while many adolescents who play video games do so with other online 'gamers' (75%), more tend to play video games with their friends in person (89%) (Lenhart et al., 2015).

3. This Is Not a Review of Disordered Internet Use

Many studies investigating Internet use and cognitive processes in adolescents have focused specifically on a subgroup of adolescents with disordered Internet use (also referred to as Problematic or Pathological Internet Use). These studies often make headlines, which can skew the public's perception into thinking that Internet use is harming adolescents. However, as by design these studies investigate a sample of the population selected because they are experiencing difficulties. Indeed, while large population surveys have found high rates of Internet use among American teenagers, the prevalence of disordered Internet use remains low. One recent large population survey spanning 11 European countries looked at the prevalence of Pathological Internet Use (PIU) in a sample of 11,956 adolescents and found that only 4.4% of adolescents met criteria for PIU (Durkee et al., 2012). This suggests that many of the studies investigating PIU do not apply to the majority of adolescents, a finding further corroborated in a longitudinal study of 1,444 adolescents that found that PIU wavered between 4.4% and 3.1% across three time points, with only 3 participants continually showing persistent PIU (Strittmatter et al., 2015). Another longitudinal study found a significant decrease in PIU between ages 14 to 16 years (Barrense-Dias, Berchtold, Akre, & Surís, 2015). It appears that self-regulating capacities are crucial for predicting which adolescents will develop PIU. In a longitudinal study of 801 Spanish adolescents aged 13 to 18 years, the ability to regulate one's Internet use at baseline predicted the amount of negative consequences experienced from Internet use six months later (Gámez-Guadix, Calvete, Orue, & Las Hayas, 2015).

4. Methods

Relevant studies were first identified through a litera-

ture search using the PubMED database to identify all available peer-reviewed studies that contained the following three keywords: 'adolescence' and 'internet' and 'cognition'. Specifically, the search was the following string: ('cognition' [MeSH Terms] OR 'cognition' [All Fields]) AND ('internet' [MeSH Terms] OR 'internet' [All Fields]) AND ('adolescent' [MeSH Terms] OR 'adolescent' [All Fields] OR 'adolescence' [All Fields]). Each of the 249 articles that met these criteria at the time of this search were then examined and categorized into the following five categories: Relevant, Application, Clinical, Review, Cyberbullying, or Irrelevant (see tables at osf.io/pq25d). An article was classified as Relevant if it included cognitive measures in relation to online behaviors and/or online structures (as described in the Introduction) in a group of adolescents or emerging adults. No studies met these criteria. In light of this, a more dynamic search procedure was used, and further studies were identified by reviewing citations to, and citations within, relevant reviews and empirical articles related to Internet use and cognition.

5. Results

Several studies were identified that utilized experimental paradigms to explore how structures present in the online environment, such as access to information and communication through text, affected the cognitive processes of participants. There were a few studies of cognitive processes that included measures of real-life online behaviors, such as social networking site use. While some studies included adolescent samples, others investigated effects in college–aged samples, or 'emerging adults'. The studies are subdivided based on the cognitive process investigated. The demographic characteristics of these studies are summarized in Table 1.

5.1. Memory

One of the first studies to examine the possible effects of ubiquitous Internet availability on cognitive processes was conducted in 2011 (Sparrow, Liu, & Wegner, 2011). This study experimentally tested a common concern about how Internet use might affect memory—specifically how having access to information stored in an external source could render individuals less likely to store information in their own memory. Drawing from the theory of *transactive memory*, where the information known by a group is treated as a memory bank from which individual members can draw (Wegner, 1987), Sparrow et al. (2011) examined how the expectation of having access to information at a later time affected the memory of undergraduate students. They found that when students expected to have future access to information, they were less likely to remember specific information but more likely to remember where to find the specific information (Sparrow et al., 2011). This result would suggest that near-constant access to the Internet could influence the kind of information an individual chooses to remember. This kind of cognitive change could be considered an adaptation to the present environment, as trying to remember many pieces of specific pieces of information is less efficient than remembering how to access these pieces of information when access is easily obtainable.

Given the high levels of information trafficked through the Internet, there have been concerns that exposure to inaccurate information through social media could encourage false memory formation. This hypothesis was tested in a group of undergraduate students who were exposed to false information through a pseudo-Twitter feed compared to a non-social media (but still web-based) source of information (Fenn, Griffin, Uitvlugt, & Ravizza, 2014). When later probed about how confident they were about specific statements, the group exposed to false information through the pseudo-twitter platform expressed less confidence in the false information presented than the group exposed to the same information in the non-social media platform (Fenn et al., 2014). These results suggest that individuals familiar with social media platforms take into account the reliability of information presented through them.

Finally, it appears that having access to the Internet affects how confident an individual is about her or his own knowledge. One study of undergraduate students found that having access to the Internet decreased an individual's confidence in knowing the answer to a question (Ferguson, McLean, & Risko, 2015). However, another suite of experiments performed on a group of adults (assessed through Amazon's Mechanical Turk) found that searching for information on the Internet increased an individual's confidence in her or his own stored knowledge (Fisher, Goddu, & Keil, 2015). Taken together, these studies suggest that having near–constant access to the Internet could affect how we process and store information. However, as these studies were conducted on college–aged and adult populations, it is unclear if these effects would be present in a sample of adolescents.

5.2. Analytical Thinking

Another common concern about Internet use is that it can lead to shallower thinking. One hypothesis underlying this concern is that having instant access to seemingly limitless information takes away the need to engage in more cognitively effortful processes. However, devising an experiment that can gauge how environmental factors impact the depth of one's thinking is no easy challenge. One recent study was able to do so by investigating how both information and cognitive strategy propagated through different kinds of networks

Table 1. Information for the studies included in this review.

Authors	Year	Design	Sample source	Sample size	Age range	Developmental comparison	Genders
Sparrow, Liu, & Wegner	2011	Cross-sectional	USA	Ex1: 46; Ex2: 60; Ex3: 28; Ex4: 34;	Undergraduate students	No	Both
Fenn, Griffin, Uitvlugt, & Ravizza	2014	Cross-sectional	USA	179	Undergraduate students. Mean age: 19 years	No	Both
Ferguson, McLean, & Risko	2015	Cross-sectional	Canada	Ex1: 38; Ex2a: 33; Ex2b: 35;	Undergraduate students	No	Not provided
Fisher, Goddu, & Keil	2015	Cross-sectional	Internet	Ex1a: 197; Ex1b: 142; Ex1b: 195; Ex2a: 192; Ex2b: 187; Ex3: 280; Ex4a: 148; Ex4b: 145; Ex4c: 131	Adults. Mean age: ~31 years	No	Not provided
Rahwan, Krasnoshtan, Shariff, & Bonnefon	2014	Cross-sectional	USA	100	University students. 18-26 years	No	Not provided
Ophir, Nass, & Wagner	2009	Cross-sectional	USA	Ex1: 41; Ex2: 30; Ex3: 30	University students	No	Not provided
Alzahabi & Becker	2013	Cross-sectional	USA	Ex1: 92; Ex2: 58	Undergraduate students. Mean age: 19 years	No	Both
Mills, Dumontheil, Speekenbrink, & Blakemore	2015	Cross-sectional	UK	33	Adolescents. 11-17 years	Adults: n=28, 22-30 years	Females
Sherman, Michikyan, & Greenfeld	2013	Cross-sectional	USA	29 pairs	University students. 18-21 years	No	Females
Teppers, Luyckx, Klimstra, & Goossens	2014	Longitudinal	Belgium	256	Adolescents. 14-19 years	No	Both
Tsitsika, Tzavela, Janikian, Ólafsson, Iordache, Schoenmakers, Tzavara, & Richardson	2014	Cross-sectional	Europe	10 930	Adolescents. 14-17 years	Younger vs. older adolescents	Both
Yang & Brown	2013	Cross-sectional	USA	193	Undergraduate students. 17-26 years	No	Both
Somerville, Jones, Ruberry, Dyke, Glover, & Casey	2013	Cross-sectional	USA	30	Adolescents. 13-17 years	Children: n=20, 8-12 years. Young adults: n=19, 18-22 years	Both
Wolf, Bazargani, Kilford, Dumontheil, & Blakemore	2015	Cross-sectional	UK	44	Younger adolescents: 10-14 years. Older adolescents: 15-18 years.	Adults: n=20, 22-35 years	Females
Silk, Stroud, Siegle, Dahl, Lee, & Nelson	2012	Cross-sectional	USA	60	Pre-adolescents and adolescents. 9-17 years	No	Both

(Rahwan, Krasnoshtan, Shariff, & Bonnefon, 2014). In this study, when undergraduate students had access to the answers provided by others in highly–connected networks, they were more likely to correctly answer a question that required analytical reasoning, but were less likely to utilize analytic reasoning in later situations that required this cognitive strategy (Rahwan et al., 2014). These findings indicate that that individuals who are part of a highly connected network (like the Internet) are less likely to adopt the kind of cognitive strate-

gy needed to reach a solution when the solution is readily available.

5.3. Multitasking

In a recent survey, 50% of adolescents reported that they often or sometimes use social media while doing homework (Common Sense Media, 2015). Although many of these teens did not feel that this kind of multitasking affected their ability to do their homework (Common Sense Media, 2015), doing two tasks simultaneously has been shown to result in performance decrements. While an early study found that self-reported heavy media multitaskers were worse at switching between two tasks than their lighter media multitasking counterparts (Ophir, Nass, & Wagner, 2009), the opposite was found for a more recent study (Alzahabi & Becker, 2013). The more recent study by Alzahabi and Becker included a direct replication of the Ophir et al. (2009) study as well as an original study with a number of methodological differences, both of which yielded the same finding that heavy media multitaskers were better at switching between tasks than light media multitaskers. These two studies investigated these multitasking effects in samples of undergraduate students, and it could be that all individuals in the more recent sample had more experience with media multitasking than the individuals in the Ophir et al. (2009) sample, given the rapid changes in media use that have occurred in the intervening period.

While not a direct study of how online behaviors influence cognitive processes, a recent study investigated specifically how one aspect of the online environment—multitasking during social interactions—could impact performance in both adolescents and adults (Mills, Dumontheil, Speekenbrink, & Blakemore, 2015). This study found that adolescents are more sensitive to additional cognitive load requirements than are adults in both social and non-social multitasking situations (Mills et al., 2015). However, both adolescents *and* adults showed performance decrements when multitasking during social interactions that required perspective taking (Mills et al., 2015). These results suggest that the natural pace of social interactions (which can evolve on a millisecond basis) could be disrupted when adolescents or adults are simultaneously keeping track of extraneous information—as is often done when using digital devices in social situations.

5.4. Processing Social Cues

It is difficult to determine what might be lost when individuals interact primarily through digital means, and experimental studies that test both offline and online forms of communication are rare. One study examined how different forms of communication (face-to-face, video chat, audio chat, and instant messaging) impact feelings of bonding and affiliation in a group of college students (Sherman, Michikyan, & Greenfeld, 2013). By coding the amount of interpersonal cues shared between two friends in these four types of interaction, these researchers were able to parse apart how digital communication could impact relationships. They found that interpersonal cues were lower in communications through digital media and that this decline was associated with decreased feelings of bonding and nonverbal affiliation cues (Sherman et al., 2013). However, the study also found that it was still possible to elicit feelings of bonding through the use of digital interpersonal cues (e.g., emoticons or typed laughter) in text-based communication, and that video chat elicited similar levels of bonding as face-to-face interaction (Sherman et al., 2013).

5.5. Social Competence

Adolescence is a time in which we hone our social navigation skills (social competence), which arguably involves a number of social cognitive processes as well as cognitive control. One of the most common online activities for adolescents is communicating with others, primarily individuals known offline (Reich et al., 2012). Use of social networking sites is associated with greater feelings of peer affiliation (Spies Shapiro & Margolin, 2014), and adolescents who use social networking sites report less peer-related loneliness than non-users (Teppers, Luyckx, Klimstra, & Goossens, 2014), suggesting that adolescents who use social networking sites are developing the necessary social skills to have healthy peer relationships. Indeed, older adolescents who used social networking sites more than 2 hours a day reported higher social competence than older adolescents who used these sites less (Tsitsika et al., 2014).

However, when an individual's social cognitive skills are lacking, using social network sites to compensate might not facilitate the development of healthy peer relations. Two recent studies suggest that the motivations for using social networking sites influence peer relationships, and the same motivations can lead to different outcomes for adolescents and young adults. In a longitudinal study of adolescents, use of social networking sites to compensate for weak social cognitive skills was associated with *increased* peer-related loneliness, but using social networking sites to form new relationships was associated with *decreased* peer-related loneliness (Teppers et al., 2014). In contrast, a study of American undergraduate students suggests that use of social networking sites has the potential to facilitate the transition from secondary school to college. Students who reported greater attempts to form new relationships through social networking sites were *less* socially adjusted and reported *more* loneliness than their peers who used social networking sites to maintain already existing relationships (Yang & Brown,

2013). However, most students in this study reported using social networking sites to maintain relationships with pre-collegiate friends rather than to establish new relationships (Yang & Brown, 2013). But no matter the motivation, the more students engaged in online interactions through social networking sites the better their social adjustment and less their sense of loneliness (Yang & Brown, 2013).

5.6. Social Evaluation

One concern about being online 'almost constantly' is how it could make an individual feel as though online peers are constantly evaluating her or him. This could be particularly problematic for adolescents, who are already highly sensitive to social evaluation and exclusion (Somerville, 2013). Therefore, what we know about how adolescents respond to social evaluation is likely relevant to understanding how being nearly always connected to one's peers could affect cognition. There have now been a few developmental cognitive studies that have explored how this feature of the online environment could affect cognitive processes in adolescents.

When a group of adolescents believed they were being watched by a peer in a laboratory setting, they reported greater embarrassment than children, and showed greater physiological levels of arousal than children or adults (Somerville et al., 2013). When a group of older adolescents (aged 15 to 18 years) were *actually* watched by a physically present peer while performing a difficult cognitive task, they performed worse than if they were watched by an adult experimenter or when performing the task alone (Wolf, Bazargani, Kilford, Dumontheil, & Blakemore, 2015). Younger adolescents (aged 11 to 14 years) performed worse on even simple cognitive tasks when being watched by a peer relative to an adult experimenter or when alone (Wolf et al., 2015). These two experiments suggest that constant social evaluation by peers could increase the baseline level of arousal, or alertness, of adolescents, as well as decrease ability to perform tasks as well as they might when not in social evaluative contexts.

Another study measured how adolescents reacted to peer acceptance or rejection in a task that simulated a live Internet chat room (Silk et al., 2012). Although participants in this study were more likely to direct their attention toward acceptance feedback and away from rejection feedback, they showed more emotional and cognitive reactivity to rejection feedback (as measured by pupil dilation) (Silk et al., 2012). Further, the participants that reacted most strongly to the rejection feedback during the task were more likely to report feelings of social disconnectedness in daily life. These findings suggest that online interactions have real–world consequences for the cognitive processes of adolescents, although it is unclear if this relationship is limited to online peer interactions.

6. Discussion

There have now been several experimental studies with cleverly designed tasks relevant to our understanding of how Internet use could impact cognition. The current review identified several experimental studies that examined how online structures or online behaviors affect cognitive processes, as well as empirical studies that assessed the effects of actual Internet use on cognitive processes. These two kinds of studies provide converging evidence to address the question of how Internet use affects the cognitive development of adolescents and emerging adults.

For the most part, access to the Internet equals access to the collective history of human knowledge, including both reliable and unreliable sources of information. The findings outlined in the present review suggest that our ways of dealing with information are different in structures that mimic access to the Internet. At least for undergraduates, having access to the collective memory bank of the Internet could decrease memory for specific pieces of information in exchange for an increased memory for how to obtain a specific piece of information (Sparrow et al., 2011). Practically, this kind of change in cognitive strategy might prove to be more efficient in a society where access to the Internet is stable. Furthermore, undergraduates appear to be weighting the information they obtain from the Internet according to the reliability of the source (Fenn et al., 2014), as well as considering the reliability of their own memory differently when access to correct information is available through the Internet (Ferguson et al., 2015).

Another feature of Internet use is the ability to engage in several tasks at once, including switching between offline and online tasks, as several studies of adolescents and emerging adults report doing (Common Sense Media, 2015; Moreno et al., 2012; Rosen, Mark Carrier, & Cheever, 2013). While there are discrepant findings as to how levels of real–life media multitasking affect the task-switching abilities of undergraduate students (Alzahabi & Becker, 2013; Ophir et al., 2009), one study found that both adolescents and adults are impaired in social interactions that require perspective taking in cognitively demanding multitasking situations (Mills et al., 2015).

Learning how to navigate our complex social world is a major developmental task of adolescence. Changes that occur during adolescence—including increased cognitive abilities, social sensitivity, and striving for independence—naturally facilitate the successful completion of this task (Blakemore & Mills, 2014). Given the prevalence of Internet use, a common concern of parents and policy makers is how online social interactions could impact adolescent social cognitive development. Early studies have reported positive social outcomes for adolescents who use the Internet to communicate with individuals known offline (Valken-

burg & Peter, 2009), and recent studies looking at social networking site use report largely the same (Spies Shapiro & Margolin, 2014). Indeed, communicating through digital means is still able to elicit feelings of bonding through the use of text-based cues like typed laughter (Sherman et al., 2013), and perhaps increased use social networking sites allows for more adept digital communication of social nuances, leading to increased overall social competence (Tsitsika et al., 2014; Yang & Brown, 2013). However, individual differences in baseline social cognitive skills might mediate the social benefits of Internet communication (Teppers et al., 2014). Finally, online evaluation from peers is likely to affect cognitive processes, although it is unclear how specific these effects are to the online environment (Silk et al., 2012; Somerville et al., 2013; Wolf et al., 2015).

7. Limitations and Future Directions

While experimental studies can give us insights that are lacking in survey-based studies, we cannot be certain that their findings are relevant to Internet use unless the effects are measured in relation to online activities. Therefore, more studies that incorporate both experimental manipulations of online behaviors or online structures should also include survey-based measures of actual internet use, as has been done in the multitasking literature (Alzahabi & Becker, 2013; Ophir et al., 2009). In addition, laboratory measures of Internet use would be more ecologically valid if they mimicked actual online behaviors like using social media platforms (e.g., Fenn et al., 2014). Furthermore, the majority of experimental studies investigating possible links between Internet use and cognition have been conducted on adults or undergraduate college students. In order to understand how near–constant access to the Internet could affect memory or the cognitive strategies of adolescents, future studies should include samples of younger participants. Finally, some concerns about Internet use have yet to be addressed in survey or experimental research. For example, we do not know how having near-constant access to the Internet, especially through mobile devices, might displace time left alone to one's own thoughts (e.g., on the bus or in a queue). As the research on how mind wandering impacts cognitive processes accumulates (Smallwood & Schooler, 2015), investigations of the opposite—having a lack of personal downtime—are similarly needed.

In addition to new empirical work, new reviews will continue to be necessary in order to integrate swiftly accumulating empirical evidence, and the effects of the latest usage of evolving digital technologies. For example, early reviews examining the relationship between Internet use and social development focused on evidence from investigations of chat room or instant messaging activities (Subrahmanyam & Greenfield, 2008; Valkenburg & Peter, 2009), whereas more recent reviews have focused on evidence from investigations of social media use (Spies Shapiro & Margolin, 2014; Wu, Outley, Matarrita-Cascante, & Murphrey, 2015). While both older and newer reviews on this topic suggest that online behaviors involving offline friends have the capability of strengthening relationships during adolescence, newer reviews were able to integrate more evidence to suggest baseline social skills increase the chance for adolescents to reap the benefits of social media use (Spies Shapiro & Margolin, 2014). Given the lack of older reviews on the topic of how Internet use affects cognitive development, the results of the current review could not be integrated into previous syntheses of the literature.

8. Conclusion

The questions addressed in the present review stem from concerns expressed by adults that behaviors surrounding new technologies, such as widespread access and usage of the Internet, could alter the typical course of cognitive development. The findings of this review suggest that cognitive changes are likely taking place, but that these changes are not necessarily impeding adolescents' or emerging adults' ability to successfully navigate our highly–connected world. Indeed, adaptation to these new technologies appears to be associated with greater integration into peer groups and even increased cognitive abilities such as faster task-switching. While these results could surprise the generation of adults that have expressed fears about the effects of new digital technologies, they may not surprise the generation of adolescents or adults that grew up with them. In fact, in societies where Internet use is ubiquitous, access to the Internet can be viewed as essential to completing major developmental tasks in adolescence. When interviewed, Italian adolescents reported feeling as though the Internet facilitated the tasks of forming one's identity, establishing personal autonomy, and strengthening peer relationships (Borca, Bina, Keller, Gilbert, & Begotti, 2015). Another study that interviewed American 13–14 year olds obtained similar reports, as these adolescents largely expressed positive perceptions of the effects of technology on their cognitive and social development (Fitton et al., 2013). Perhaps any changes in cognition that accompany Internet use are not a cause for concern, but rather a positive adaption to a changing environment.

Overall, the findings of the present review cannot give a definitive answer to the question of how Internet use could affect the cognitive development of adolescents. There is simply not enough empirical evidence accumulated to make a case that Internet use is altering the cognitive abilities of adolescents who have grown up with near-constant access to the Internet. There is evidence for changes in cognitive strategies in experimental paradigms that mimic online environments, but most of these studies have investigated sam-

ples of undergraduate students. Future studies that integrate experimental manipulations of online behaviors or online structures with measures of actual Internet use will be necessary, as well as reviews of the growing literature on cognitive processes and Internet use.

Acknowledgments

The author thanks Joseph Mitchell for his comments on previous versions of the manuscript and Celilo Mitchell for initial inspiration.

Conflict of Interests

The author declares no conflict of interests.

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Media and Communication (ISSN: 2183-2439)
2016, Volume 4, Issue 3, Pages 13-23
Doi: 10.17645/mac.v4i3.515

Article

Teens, Health and Technology: A National Survey

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Submitted: 23 November 2015 | Accepted: 11 March 2016 | Published: 16 June 2016

Abstract
In the age of digital technology, as teens seem to be constantly connected online, via social media, and through mobile applications, it is no surprise that they increasingly turn to digital media to answer their health questions. This study is the first of its kind to survey a large, nationally-representative sample of teens to investigate how they use the newest digital technologies, including mobile apps, social networking sites, electronic gaming and wearable devices, to explore health topics. The survey covered the types of health topics teens most frequently search for, which technologies they are most likely to use and how they use them, and whether they report having changed their behaviors due to digital health information. In addition, this survey explores how the digital divide continues to impact adolescents. Results of this study indicate that teens are concerned about many health issues, ranging from fitness, sexual activity, drugs, hygiene as well as mental health and stress. As teens virtually always have a digital device at their fingertips, it is clear that public health interventions and informational campaigns must be tailored to reflect the ways that teens currently navigate digital health information and the health challenges that concern them most.

Keywords
adolescents; digital technology; health; information-seeking

Issue
This article is part of the issue "Adolescents in the Digital Age: Effects on Health and Development", edited by Dan Romer (University of Pennsylvania, USA).

1. Introduction

1.1. The Internet and Health Information-Seeking

With the advent of digital technology, adolescents have become well-adjusted to using digital tools, such as the Internet. According to a 2015 Pew Research Center report, 92% of adolescents ages 12–17 report going online daily. In fact, adolescents and young adults have far surpassed all other age groups in Internet use. Relatedly, social networking also plays a large role in the lives of adolescents with 71% of teens reporting that they use more than one social networking site (Lenhart, 2015). A recent Common Sense Media report indicated that 45% of teens reported that they use social networking sites daily. However, according to the report, daily social media use still lags far behind daily traditional media use (e.g., music and television) (Rideout, 2015).

When it comes to which topics teens search for online, a majority of research regarding adolescent online health information seeking has centered on sexual health. Keller, Labelle, Karimi, & Gupta (2002) reported that online information regarding sexual health is prevalent. Despite this finding, Mitchell, Ybarra, Korchmaros and Kosciw (2014) found that very few heterosexual youth search for sexual health information online. On the other hand, homosexual youth are far more likely to look up such information, with 78% of this demographic reporting that they had

searched for sexual health information online (Mitchell et al., 2014).

Rather than turn to the Internet, adolescents appear to turn to interpersonal sources when facing questions about more sensitive health topics. Only 17% of teens report using the Internet to search for topics that they may be uncomfortable discussing with others (such as sexual health) (Lenhart, 2010). Willingness to search for sensitive health information online also differs by age and gender. Girls, especially older girls, are far more likely to search for uncomfortable health topics online. On the other hand, younger boys (ages 12–13) were the least likely among adolescents to search for sensitive health topics (Lenhart, 2010). Rather, studies indicate that teens prefer to ask parents, teachers and friends about sensitive health questions, rather than search on the Internet (Gray, Klein, Noyce, Sesselberg, & Cantrill, 2005; Jones & Biddlecom, 2011).

However, adolescents' online health information seeking is by no means only restricted to the topic of sexual health. A 2010 Pew Research Center report indicated that 31% of youth ages 12–17 report looking up fitness-related information online, a slight increase from 28% in 2006. This study also indicates that teens searched for this information less frequently than adults, with a reported 38% of those over 18 seeking this information (Lenhart et al., 2010). In addition, a focus group study with adolescents indicated that adolescents search for a wide range of health topics on the Internet including sexual health, relationship health, specific medical conditions, violence, body image and nutrition (Skinner, Biscope, Poland, & Goldberg, 2003). However, there is a lack of recent studies indicating which health topics are searched for online by adolescents.

As with the Internet at large, adolescents also have access to a variety of health information via social networking sites (Lenhart, 2015). However, one study among low-income youth indicates that they may be very wary of using social networking sites for health-related questions, due to the lack of anonymity that these sites afford (Divecha, Divney, Ickovics, & Kershaw, 2012). The prior study was not conducted with a large or nationally representative sample. Thus, there remains a gap in research on adolescent use of social media for health.

1.2. Mobile and Wearable Technology for Health

A large percentage of adolescents use mobile media, with nearly 70% of youth ages 13–17 owning a smartphone (Nielsen, 2013). As more adolescents have access to mobile media through the use of smartphone technology, the potential to reach this demographic with mobile health information and applications also has grown. There are a wide variety of mobile health applications readily available to adolescents. In 2011, there were 1,056 "Healthcare and Fitness" applications available in the Apple App Store (Liu, Zhu, Holroyd, & Seng, 2011). Nearly 37% of these apps were categorized as fitness apps or tracking apps (e.g., apps designed to track caloric intake) (Liu et al., 2011).

Recent years have seen a surge in *wearable* health tracking devices. Some studies have examined the use of wearable medical technology for chronic health conditions such as diabetes with promising results (Georga, Protopappas, Bellos, & Fotiadis, 2014). Most commercially available health trackers are geared toward fitness and exercise, obviously with promising effects on physical activity (Kranz et al., 2013). Unfortunately, adolescent use of mobile health applications and wearable health technology has not been assessed. Overall, there remains a gap in literature in regards to how adolescents use the Internet, mobile technology and wearable devices for health as well as which health topics adolescents frequently search for. Therefore, we proposed the following research questions to address in our national survey of adolescents use of technology for health*: how do adolescents use the Internet, mobile applications and wearable health devices to search for health information? Which health topics do adolescents most frequently search online?*

1.3. Sources of Health Information Online

When searching for health information online, adolescents often rely on easily accessible and convenient information. In one study of adolescent health information-seeking online, scholars noted that participants often began their searches by going to a search engine (e.g. Google). Adolescents who used search engines noted that the vast number of results generated through search queries made it quite difficult to choose a site or determine its credibility (Gray et al., 2005). When using search engines online to answer health-related questions, adolescents tend to choose between the first nine results, without searching further (Hansen, Derry, Resnick, & Richardson, 2003). Thus, adolescents' use of the Internet to search for health information may be limited in relation to their search heuristics and tactics. However, most studies regarding adolescent information-seeking tactics online have been conducted observationally or with smaller samples. To fill this gap in existing literature, we posed the following research question: *how do adolescents search for health information online?*

1.4. Digital Health Information and Behavior Change

Research has demonstrated the use of digital platforms to stage health behavior interventions among adolescents. A systematic review of Internet interventions

among adolescents and young adults revealed that by using tailored messaging and reminders to perform positive health behaviors along with an incentives-based approach, Internet interventions proved more successful at eliciting behavior change (Crutzen et al., 2010). Thus, scholarship demonstrates that health information found online can indeed be used to change adolescent health behavior.

In the USA, scholars and government officials have recently begun to research how such mobile applications can be used to assist teens in regards to health issues. For instance, the National Institute of Health reported the unveiling of *SmokefreeTXT*, a mobile application designed to help teens quit smoking (Daniels, 2012). Intervention studies have shown great potential of mobile-phone apps to lead to positive health outcomes (e.g., increased physical activity) (Ahtinen et al., 2009; Tsai et al., 2007). For example, one study also found that gamification and interactivity in a mobile application for adolescents with type 1 diabetes led to improvement in blood glucose monitoring among participants (Cafazzo, Casselman, Hamming, Katzman, & Palmert, 2012). Interestingly, the majority of these applications are still simple text-messaging services (Daniels, 2012; Levine, McCright, Dobkin, Woodruff, & Klausner, 2008; Rodgers et al., 2005).

These studies indicate that mobile applications may help promote positive health behaviors and behavior change among adolescents. However, little is known regarding how existing health information, found via the Internet and mobile applications impacts health choices of young people. In addition, most studies regarding adolescent health behavior change are conducted with smaller samples. Thus, a study with a large, nationally-representative sample would add to existing knowledge. Therefore, we asked the following research question: *how does health information found via the Internet and mobile applications impact adolescent health behavior?*

1.5. Adolescents and the Digital Divide

While adolescents now have greater access to the Internet and digital technology than ever before, access to digital information remains unequal. Youth who are also low income report going online less frequently. However, lower income adolescents are more likely to use social networking sites than higher income youth. Furthermore, there is a smaller divide between lower and higher income youth in regards to mobile access (Lenhart, 2012). While low-income youth are receiving greater access to the Internet and digital technology, there is still a large gap in how youth of different socio-economic groups use the Internet. Wealthier adolescents are more likely to use the Internet for information while poorer adolescents are more likely to use the Internet for entertainment (Peter & Valkenburg, 2006). However, research regarding how the digital divide and income inequality impacts adolescent health remains limited. Thus, the following research question was posed: *what are differences among youth of low, middle and high economic status regarding digital access and health topics?*

2. Methods

2.1. Participants

To study these research questions, we conducted a nationally-representative survey of 1,156 U.S. teens ages 13 to 18 years old, conducted among teens in English-speaking households from October 21 through November 9, 2014, and among teens in Spanish-dominant households in March 2015. Approximately half of the respondents were between the ages of 13 and 15 and half were between the ages of 16 and 19. 51% of adolescent respondents were male. The average annual household income of respondents was $50,000 to $59,000. The majority of respondents were White, non-Hispanic (56%), n = 604); 22% (n = 241) were Hispanic/Latino, 14% (n = 144) Black, Non-Hispanic, and 9% reported other and mixed race, Non-Hispanic (n = 58).

The survey was administered online by the GfK Group using members of its KnowledgePanel. Parental and teen consent were obtained, and the survey was offered in English or Spanish. GfK's KnowledgePanel is the first probability-based online research panel. Panel members are randomly recruited through address-based sampling methods (previously GfK relied on random-digit dialing methods). Households that are not already online are provided with notebook computers and access to the Internet if needed. The use of a probability-based sample means that the results are substantially more generalizable to the U.S. population than are results based on so-called convenience panels, which only include participants who are already online, and who volunteer through word-of-mouth or advertising to participate in surveys.

The margin of error for the full sample is +/- 3.5% and the completion rate for the survey was 48% (the completion rate refers to the number of panelists who completed the survey out of the total who were invited to participate). Unless otherwise noted, all findings refer to the full sample of 13- to 18-year-old respondents. Where relevant, findings are broken out by age, gender, race/ethnicity, and socio-economic status. Low-income families are those with annual income of less than $25,000; middle-income is $25,000–75,000 a year; and high income is over $75,000 a year. Percentages may not total 100% due to rounding, the omission of "refused" or "don't know" responses, or because multiple responses were allowed.

2.2. Demographic and Health-Related Variables

Panelist data on yearly household income was provided by GfK. Low-income families are those with annual income of less than $25,000; middle-income is $25,000–75,000 a year; and high income is over $75,000 a year.

Activity level was assessed by asking participants, "In the past 30 days, how often have you participated in physical activities, such as playing sports, running, working out, taking a dance class, or doing yoga?" Participants were asked to select from "often," "sometimes," "only once or twice" or "never."

Participant body mass index (BMI) was assessed using self-reported height (in inches) and weight (in pounds). Finally, general level of health was assessed through the question "In general, how is your health?" Participants were asked to select "excellent," "good," "fair," or "poor."

2.3. Sources of Health Information

Participants were asked how much health information they had received from the following sources: parents, health classes, doctors/nurses, the Internet, social networking sites, friends, siblings, ads, TV news, other TV shows, newspaper articles, magazine articles, radio and books. Responses ranged from "a lot," "some," "only a little" to "none." This question was used to determine top sources of health information as well as how much teens used the Internet and social networking for health information.

Use of specific online sources was assessed by asking participants whether they had used "any of the following for information, advice or tools on a health topic: Google, YouTube, Wikipedia, Twitter, Yahoo, Facebook, any other social networking site, a website specifically for teens, a medical website, your doctors web site, an online support group or community, online tools to track your health, and blog posts about a health topic."

Usage of mobile apps for health information was assessed through the question "How often do you use a health-related mobile app?" Responses ranged from "often," "sometimes," "hardly ever," to "never."

2.4. Health Behavior Change

To assess whether digital technology had aided teens in changing their behavior, participants were asked, "Have you ever changed your behavior because of health related information online?" Participants were also asked if they had ever changed their behavior because of any of the health-related mobile apps they used. Additionally, participants were queried regarding whether they had changed their weight, fitness routine or diet or nutrition due to online information or mobile apps.

3. Results

3.1. Digital Platforms Used for Health-Information Seeking

3.1.1. Internet

A total of 84% of teens reported having received health information online during their lifetime, including a quarter of all teens (25%) who said they have received "a lot" of health information online, 36% who get "some" and 22% who get "only a little" health information online. The 25% of teens who get a lot of health information online is less than half the proportion that gets a lot of information from their parents (55%), but it is surprisingly close to the proportion that gets "a lot" of health information from doctors and nurses (29%). And the Internet far outstrips other "traditional" media as a source of health information for teens: only 10% said they get a lot of information from books, 9% from TV news, and 3%from newspaper.

Nevertheless, parents remain the most frequently turned to source of health information, with 55% of teens reporting that they get "a lot" and 33% reporting that they get "some" health information from their parents. Furthermore, 29% teens also reported getting "a lot" and 40% reported getting "some" health information from doctors and nurses.

Looking for health information online is not a very frequent activity for most youth. About a quarter (24%) of teens sought health information online at least monthly or more often. The largest group of teens (38%) said they go online for health information only a few times a year. Another quarter do so less often than a few times a year, while 16% never look for health information on the Internet.

Additionally, a multiple regression analysis was conducted to determine which demographic and health-related variables predicted use of the Internet for health information-seeking ($R = .26$, $R^2 = .07$, $F(10, 1072) = 8.78$, $p = .000$). Age, race, income, physical activity level and general health significantly predicted use the Internet for health. Older ($\beta = .05$, $p < .05$), wealthier ($\beta = .02$, $p < .01$), more active ($\beta = .16$, $p = .000$) and healthier ($\beta = .21$, $p = .000$) teens reported using the Internet for health more frequently. African–American ($\beta = .50$, $p = .000$) and Hispanic ($\beta = .20$, $p < .05$) teens reported using the Internet for health to a greater extent than their white counterparts (see Table 1).

3.1.2. Social Networking Sites

Most teens do not turn to social networking sites for health information, but some do. One in ten teens (10%) said they get "a lot" of health information from social networking sites, and an additional 23% said they get at least "some" from such sites.

Table 1. Predictors of digital platform use for health-information seeking.

Digital Platform	Internet			Social Networks			Mobile Apps		
	β	*T*	*Sig.*	*β*	*T*	*Sig.*	*β*	*T*	*Sig.*
Age	.08	2.55	.011	.07	2.20	.028	-.06	-.98	.329
Gender	.01	.34	.732	.09	3.17	.002	.21	3.31	.001
Race									
Black	.15	4.63	.000	.13	4.07	.000	.01	.16	.874
Hispanic	.07	2.37	.018	.08	2.44	.015	-.01	-.02	.938
Multiracial	.03	.85	.394	.06	1.84	.066	-.03	-.40	.683
Other	-.05	-1.74	.081	-.06	-1.99	.047	.02	.31	.760
Income	.09	2.87	.004	.02	.56	.576	-.01	-.15	.881
Physical Activity Level	.17	5.40	.000	.14	4.47	.000	.10	1.52	.130
General Health	.11	3.84	.000	.12	3.91	.000	-.02	-.25	.802
BMI	.05	1.67	.092	.01	.13	.896	-.17	-2.50	.013
Model Summary: R^2 (Adjusted R^2)		.08 (.07)			.08 (.06)			.09 (.04)	

A multiple regression analysis was performed to determine demographic and health-related predictors of social network use for health (R = .26, R^2 = .07, F(10, 1072) = 7.81, p = .000). Age, gender, race, physical activity level and general health were significant predictors of how much information teens reported getting from social networking sites. Teens who were older (β = .04, p < .05), female (β = .21, p < .01), more active (β = .13, p = .000) and in better health (β = .20, p = .000) were more likely to use social networking sites for health information. African–American (β = .42, p = .000) and Hispanic (β = .20, p < .05) teens reported using social networking sites for health more than their white counterparts. Conversely, teens in the "other" race category (β = -.29, p < .05) reported using social networking sites for health less frequently than white teens (see Table 1).

3.1.3. Mobile Health Applications

Among all 13- to 18-year-olds, 62% reported having a smartphone, 51% having a laptop, and 37% having their own tablet device. A total of nearly three-quarters (73%) had either a tablet or smartphone, which would allow them to download and use mobile health apps, while 27% had neither mobile option, and thus were unable to use such apps on a regular basis. Among teens with a mobile device, 29% had downloaded a health-related app (21% of all teens). Fitness and nutrition-related apps were by far the most common among the topics asked about in this survey. Nearly a quarter (23%) of teens with mobile access had downloaded an app related to exercise or fitness, while 14% had downloaded a calorie-counter or other nutritional app. Although 21% of all teens had downloaded a health-related mobile app, far fewer actually used them. Among those who had downloaded a health-related app, almost half (47%) hardly ever or never used them, another 45% sometimes used them, and 8% often used them. (Among all teens, 10% hardly ever or never used their health-related mobile apps, 10% sometimes used them, and 2% often used them.)

A multiple regression analysis was conducted to determine which demographic and health-related variables predicted frequency of health app use (R = .30, R^2 = .09, F (10, 232) = 2.22 p = .02). Gender and BMI were significant predictors of health-related app usage. Females (β = .37, p < .01) and teens with a lower BMI (β = -.02, p < .05) reported using health-related mobile apps more frequently (see Table 1).

3.1.4. Wearable Health Devices

The vast majority of teens (91%) had never used a wearable health tracker such as a Fitbit or Fuel Band. Indeed, the conversation in focus groups indicated that many teens consider such devices an "adult" thing. According to the survey, only 2% of teens were current users of such devices, while 5% said they've used one in the past. The sample size of wearable device users was too small for further analysis.

3.2. Health Topics Researched Online

Among the topics asked about in this survey, fitness and nutrition were by far the most likely topics for teens to have researched online. Among all teens, 42% had looked for information on fitness and exercise online, and 36% had done the same for information about diet and nutrition (see Table 2).

Clearly, the Internet has become a key resource for young people concerned about eating well and exercising. Stress and anxiety seem to be other key concerns for teens, with 19% having looked for information about these topics online—the third most-common topic researched online (among those we asked about).

Table 2. Differences in health concerns and ownership of digital devices by family income.

Among 13 to 18 year olds, % who…	Among all	Low-income (<$25k per year)	Middle-income ($25-$75k per year)	High-income (>$75k per year)
Have a family member who has faced a significant medical problem in the past year	35	52	39	27
Say each issue is "very" important to them personally				
ADHD	19	27	24	12
Cancer	24	40	28	17
Colds/flu	17	28	21	10
Dental health	36	48	39	29
Depression/mental illness	28	44	31	21
Diabetes	21	38	24	12
Domestic violence/sexual assault	30	45	33	22
Drug/alcohol abuse	32	43	37	24
Eating disorders	22	31	27	14
Heart disease	19	32	24	11
Pregnancy	27	34	33	19
Smoking	27	37	33	19
Have their own:				
Laptop	51	32	50	58
Tablet	37	26	38	42
Smartphone	62	44	60	69

Other top-ten topics researched online include sexually transmitted diseases (STDs) (18%), puberty (18%), sleep (16%), depression or other mental health issues (16%), hygiene (12%), colds/flu (12%), and drug or alcohol abuse (12%).

Girls were more likely than boys to have looked up certain topics online: for example, depression (22% of girls, compared to 10% of boys), diet/nutrition (44% of girls vs. 29% of boys), stress/anxiety (25% vs. 14%), and eating disorders (17% vs. 5%).

3.3. Sources of Health Information Online

Many teens use search engines such as Google to direct them to health information (49%) or visit medical websites (31%). But some teens use less traditional types of online platforms to get health information. For example, one in five (20%) had gotten health information from YouTube, 9% from Facebook, and 4% from Twitter. Among those who search for health information online, younger teens (13- to 15-year-olds) were more likely than older ones to have gotten health information from YouTube (28% vs. 21%) and to have visited a website specifically for teens (12% vs. 7% of older teens); Hispanic youth were more likely than others to have used Yahoo to search for health information (23% vs. 10% of White and 8% of Black youth); and girls were more likely than boys to go to medical websites (42% vs. 32%).

3.3.1. Search Methods

Among the 84% of teens who had used the Internet for health information (online health-seekers), 58% said they "often" start their searches by Googling a topic. Far fewer use other search engines this often (14%) or go directly to a site they are familiar with (23%). Some teens simply come across health information online, while browsing (9% say this often happens), through links on social network sites (6%), or because of seeing something in an ad (3%).

Once teens have Googled a health topic, half (50%) said they usually click on the first site and only go further if they still have questions after reading the information on that site. A slightly smaller proportion (44%) said they generally check several sites so they can compare the information they're getting. Black (20%) and Hispanic (22%) youth were more likely than White youth (10%) to say they often look for health information online by using search engines other than Google.

3.4. Digital Health Information and Behavior Change

Among those who have looked for health information online (84% of all teens), 34% said they have changed their behavior because of what they found. Among those who have used a mobile health app (21% of all teens), 36% said they changed their behavior because of the app. And among those who used a wearable digital health device (7% of all teens), 17% said they changed their behavior because of it. From the base of "all teens," this means that 28% say they have changed a health-related behavior due to online information, 7% due to a mobile app, 2% due to digital games, and 1% due to wearable devices.

Many teens use the Internet and digital health tools to advance their fitness and nutrition. Because of national concern with obesity, the survey asked specifically whether teens had changed their fitness routines or diets due to online health information or digital health tools, and also asked whether their weight had changed as a result. Among the base of all teens, 18% reported having changed their diet or nutrition due to online health information, and 15% reported having changed their fitness routine; 8% said their weight had also changed. Among all teens, 5% reported having changed their diet/nutrition due to a mobile app, and the same percent reported changing their fitness routine; 3% reported a change in their weight.

In trying to explore whether some youth are more likely than others to change a health behavior in response to online information, the survey data on this issue were analyzed by age, gender, family income, and race/ethnicity. No differences were located by age, gender or family income. However, Black or Hispanic teens were more likely than other teens to report having changed a health behavior in response to online health information, with 40% of Black and 42% of Hispanic teens who get health information online reporting a behavior change in response to it, compared with 29% of White youth.

3.5. Adolescents and the Digital Divide

The survey indicates there is still a substantial divide in personal ownership of digital devices. Data were analyzed by family income, parent education, and race/ethnicity. The largest and most consistent differences in digital device ownership occurred by income. There was no significant difference in the percent of teens who had their own desktop computer (24% among all), but there were substantial differences in the percent who have their own tablet (a 17% age point gap by income), laptop, or smartphone (25% age point gaps) (see Table 2).

The most widely available mobile digital device was the smartphone, which 62% of all 13- to 18-year-olds had. However, access varies substantially, from 44% of low-income to 69% of higher-income teens. Half of all teens (51%) reported having their own laptop, but again, this varied from 32% of low-income youth to 58% of higher-income teens. Overall, 37% of teens reported having their own tablet device, ranging from 26% of low-income teens to 42% of higher income ones (see Table 2).

Concern over various health topics also varies by income level. Teens from lower income levels tended to have greater concern over health topics such as ADHD, depression/mental health, heart disease and pregnancy. As income increased, concern for such topics tended to decrease. Overall, low-income teens were more likely to report that a family member had a significant health problem in the past year (see Table 2).

4. Discussion

In this study, we sought to understand how teens are using the Internet, mobile apps and wearable health technology as sources of health information. Despite the fact that the Internet offers adolescents anonymous access to an abundance of information on virtually any health topic they could think off, it is perhaps heartening that young people still primarily rely on interpersonal sources of health information, such as their parents, doctors or nurses. This may indicate that the Internet is not replacing interpersonal sources, but rather, supplementing them. This result confirms previous findings that teens are more comfortable seeking out health information from interpersonal sources, especially for sensitive health topics (Gray et al., 2005; Jones & Biddlecom, 2011).

Despite the importance of interpersonal sources of health information, the vast majority of teens—84%—also turn to the Internet for health information, and one in four say they get “a lot” of their health information online. The Internet has far eclipsed other media as a source of health information and has empowered young people to arm themselves with information and tools to address their own health concerns and to help those around them.

In essence, the study indicates that when it comes to teens and health information, the Internet is essentially functioning the way one would hope it would. Young people are using online health information to help them eat healthier, sleep better, cope with stress, and stay fit. When they have everyday health issues such colds or sprains, they use the Internet for advice or to prepare for or follow-up on doctor’s visits. When they face more serious challenges such as depression, attention deficit disorder, or self-harm, they are looking for and using tools to care for themselves. And when family members face significant problems such as diabetes, cancer, or Alzheimer’s, teens are using the Internet to learn more and find out how they can help.

A key goal of this study was to explain which health topics teens search online. As prior studies indicated, adolescents are concerned with a myriad of health topics, ranging from mental health to physical health (Skinner et al., 2003). Teens seem particularly concerned with diet and fitness, with these topics far outpacing the others. Far more adolescents reported searching for these topics than those who reported searching for more sensitive health topics (e.g. sexual health, depression and anxiety). This confirms previous findings that teens may be wary of searching for sensitive health topics online (Gray et al., 2005; Jones & Biddlecom, 2011; Lenhart, 2010). Nevertheless, our findings indicate that topics such as mental health are of importance to a substantial percentage of adoles-

cents, and adolescents are willing to seek information about these topics online. Thus, this highlights the importance of ensuring that teens are able to find accurate information about sensitive and serious health topics online.

When it comes to adolescents' use of social networking sites for health, results indicate that teens still tend to be wary of posting health-related questions or viewing health related information on social media. While the Internet may afford teens some semblance of anonymity, the case may not always be the same for social media. This finding confirms past research which indicates that teens may be wary of discussing health topics, especially those of a sensitive nature, when their names can be associated with such information (Divecha et al., 2012). This finding may indicate that social media may not be the best outlet for attempting to reach adolescents with health information.

This study also sought to understand how teens use the newest sources of health information—apps and wearable devices. As the number of mobile apps for health steadily grows, adolescents seem to slowly increase usage of such sources of information. However, the Internet still outpaces mobile health apps as sources of information. Furthermore, most teens report downloading apps, yet rarely or never using them. This may indicate that apps do not always hold the attention of teens past initial use. Future research should examine the mechanisms of mobile apps for health that would elicit consistent use from teens. Adolescent use of wearable devices is still very low, potentially indicating that teens see such devices as not for their age group.

Our analysis also revealed key demographic and health-related differences among the use of digital devices for health. Teens who were older, healthier and more active reported using the Internet more for health purposes. Similarly, teens who were older, healthier, and more active also used social networking for health more often. Additionally, girls tended to use social networking for health more than boys. Explanations for this may include that teens who are older are more accustomed to Internet use than their younger peers, and thus, may seek health information more frequently. Teens who are older may also face more health challenges and questions than younger teens, such as questions that surround sexual activity. Furthermore, teens who are in good health and pursue active lifestyles may be primed to search for information which allows them to stay active, fit and in good health. This may also explain why teens who were more active and had a lower BMI tended to use health-related mobile apps more frequently. This comes as little of a surprise as one of the most frequently downloaded types of apps among teens were fitness apps.

Our analysis also revealed racial differences regarding use of the Internet and social media for health. African–American and Hispanic teens were more likely than their white counterparts to use these platforms for health information (although teens in the "other" category were less likely than white teens to use social networking for health). This may indicate that some non-white teens may be relying on digital health information more so than their white peers. Future studies should examine the cultural and socio-economic factors that may contribute to this reliance.

Such racial-ethnic differences were not observed for mobile applications. Mobile applications for health, while pervasive, are still a relatively new technology. Thus, although a sizable portion of teens report using them, the Internet and social media far outpace in terms of teen use. Despite their novelty, access to such mobile technology is becoming more equal between racial-ethnic groups (Lenhart, 2015). It also appears that the use and application of such technology for health is also becoming more equal among teens. Implications of this finding are that scholars and interventionists may consider use of the Internet and social media to reach teens and that mobile applications may be used to reach a more diverse sample of teens.

Our next research question queried how adolescents use the Internet to search for health information—the online sources most frequently used and the ways that teens navigated these sources. Google emerged as a top source that adolescents gravitate toward when searching for health information online, far above other search engines and social media sources (e.g. Youtube and Twitter). While the majority of teens tended to use Google, Black and Hispanic teens were far more likely to use search engines other than Google. Future research should examine why minority teens tend to use these sources.

Teens also reported that they start their searches with Google, similar to previous studies (Gray et al., 2005). Also similar to past research (Hansen et al., 2003), participants indicated that they often selected the first search result in Google, without searching further. This may indicate that when teens search for information, their searches may be more cursory and quick, without the use of in-depth search tactics. On the other hand, a sizeable percentage of teens reported cross-checking information with other sources, which may indicate a higher level of digital literacy. Future research should examine under which circumstances and which demographic and educational variables correlate with cursory or extended health information seeking online. These findings also highlight the need to ensure that information available online is accurate and helpful to adolescents, as they may not know how to properly search for the best health resources.

Our subsequent research question sought to examine the potential of existing online and mobile health information in eliciting health behavior change among

adolescents. Prior research has indicated that the Internet and mobile devices can operate as very successful platforms for staging health behavior interventions with adolescents (Crutzen et al., 2010). However, this study was the first of its kind to examine health behavior relating to existing Internet-based health information, using a nationally representative sample. Of those who had used the Internet to search for health information, about one third reported changing their health behavior due to the information they found. Similarly, about a third of those who had downloaded a mobile app reported changing their behavior due to the app. These findings indicate the potential of digital health information to change adolescent health behavior. In addition, a greater percentage of Black and Hispanic teens reported that online information had changed their behavior. This may indicate that online platforms may be uniquely positioned to reach this demographic. Overall, our findings indicate that the digital health information that adolescents frequently access may have the power to influence their health behaviors.

Our fifth and final area of interest concerned how the digital divide impacts adolescents. While there appears to be greater equality in access to desktop computers, our findings indicate that there is still a gap in access to laptop computers, smartphones and tablets. This corroborates previous research, which showed that, although gaps have been closing, there still remains inequality in access to digital technology and information (Lenhart, 2012; Peter & Valkenberg, 2006). Our findings also indicated that, across a range of different health topics, lower income teens tend to have more concern over health issues than their higher income peers. This is the case for many highly sensitive health topics (e.g. depression, domestic violence/sexual assault, drug/alcohol abuse, eating disorders and pregnancy). Lower income teens also reported greater instances of family health problems than their higher income peers. As the digital divide continues to disadvantage lower income youth, these findings are of particular concern. While lower income teens may have greater concern over potential and existing health problems, they may have less access to the information that may help ease their worries, provide education or even change their behavior.

5. Conclusion

This study was not without limitations. First, this study relied on self-report. As adolescents may not accurately remember their exact digital search behaviors, the information they viewed and the impact this information had on their health behaviors, future research is still necessary. In the future, scholars should examine the impact of specific sources of health information on adolescent health knowledge and behavior.

While participants in this study indicated whether digital information helped change their health behaviors, there is no record of what these specific behaviors were (e.g. how teens changed their weight) or whether these behaviors were healthy or unhealthy. Future research should examine the specific types of health behaviors that digital health information changes and whether these changes positively or negatively impact the health and well-being of adolescents.

In the age of digital media, teens are virtually tethered to technology and digital devices. As access to digital information has increased, teens are able to reach health information with a click of a mouse or tap on a smartphone. Although teens still heavily rely on people above technology when it comes to health information, they also use digital technology to a great extent. Thus study underscores the importance of making sure there is accurate, appropriate and easily accessible health information available to teens online. As teens use and act upon this information, it is crucial that what they are viewing will improve their health and well-being. Furthermore, this study highlights the importance of educating teens to properly navigate the ever-increasing digital library of health information, as well as how to search for answers to health questions without merely relying on the first result they find. Finally, this study indicates that the digital divide still impacts teens in the United States—greater effort to bridge these gaps may have influence on their health information-seeking and health behavior. Although digital health information is clearly not a panacea, adolescent use of digital tools to better understand their health may allow today's youth to have greater autonomy in regards to their health and allow them to pursue healthier choices.

Conflict of Interests

The authors declare no conflict of interests.

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Media and Communication (ISSN: 2183-2439)
2016, Volume 4, Issue 3, Pages 24-34
Doi: 10.17645/mac.v4i3.523

Article

The Role of Parents in Problematic Internet Use among US Adolescents

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Submitted: 7 December 2015 | Accepted: 25 February 2016 | Published: 16 June 2016

Abstract
The internet has transformed the way youth communicate, learn, and network, with implications for their broader social, psychological, and physical health and well-being. With the technological capability of accessing the internet from anywhere, at any time, paired with the enormous variety of internet activities in which youth engage—from social networking to chatting to streaming videos to playing games to watching television content—instances of problematic internet behavior have emerged. We conducted an online national survey of 629 US adolescents ages 12–17 years old and a matching survey of one of their parents. We investigated the relationship between problematic internet behavior and parental monitoring, parental mediation of internet use, and parental estimates of their adolescent's time spent using computers. Analyses showed that problematic internet use was associated with less parental monitoring and parental mediation and poorer parental relationships. Adolescents that spent a lot of time on the computer were also more likely to engage in problematic internet use. Although we cannot determine the direction of the relationships, results support the important role of parents in adolescents' problematic internet use.

Keywords
adolescents; computer time; internet addiction; parental mediation; parental monitoring; problematic internet use

Issue
This article is part of the issue "Adolescents in the Digital Age: Effects on Health and Development", edited by Dan Romer (University of Pennsylvania, USA).

1. Introduction

Youth are avid users of the internet. According to the Pew Research Center, 95% of adolescents (ages 12–17 years) and young adults (ages 18–29) in the United States are online, which is a figure that has for the most part remained stable for nearly a decade (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013). Additionally, differences in internet access based on income and race are not as steep as previously noted, especially among younger adults (Smith, 2014). Among youth in the United States, estimates of time spent on a computer, but not necessarily online, range from an average of 1.4 hours per day among 15–18 year old youth (Rideout, Foehr, & Roberts, 2010) to 2.6 hours per day among youth ages 12–17 years (Bleakley, Vaala, Jordan, & Romer, 2014). And finally, mobile technologies like smartphones have made the internet more accessible, as ownership of such devices among youth has increased in recent years (Madden et al., 2013).

With the internet as a prominent and accessible fixture in the lives of youth, one concern is that young people may use, or overuse, the internet is ways that could be described as "problematic." With the technological capability of accessing the internet from anywhere, at any time, paired with the enormous variety of internet activities in which youth engage—from social networking to chatting to streaming videos to playing games to watching television content—instances of problematic internet behavior have emerged. The term

"internet addiction" is often used to describe compulsive internet use in the same way as clinically diagnosable behavioral and substance-use addictions. However, there is widespread disagreement about basic terminology and definitions pertaining to the idea of internet addiction, and whether it is a diagnosable condition or disorder (Mitchell, 2000). Additionally, the inclusion of "Internet Gaming Disorder" in the DSM-5 (American Psychiatric Association, 2013) has done little to clarify the various conceptualizations of problematic internet use, often referred to interchangeably as internet addiction, gaming addiction, cyberspace addiction, online addiction, net addiction, Internet addicted disorder, and high Internet dependency (Douglas et al., 2008).

Using data from a national survey of US adolescents and their parents, we investigated problematic internet behavior and its association with parental factors and the home media environment. We describe the extent to which indicators of problematic internet use are reported, and estimate how parental influence is associated with these signs of problematic internet use. The parental factors we consider are parental monitoring, parental mediation of internet use, parent–teen relationship quality, and parent perception of their teen's time spent using computers.

2. Problematic Internet Use

Competing definitions and theoretical approaches, and inconsistent measurement, have led to a range of estimates on the prevalence of pathological internet use (Moreno, Jelenchick, Cox, Young, & Christakis, 2011), and controversy surrounds the meaning of the classification. In particular, some argue that rather than being a unique disorder, it is more useful to consider it a coping mechanism for other problems (e.g., Davis, 2001). Others question whether the behavior is truly an addiction to the internet per se, or merely a convenient outlet for behavior that would otherwise occur offline, such as gambling, gaming, or use of pornography (e.g., Griffiths, 2005).

One model of problematic internet use introduced by Davis (2001) uses a cognitive-behavioral approach that labels the behavior as pathological internet use rather than internet addiction. In particular, the model suggests that persons suffering from depression, anxiety, or substance use disorders may retreat to the internet as a way of coping with their disorder, especially as a substitute for offline social activity. Furthermore, certain maladaptive cognitions that accompany these disorders can enhance attraction to the internet, such as beliefs of low self-worth that incline the user to retreat to more satisfying online forms of interaction with persons unknown to the individual, such as gaming or certain types of social networking. Social isolation and lack of social support in the offline world, often associated with other disorders, are likely to increase attraction to such online forms of social interaction (Davis, 2001).

Regardless of what draws individuals to engage in it, however, problematic internet use is associated with negative interpersonal and psychosocial outcomes (Caplan & High, 2011). In adolescents and emerging adults, specifically, it has been found to be associated with increased rates of attention deficit hyperactivity disorder (Yoo et al., 2004), sleep disturbances and excessive daytime sleepiness (Choi et al., 2009), problematic alcohol use (Ko et al., 2008), and impaired academic performance (Jacobsen & Forste, 2011; Kubey, Lavin, & Barrows, 2001). Therefore, understanding the antecedents and correlates of problematic internet use could serve not only to reduce the proximate behavior, but also to ameliorate these other issues as well.

Despite these competing definitions, two studies on internet behavior among adolescents from Europe are worth mentioning because of their cross-national samples. In a study by Durkee et al. (2012), which included participants (n=11,956) with a mean age of 14.9 (SD 0.89) across 11 European countries, the overall prevalence of what they called problematic internet use was 4.4% (Durkee et al., 2012). Estimates varied by gender and country, with boys exhibiting greater problematic internet use than girls. A later study by Tsitsika et al (2014) found 1% of adolescent participants (n=13,284 from seven European countries) exhibiting internet addiction according to criteria based on the Internet Addiction Test (IAT,Young, 1998), with 12.7% exhibiting problematic internet behavior. The authors concluded that 13.9% showed "dysfunctional" internet behavior, defined as the sum of the two IAT classifications. Similar to the Durkee et al (2012) study, differences were found in rates by gender and country, once again with boys displaying greater internet addiction than girls. In the present study, we characterize a sample of adolescents from the United States, ages 12–17 years, with regard to the extent of their problematic internet use.

3. Parental Influence on Internet Use

The role that parents play in adolescents' problematic internet use is an important influence to consider. This is the case both in regard to the environment in which problematic use may occur and in identifying potential points of intervention. Few studies have examined parental context as a correlate of problematic or addictive internet behavior. Findings in both Asian (Chng, Li, Liau, & Khoo, 2015) and European (Siomos et al., 2012) samples of adolescents exhibiting problematic internet use report less favorable relations with parents. Additionally, there is evidence that adolescents with less parental monitoring experience greater harassment online, such as receiving upsetting emails or instant messages and having rumors posted about them on social media (Khurana, Bleakley, Jordan, & Romer, 2014).

Parental monitoring/knowledge. Parental monitoring is considered to be a set of parenting practices or behaviors through which parents are aware of their adolescents' whereabouts, peers, and activities (Borawski, Ievers-Landis, Lovegreen, & Trapl, 2003; Stattin & Kerr, 2000). Studies on risk-taking and adolescent antisocial behavior consistently demonstrate that the amount of parental monitoring perceived by an adolescent is protective (Borawski et al., 2003; DiClemente et al., 2001; Kerr, Stattin, & Burk, 2010; Li, Stanton, & Feigelman, 2000) against engaging in risky behaviors such as unprotected sex (Borawski et al., 2003; Huebner & Howell, 2003) as well as alcohol and drug consumption (DiClemente et al., 2001). However, there are challenges to validity of the parental monitoring construct, which some argue is actually measure of "parental knowledge" (Stattin & Kerr, 2000) and not active parental efforts to track their child's activities. Also at issue is how parents come to obtain the knowledge about their adolescents that allows them to effectively "monitor": through child disclosure, parental solicitation, and/or parental control (e.g., rules and restrictions) (Racz & McMahon, 2011). Studies have shown that parental knowledge is most likely a function of an adolescent's disclosure or other personality traits, and that it is parental knowledge rather than restrictive parental behavior that is associated with less problem behavior (Kerr et al., 2010). In this study we use the "parental monitoring" terminology to remain consistent with prior literature but recognize that our measures are better indicators of parental knowledge and not necessarily active parental surveillance.

Research pertaining to general parental monitoring of adolescent behavior and internet use has largely taken a risk-reduction perspective as well by focusing on problematic behaviors. For example, international studies have shown that parental monitoring and similar constructs (e.g., parent–child cohesion; parent involvement) are associated with lower rates of teen exposure to risky online content (i.e., sexual and violent content, gambling sites, and interaction with strangers (Cho & Cheon, 2005) and teen internet addition (C.-H. Lin, S.-L. Lin, & Wu, 2009; Xu, Turel, & Yuan, 2012), but may be unrelated to cyberbulling or cyber-victimization (Aoyama, Barnard-Brak, & Talbert, 2012; Mesch, 2009). Limited research has examined relationships between parental monitoring and youth online behavior with regard to time spent online or on specific internet activities that are not necessarily risky. One analysis by Sun and colleagues (2005) showed that parental monitoring was related to US adolescents' internet use at home but not at school. Given documented concerns among parents about the amount of time their children spend online (Livingstone & Bober, 2004) parental monitoring may be related to lower rates of teen computer use overall as well as time spent in specific online activities (Vaala & Bleakley, 2015). Given prior research on the protective effects of parental monitoring on health risk behaviors and media behavior, we expect that adolescents who perceive greater parental monitoring will be less likely to report indicators of problematic internet use.

Parental mediation. In the youth and media literature, parental mediation has three distinct forms: (1) active mediation refers to parent-child discussion about media content; (2) restrictive mediation includes parents' rule-setting or limiting the time or content of children's media use; and (3) co-viewing occurs when parents view or use media together with children (Nathanson, 2002). Mediation is different from parental monitoring/knowledge in that it is specific to media activities (as opposed to monitoring, which is concerned with all behavior). Each of these mediation behaviors has evidenced varying patterns of influence on children's media use and the effects of media content, depending on the nature and context of the parental mediation (e.g. co-viewing TV can increase negative effects of unfavorable content if children perceive parents to be condoning the onscreen behaviors (Nathanson, 2002)). Although the roots of the framework are in television research, parental mediation behaviors have been re-conceptualized more recently to include mediation of children's and adolescents' newer digital media use as well (Clark, 2009; Livingstone & Helsper, 2008). Forms of internet mediation include discussion of online content, the rules parents set, and monitoring and co-use behaviors that could directly constrain the amount of time adolescents are able to use the computer and types of content with which they engage online (Vaala & Bleakley, 2015).

In analysis of 2004 data with 906 teens and their parents in the UK, Livingstone and Helsper (2008) found that parental mediation techniques were largely unrelated to teens' online behavior, though banning the social interaction features of the internet (IM/chat; email) was associated with less exposure to online risks. Sasson and Mesch (2014) found in a sample of 10–18 year old Israeli youth that social mediation was not associated with risky online activity. Mediation that included checking their child's email/online accounts or installing tracking software was actually related to participation in *more* online risky activities. In contrast, Kirwil (2009) examined the internet mediation practices among parents of children and adolescents across 18 European countries, as well as the self-reported exposure of their children to online risks. She found that the extent of parental mediation and the effectiveness of that mediation in shielding youth from online risks varied by country. Across most countries, "social mediation" techniques, which include co-use and the communication of rules between parents and children was generally more common and more effective than software or hardware that restricts use (i.e., "system-

based restriction") (Vaala & Bleakley, 2015). The conflicting evidence for the effect of parental mediation on problematic behavior makes it difficult to hypothesize a directional effect. However, we include it as a potentially important predictor.

Parental relationship quality. Research with both Asian (Chng et al., 2015) and European adolescents (Siomos et al., 2012) suggests that problematic internet use is associated with poor parental relationships. This pattern is consistent with one theory of problematic internet use that attributes the behavior to an attempt to cope with problems encountered offline, such as unsupportive peers and families (Davis, 2001). We examined this factor as a potential contributor to problematic internet use.

Accuracy of parental estimates of computer use. It is common practice to use parental reports of time their children spend with particular media (Bryant, Lucove, Evenson, & Marshall, 2007). Parent reports may be used as estimates of media use when obtaining a child or adolescent estimate is not possible due to age and/or availability constraints associated with the research process. However, having estimates of use from both parents and adolescents in the present study allows for direct comparison of parent and adolescent estimates of time spent on the computer. In a review of studies that assessed measures of television viewing that test the relationship between parent and child report, they were well correlated with one another, but parents underestimated the amount of time their children spend watching television (Bryant et al., 2007). We expect a similar relationship for computer use.

The relative discrepancy between a parents' estimates of their adolescent's media use and the adolescent's actual use could play a role in problematic internet behaviors. In particular, we expect that adolescents who use the computer a great deal but whose parents do not know the extent of their use may be more likely to exhibit problematic internet use behaviors. This expectation is based in previous work on the relationship between parental variables and adolescent internet use (e.g., C.-H. Lin et al., 2009; Vaala & Bleakley, 2015; Xu et al., 2012).

4. Methods

The purpose of the Annenberg Media Environment Survey (AMES) was to assess the media use and environment of parents and their children. Data were obtained in Spring 2012 from an online survey of 629 adolescents ages 12–17 years old and one of their parents who were members of an internet research panel maintained by the survey firm Gfk. Parent respondents were randomly selected from an online probability panel (KnowledgePanel) maintained by GfK. The panel is designed to be representative of adults (ages 18+) in the United States. GfK relies on probability-based sampling (random-digit dialing and address-based sampling) to recruit households to the panel. Households are provided with access to the internet and hardware if needed to reduce the risk of selection bias.

Of eligible parents of adolescents (n=1833), 49% (n=899) completed the survey. Approximately 70% (n=629) qualified for the sample based on their adolescents' participation and on the quality of their data as determined by GfK. Eighty percent of eligible parents gave consent for their adolescent to participate, and 98.9% of those adolescents completed the survey. Only parents whose adolescent completed the survey were included in the sample (n=629). Adolescent respondents were weighted to be representative of the U.S. population ages 12–17 based on the following data from the Current Population Survey: gender, age, race/Hispanic ethnicity, census region, metropolitan area, and household income. The weights help to correct for any bias that may have occurred during the sampling process. Parental consent and teen assent was obtained for adolescent respondents. The study was approved by the Institutional Review Board at the University of Pennsylvania.

The unweighted sample of adolescents (n=629) is 49.3% female with mean age of 14.8 (SD 1.64) years. Parent respondents were 58.0% female. The average parent age was 44.9 years (SD 7.06) and 83% were married. Parent education level was 33.2% high school or less, 31.2% some college, and 35.6% college graduates. The majority of parent respondents were white (68.4%), 9.2% were African American, 19.1 Hispanic, and 3.3% were reported as other.

5. Measures

Problematic internet use. Adolescents were asked to answer four questions about their internet use, irrespective of whether it was accessed through a computer or a cell phone. These items were adapted from Young's original criteria (Young, 1998) and used a 4-point scale (ranging from never [0] to often [3]) as responses to how frequently adolescents had the following experiences when using the internet: (1) You stay on the internet (online) longer that you thought you would? (2) You find yourself thinking about when you will go online again? (3) You have trouble trying to cut down on the amount of time you spend online? and (4) Your grades or schoolwork have suffered because of the amount of time you spend online? A composite problematic internet use index was created for analytic purposes (Cronbach alpha (α) =0.82; *M*=1.20 *SE*=0.04). Frequencies of these items are shown in Table 1, with the distribution of the index presented in Figure 1.

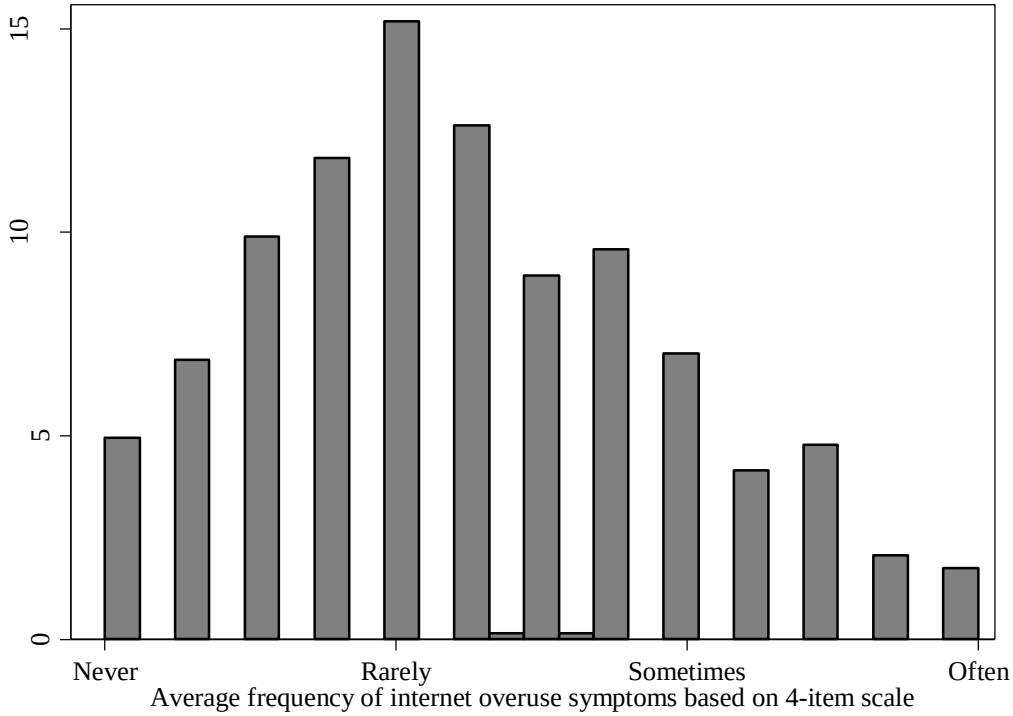

Figure 1. Distribution of problematic internet use scale (4 items, Alpha .82) (Not weighted).

Table 1. Frequencies for symptoms of problematic internet use.

Item	Never	Rarely	Sometimes	Often
	%	%	%	%
Stay online longer than you thought you would	6.1	17.6	54.7	21.6
Think about when you will go online again	25.7	37.4	28.0	9.0
Have trouble cutting down the amount of time you spend online	32.1	37.4	21.1	9.3
Grades or school have suffered because of amount of time online	60.0	24.2	12.4	3.3

Note: Weighted estimates.

Parents' estimates of their adolescent's computer time. Parents and adolescents were both asked about the time each adolescent spends using a computer. We asked adolescents to estimate the time they spend "using a computer" on a "typical weekday, for example last Tuesday" and on a "typical weekend day, for example last Saturday," between the time they wake up and noon, noon and 6pm, and 6pm and the time they fall asleep. Computer time was defined as using a desktop, laptop, or tablet. The responses were close-ended and ranged from 0 minutes to 7 hours in 30 minute increments. The same questions were asked of parents about their adolescent's computer use. Average daily computer time was calculated by multiplying weekday viewing by 5, weekend day viewing by 2, summing, and dividing by 7, representing daily computer use in hours. Thus we have two time measures: parent report of adolescent computer time and adolescent self-report of their own computer time. This time use measure is similar to others used commonly to measure parents' and children's media use (e.g., Bleakley, Jordan, & Hennessy, 2013; Rideout et al., 2010).

Perceived parental monitoring/knowledge. Eight items were used to measure adolescents' perceived parental monitoring (Cottrell et al., 2003; Stattin & Kerr, 2000), or the extent to which adolescents believe their parents know about their whereabouts and activities. On a scale from (1) never to (5) always, the items asked how often a parents know, for example: "what you are doing during your free time?" and "when you have an exam or paper due at school?" The mean of the items served as the measure of parental monitoring [α=0.89; *M*=3.14, *SE*=0.04] (Cottrell et al., 2003).

Perceived parental mediation. Mediation items were informed by Livingstone & Helsper (2008), though inclusion of their entire 24-item measure was not possible due to space limitations and the fact that the items were being asked of adolescents rather than parents. We included items similar to those included in their "active co-use", "interaction restrictions" and "monitoring" mediation dimensions, and expanded the response options from binary to a 4-point scale from (1) never to (4) often. Adolescents were asked: "In the past 30 days, how often has a parent: "forbidden or

blocked certain websites that you might use", "restricted the amount of time you spend online?", "monitored or tracked what you are doing online, such as tracking your Facebook page or checking your search history?", and "used the internet with you?" The mean of the 4 items was used to create the internet mediation scale (α=0.79; *M*=2.55 *SE*=0.05).

Perceived relationship quality with parents. Four items were used to assess an adolescent's relationship quality with his or her parents. Adolescents reported how often, from never (1) to often (4), their parents: "praise you for doing well," "criticize you or your ideas," "help you do things that are important to you,", and "blame you for his/her problems." The items were averaged to create a scale (α=.72, *M*=:3.34 *SE*=0.02). The criticize and blame items were recoded so that the higher the value on the scale, the better the relationship quality.

We examined the correlations among the three parental influence variables—perceived parental monitoring/knowledge, perceived parental mediation, and perceived relationship quality—to verify that they represented distinct dimensions of parental influence. Only parental monitoring and relationship quality were significantly correlated with one another (*r*=0.50, *p*<.01). Parental mediation of internet use was not correlated with either parental monitoring (*r*=0.02, ns) or relationship quality (*r*=0.03, ns).

Covariates. We included several demographic characteristics as covariates, such as gender, race (white as referent group), and adolescent age (younger adolescent, 12–14 years; older adolescent, 15–17 years), as well as having a computer with internet access in the bedroom. Also included were sensation seeking and impulsivity, due to their association with problematic internet use in some samples (Cao, Su, Liu, & Gao, 2007; S. S. Lin & Tsai, 2002; Mehroof & Griffiths, 2010). Sensation-seeking was measured using the 4 item BSSS (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002). Items were measured on a 4-point scale of strongly agree (1) to strongly disagree (2) (α=0.78; *M*=2.27, *SE*=0.03). Impulsivity was measured using three items from the Eysenck Impulsivity Scale (Eysenck, Pearson, Easting, & Allsopp, 1984), asking how often, from never (0) to often (3), the adolescent reported: doing or saying things without stopping to think, getting into a jam because you do things without thinking, and thinking carefully before doing something new. (α=0.67; (*M*=1.73, *SE*=0.03).

6. Statistical Analysis

Variables are adolescent self-reports unless otherwise noted, when we used parental reports. Regression analyses were conducted to estimate the extent to which problematic internet use was associated with parental monitoring, parental internet mediation, parental report of their adolescent's computer time, and additional covariates. We also tested an interaction between parent and adolescent report of computer time. Stata 13 was used for all analyses.

7. Results

Problematic internet use. The most commonly reported behavior was staying online longer than anticipated, with over 75% of the sample reporting that happened at least sometimes. Figure 1 shows the distribution of the problematic internet use scale. About 20.4% of the sample reported never or rarely engaging in all 4 of the problematic behaviors. About 32.9% reported engaging in only 1 problematic behavior either sometimes or often; 18.4% reported 2 behaviors; 17.5% 3 behaviors, and 10.8% reported engaging in all 4 problem behaviors either sometimes or often. Neither age nor gender was related to the problematic internet use scale.

Parents' estimates of their adolescent's computer time. Table 2 shows both parent and adolescent reports of adolescents' computer time. The mean difference between adolescent and parent reports of time were tested using Wald tests. Parent and adolescent estimates were correlated at *r*=0.69. However, on an average day, parents underestimated the amount of time their teen spends on the computer by about 18 minutes, mostly due to underestimates of computer time in the morning and after school. The discrepancy between adolescent use estimates and parent use estimates was not associated with either parental monitoring or parental mediation.

Regression analyses. Table 3 shows the results of the regression analysis for parental influence on problematic internet use. Maximum likelihood estimation was used and unstandardized regression coefficients are reported. As shown, several perceptions about parents were related to problematic internet use. Greater parental monitoring/knowledge was related to less problematic internet use (*b*=-0.21, *SE*=0.06, *p*<.01), as was parental mediation of internet use (*b*=-0.09, *SE*=0.04, *p*<05) and parental relationship quality (*b*=-0.18, *SE*=.07, *p*<01). Time spent using a computer, as estimated by adolescents, was positively associated with problematic internet use (*b*=0.07, *SE*=0.02, *p*<01); parent report of their teen's computer time was not related to problematic internet use.

An interaction term between parent and adolescent time estimates was added to the regression to determine if symptoms of problematic internet use were more likely in instances in which parents and adolescent reports did not coincide. The interaction was statistically significant; see Figure 2 for a graph of the interaction.

Adolescents who spent more time with computers were more likely to exhibit problematic internet use when their parents estimated they spent less than 2

hours a day (below the median) compared to those adolescents who spent more time with computer but whose parents estimates were higher and therefore more closely aligned with their own. This suggests that parental accuracy in terms of time spent on the computer is related to the likelihood of problematic internet behaviors. The difference or discrepancy between parental and adolescent reports was not correlated with parental monitoring/knowledge (r=0.07, ns), parental mediation (r=0.07, ns) or relationship quality (r=0.03, ns).

There were also some demographic differences. African American teens were less likely to report problematic internet use than their white peers (b=0.20, SE=.03, p<.05), and greater impulsivity was also associated with more problematic use (b=0.21, SE=.06, p<.01).

Table 2. Weighted parent and adolescent reports of adolescents' hours spent with television, video games, and computer on weekdays and weekends, by time of day.

	Parent report (n=629)	Adolescent report (n=629)
	Mean (SE)	Mean (SE)
Computer use		
Weekday		
AM	0.53 (.06)	1.23 (.07)***
Midday	0.82 (.05)	1.05 (.06)**
PM	1.12 (.05)	1.01 (.05)
Average weekday	2.44 (.12)	3.27 (.15)***
Weekend day		
AM	0.74 (.04)	0.80 (.06)
Midday	1.06 (.06)	1.08 (.06)
PM	1.08 (.07)	1.07 (.06)
Average weekend day	2.86 (.15)	2.92 (.16)
Average day	2.59 (.12)	3.17 (.14)**

Note: Parent estimates weighted to parents. Adolescent estimates weighted to adolescents. ** p<01; *** p<001.

Table 3. Effects of parental environment and media access on problematic internet use among 12–17 year old adolescents (n=595).

Adolescent sample	**b (SE)**
Parent variables	
Parental monitoring	**-0.15 (.06)**
Parental mediation (internet)	**-0.09 (.04)**
Relationship quality	**-0.18 (.07)**
Media time and access variables	
Bedroom computer with internet access	0.004 (.07)
Average daily time (hours) spent using a computer—adolescent report	**0.06 (.02)**
Average daily time (hours) spent using a computer—parent report	0.01 (.02)
Demographic and personality variables	
Child gender (Female)	0.04 (.06)
Child age	-0.002 (.02)
Parent race (referent: White)	
African American	**-0.19 (.09)**
Hispanic	-0.03 (.08)
Other	0.04 (.21)
Sensation seeking	0.08 (.05)
Impulsivity	**0.21 (.06)**
Interaction: Adolescent report of time * Parent report of time	**-0.01 (.00)**

Note: Bolded values are statistically significant at p<.05. The unstandardized regression coefficients reported in this table were estimated prior to inclusion of the interaction term.

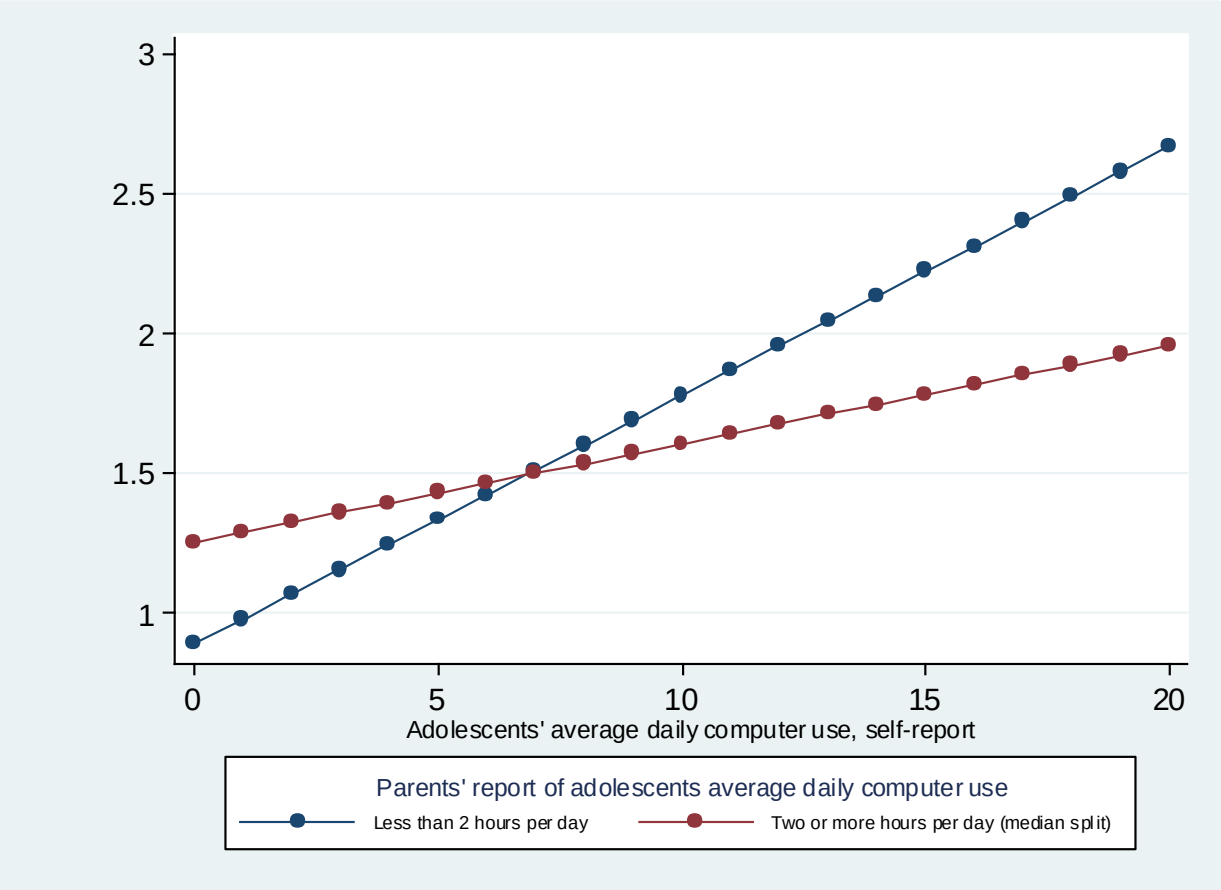

Figure 2. Interaction of parent and adolescent time estimates of computer use on problematic internet use. Note: A median split is used for graphing purposes. Both variables were treated as continuous in the interaction term. This graph is based on unweighted data.

8. Discussion

The internet and its various uses are featured prominently in the media lives of youth. Accompanying their use is a concern about misuse and/or overuse of the internet in ways that would be considered problematic. In a national sample of adolescents from the United States, we found that some symptoms of problematic internet use are quite common (i.e., staying online longer than anticipated), especially among white youth, but only about 10% of the sample reported any occurrence of all 4 problematic behaviors. However, parental monitoring, parental mediation, and better relationship quality were associated with less problematic use, and parents' perceptions of their adolescent's time also mattered for some teens as well.

These results provide evidence that problematic internet use is associated with potentially modifiable home environment factors. Parental monitoring, for instance, is consistently associated with less risky behavior (e.g., Borawski et al., 2003) and media use (e.g. Vaala & Bleakley, 2015). Among this sample of youth, teens who reported increased parental monitoring was less likely to report problematic internet behaviors. However, parental monitoring as perceived by the adolescent is often considered to be an indicator of an adolescent's willingness to disclose information about their lives (Kerr et al., 2010; Stattin & Kerr, 2000), and this view is supported by the moderate correlation between parental monitoring and perceived relationship quality. There was a similar relationship with parental mediation activities, as parents who monitor their adolescents' media use and time may have greater concerns about media in general. Youth who reported increased mediation, which included blocking certain websites, restricting time, tracking internet use and co-use of the internet, were also less likely to report problematic behaviors. This is consistent with some studies (Khurana, et al., 2014; Kirwil, 2009; Livingstone & Helsper, 2008) but not with others that found some mediation strategies to be associated with a greater amount of online risky activities (Sasson & Mesch, 2014). Better parental relationship quality was also associated with fewer symptoms of problematic internet use. Overall, these findings suggest that adolescents engaging in problematic internet use live in families with less connection to and support from parents. It could be that youth who have poorer relationships with their parents turn to the internet to compensate, or that problematic use weakens or strains the parent-teen relationship.

Unlike parental monitoring, mediation, or relationship quality, parental estimates of their adolescents' report of their time spent with a computer was not significantly associated with problematic internet use. Instead, parent estimates were only relevant to problematic internet use in instances when adolescents spent more time with a computer than their parents estimated (i.e., their parents underestimated their time). It is unclear what a parent's underestimate represents. Post hoc analysis suggested that the differences between parental and adolescent estimates were not significantly correlated with either adolescent or parent reports of parental monitoring, parental mediation, or relationship quality. Thus, this predictor appears to reflect a general lack of awareness of the teen's computer use. Essentially, it seems that adolescents in homes in which parents engage in less monitoring, less mediation, have a strained relationship with their teen, or are unaware of their teen's excessive computer use are exhibiting more problematic internet behaviors.

Limitations. As with any cross-sectional survey, the direction of the relationships between parental influences and adolescent internet use cannot be determined. Additionally, although the items used to measure problematic internet use were adapted from a standard measure of internet addiction (Young, 1998), without a more comprehensive measure we may be missing key aspects of the construct that could be related to parental influences differently than the relationships we have described here. More research, especially longitudinal designs, are needed to more fully understand the relationships between these variables. The use of self-report to measure problematic internet use, although a common practice, is a limitation as well. Adolescents may not recognize their own problematic behavior as assessed with these measures, or may have over inflated notions about what is problematic, resulting in over or under estimates of problematic use. Finally, although we asked participants about their internet behaviors, encompassing access by both computer and mobile phone, we did not compare the two access points. Smartphones may make it easier for adolescents to access the internet at all times of day and with less parental intervention than computers, and this possibility only grows with the popularity of smartphones. Future research may wish to compare the current findings for internet use on computers and phones.

Conclusion. Problematic internet use is often linked to a myriad of negative psychological, interpersonal, and academic outcomes for adolescents and emerging adults (Caplan & High, 2011; Choi et al., 2009; Jacobsen & Forste, 2011; Ko et al., 2008; Yoo et al., 2004). It is important to understand what conditions are associated with problematic internet use in order to understand how to reduce its prevalence and effects. The present work focused on parental variables such as monitoring, mediation, relationship quality, and accuracy of time estimates to explore how the parental and home context may be related to adolescent problematic internet use. As expected, perceived parental monitoring and mediation of internet use are associated with reduced problematic internet use, as was a better parent-teen relationship. In addition, adolescents who report high computer use but whose parents underestimate their use reported more problematic internet use. These results suggest that the relationship between parents and their teen is an important factor in understanding adolescent problematic internet use and that parents may both reduce as well as contribute to problematic adolescent internet use.

Acknowledgments

The authors would like to thank the Annenberg Public Policy Center for their support of this survey.

Conflict of Interests

The authors declare no conflict of interests.

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Media and Communication (ISSN: 2183-2439)
2016, Volume 4, Issue 3, Pages 35-49
Doi: 10.17645/mac.v4i3.522

Article

Marketing to Youth in the Digital Age: The Promotion of Unhealthy Products and Health Promoting Behaviours on Social Media

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Submitted: 7 December 2015 | Accepted: 11 March 2016 | Published: 16 June 2016

Abstract
The near-ubiquitous use of social media among adolescents and young adults creates opportunities for both corporate brands and health promotion agencies to target and engage with young audiences in unprecedented ways. Traditional media is known to have both a positive and negative influence on youth health behaviours, but the impact of social media is less well understood. This paper first summarises current evidence around adolescents' exposure to the promotion and marketing of unhealthy products such as energy dense and nutrient poor food and beverages, alcohol, and tobacco on social media sites such as Facebook, Twitter, Instagram and YouTube. We explore emerging evidence about the extent of exposure to marketing of these harmful products through social media platforms and potential impacts of exposure on adolescent health. Secondly, we present examples of health-promoting social media campaigns aimed at youth, with the purpose of describing innovative campaigns and highlighting lessons learned for creating effective social media interventions. Finally, we suggest implications for policy and practice, and identify knowledge gaps and opportunities for future research.

Keywords
advertising; alcohol; junk food; social marketing; social media; tobacco; youth

Issue
This article is part of the issue "Adolescents in the Digital Age: Effects on Health and Development", edited by Dan Romer (University of Pennsylvania, USA).

1. Introduction

The digital age, in which youth are increasingly online, presents both challenges and opportunities for influencing their health and well-being. The potential to target and reach young people via online channels, both for companies selling unhealthy products and for institutions trying to positively influence health behaviours, is unparalleled.

The most recent media monitoring data from the Pew Research Centre shows that 92% of 13–17-year-olds in the United States (US) report going online daily, with 56% doing so several times a day and 24% "almost constantly" (Pew Research Center, 2015). Among these 13–17-year-olds, 71% use Facebook, 53% use Instagram, 41% use Snapchat, and 33% use Twitter. In 2014, among 18–29-year-old US internet users, 87% used Facebook, 53% used Instagram, 37% used Twitter, and 34% used Pinterest (Duggan, Ellison, Lampe, Lenhart, & Madden, 2015).

Importantly, the rise of social media has taken place concurrently with changes in the way people ac-

cess the internet; the use of mobile devices which allow access "from anywhere at anytime" mean that people are exposed to marketing messages on social media near or at the point of purchase/decision-making. The Pew youth media study noted that 88% of teens have a mobile phone, with 73% owning or having access to a smartphone; over 90% access the Internet from their mobile device, and those who do so are online more frequently (Pew Research Center, 2015).

By far the most commonly used, and extensively researched, social networking platform is Facebook. In 2013, less than a decade after its launch, Facebook had 1.23 billion monthly users worldwide (Facebook, 2014). While the most comprehensive usage data comes from the US, we also know that in Australia Facebook had 12 million users in 2014 (Ross, 2014); and in the UK more than 40% of 6–14-year-old and 90% of 15–24-year-old internet users were accessing Facebook in 2011 (Winpenny, Marteau, & Nolte, 2014).

Another social networking platform popular with youth is YouTube, an interactive video-sharing site where users can upload their own videos and receive feedback and comments. Youtube is the second most popular social networking site (Pew Research Center, 2014), with over one billion users and video content which reaches billions of views per day (YouTube, 2015). YouTube is particularly popular with adolescents (three-quarters of 12–15-year-olds in the UK watch YouTube [Ofcom, 2014]) and young adults (YouTube reaches more 18–34-year-olds in the US than any cable network [YouTube, 2015]).

In this paper, we first summarise current evidence around youth exposure to the promotion and marketing of three categories of unhealthy products—energy dense and nutrient poor food and beverages, alcohol and tobacco—on social media sites such as Facebook, Twitter, Instagram and YouTube. We then present examples of health-promoting social media campaigns aimed at youth, with the aim of highlighting innovative and effective components of such campaigns.

2. Youth Exposure to Promotion and Marketing of Unhealthy Products on Social Media

There is overwhelming evidence that children, adolescents and young adults are exposed to and influenced by marketing of unhealthy products in traditional media (Anderson, de Bruijn, Angus, Gordon, & Hastings, 2009; Cairns, Angus, & Hastings, 2009; National Cancer Institute, 2008). The Internet provides marketers with an array of new channels and tools for disseminating their messages. However, the advent of social media has fundamentally altered the marketing landscape—moving young audiences from passive recipients of advertising to active participants in the co-creation and dissemination of marketing messages. Unlike traditional forms of advertising that target potential customers with ads, companies that join in the "complex network of relations" of social media "befriend" their customers, which is a particularly appealing approach for companies wanting their consumers to express their personality through brand association (Freeman & Chapman, 2010). In the following sections, we outline how youth are exposed to and interact with messages from companies selling unhealthy food and beverages, alcohol and tobacco on social media.

2.1. Energy Dense and Nutrient Poor Food and Beverages

Childhood and adolescent obesity is a global public health challenge. In the US for example, 34.5% of all 12–19-year-olds are considered overweight or obese and these young people are at high risk of going on to develop chronic health conditions in adulthood caused by their excess weight (Ogden, Carroll, Kit, & Flegal, 2014). The promotion of energy dense and nutrient poor food and beverages on social media is well documented in marketing case studies of successful campaigns. From Oreo cookies (Our Social Times, 2013) to Burger King chicken sandwiches (Colenso BBDO, 2015) and bottles of Coke (Shively, 2014), social media platforms have proven an ideal avenue for brands to experiment with irreverent and highly sharable campaigns (see Figures 1 and 2 for examples of these campaigns). Social media platforms are proving to be an ideal medium for food and beverage companies to engage with young people. A US market research survey found that 63% of 13–32-year-olds have posted a photo on social media of food or drinks they or someone else was consuming, and 57% have posted on social media about what they're eating (YPulse, 2015). The photo-sharing social media site, Instagram, with more than 40% of users aged 16–24 (DMR, 2015), currently has over 71 million posts tagged as #foodporn. Savvy food and beverage companies capitalise on this consumer-driven marketing.

In 2014, it was estimated that social media advertising by food and beverage brands across the 12 top international markets would reach US$3.0 billion (Socintel360, 2014). In the US, the Federal Trade Commission reported that total youth-targeted (age 2–7) food marketing expenditures on new media, including corporate websites, advertising on third-party children's websites, marketing via mobile devices, and social media, increased by $45.9 million from 2006 to 2009, totalling $122.5 million (Powell, Harris, & Fox, 2013). While a broader body of work has assessed the impact of this increase in web-based food and beverage marketing on children, only a small number of public health studies have assessed the content and types of marketing aimed at young people through social media platforms.

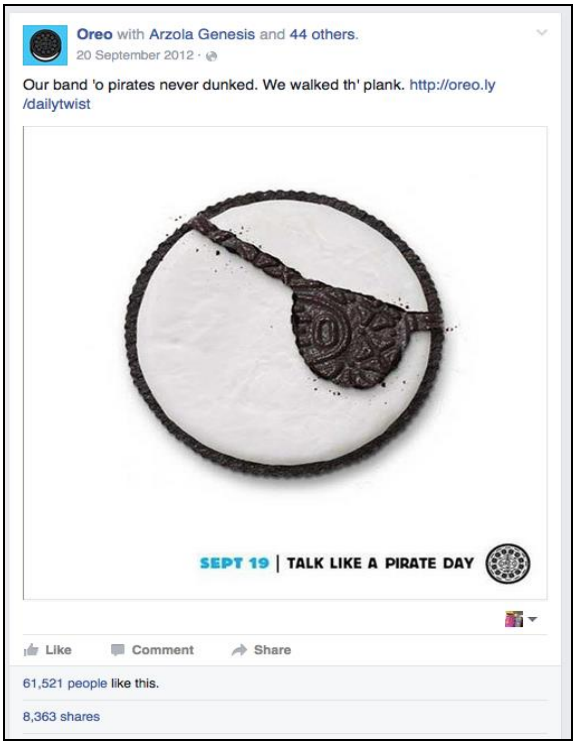

Figure 1. A typical post by the official Oreo cookie Facebook page. Source: https://www.facebook.com/oreo/timeline

Figure 2. The successful subservient chicken campaign by Burger King. Source: http://www.subservientchicken.com

2.1.1. Techniques Employed by Food and Beverage Marketers on Social Media

An Australian study that audited the digital media marketing tactics of three top selling food and beverage brands found that, of the 21 digital promotional platforms employed by the three brands, seven were located on the popular social media site, Facebook (Boelsen-Robinson, Backholer, & Peeters, 2015). The target audience for this digital marketing was deemed to be primarily adolescents aged 13–17 and children aged 12 and under. Common techniques used to engage children and adolescents with these unhealthy food and beverage brands included flash animation, music and games. A more extensive study of the 27 most popular food and beverage brand Facebook pages in Australia found that marketing features unique to social media, such as competitions based on user-generated content that increase consumer engagement, were used widely (Freeman et al., 2014). Twenty-three pages included strong evidence of increased interaction between brand owners and Facebook users, with the page administrators responding directly to user posts, liking and replying to comments made by users, or sharing user posts. Adolescent (13–17-years-old) and young adult (18–24) Facebook users appeared most receptive to engaging with the marketing content. These users were found to willingly spread marketing messages on behalf of food and beverage corporations with seemingly little incentive required.

2.1.2. Exposure to Food and Beverage Marketing on Social Media

Measuring young people's actual exposure to food and beverage marketing on social media platforms and the effect this exposure has on their dietary choices is an urgent public health priority. Exposure to social media advertising has likely increased alongside the increased use of social media and increased spending on social media advertising. A comprehensive 2012 US monitoring study of 18 different popular chain fast-food restaurants found that online display advertising on Facebook alone totalled almost $6 billion and represented 19% of all fast food display advertising (Harris et al., 2013). The individual social media pages of 17 of the 18 fast-food outlets assessed in the study had 1 million or more Facebook likes (compared with nine in 2010), and six had more than 10 million (Harris et al., 2013).

In light of unhealthy food and beverage brands heavily using social media advertising (Montgomery, Chester, Grier, & Dorfman, 2012), public health professionals have called for interventions and polices targeted at protecting children (World Health Organisation, 2010), adolescents (Williams, 2013) and young adults (Freeman, Kelly, Vandevijvere, & Baur, 2015). The predominantly voluntary nature of advertising codes meant to only limit young children's exposure to unhealthy food and beverage marketing has had a minimal impact on their actual exposure to advertising (Boelsen-Robinson et al., 2015; Obesity Policy Coalition, 2011). Additionally, most voluntary codes do not encompass social media platforms as these are seen as primarily targeting adolescents and young adults who fall outside the voluntary codes (Boelsen-Robinson et al., 2015).

2.2. Alcohol

A common finding across countries is that 18–24-year-olds are the age group with the most problematic levels of alcohol consumption. For example, in the US, it has been estimated that over 13 million 18–24-year-olds drank five or more standard drinks in a single sitting at least monthly in 2013 (SAMHSA, 2013). In Australia in the same year, 46% of this age group reported drinking five or more standard drinks in a single sitting at least monthly, including 18% who reported drinking 11 or more (Australian Institute of Health and Welfare, 2014).

There is increasing evidence that alcohol initiation during childhood or adolescence is associated with more problematic drinking in adulthood; and that alcohol advertising is associated with drinking initiation (Anderson et al., 2009; Smith & Foxcroft, 2009). Thus, one of the primary aims of regulatory restrictions on broadcasted alcohol marketing is to reduce youth exposure to alcohol marketing per se and/or to particular messages or appeals in alcohol advertising (Jones & Gordon, 2013). However, it appears that such restrictions, which are typically in the form of industry self-regulation, are ineffective even in traditional media such as magazines and television (Hastings et al., 2010; Jones, Hall, & Munro, 2008; Smith, Cukier, & Jernigan, 2014). Social media provides alcohol marketers with new opportunities for avoiding even these restrictions and engaging with young people (Jernigan & Rushman, 2014; Jones, Robinson, Barrie, Francis, & Lee, 2015).

By far the most researched social networking platform for alcohol-related content is Facebook, with increasing evidence of an association between user-generated alcohol-related posts on young people's Facebook profiles and (problem) drinking (Hebden, Lyons, Goodwin, & McCreanor, 2015; Litt & Stock, 2011; Moreno, Christakis, Egan, Brockman, & Becker, 2012; Ridout, Campbell, & Ellis, 2011). However, alcohol is a common topic of conversation across all forms of social media; for example, studies of Twitter traffic have identified that self-referent drinking-related tweets are common and peak on weekend nights, public holidays and special events (Ramezani, Terdal, Pepper, & Anderson, 2014; West et al., 2012).

2.2.1. The Rules (and Tools) for Alcohol Marketing on Social Media

In the US, industry-specific codes govern alcohol marketing on digital media. The provisions include placement only where at least 71.6% of the audience is of the legal purchase age,[1] requiring age affirmation prior to engagement in direct interaction with a user, and ensuring forwardable content includes instructions not to forward to individuals below the legal purchase age (Beese, 2015). Other countries provide varying degrees of regulation or guidance on the placement of alcohol marketing online, including social media;[2] and there have been calls for a global response to the regulation of online alcohol marketing (Casswell, 2012). In Australia, the industry code (ABAC Scheme, 2014) covers "digital communications (including in mobile and social media and user generated content)"; however, the Code focuses on content rather than placement. ABAC also provides marketers with best practice guidelines, which include age verification—but the document emphasises that "This advice is non-binding…it is intended as guidance to assist advertisers and agencies" (ABAC Scheme, 2014). Finland is one of few exceptions to this process of allowing industry bodies to drive the social media agenda, with a ban on alcohol advertising in social media imposed from the beginning of 2015 (European Centre for Monitoring Alcohol Marketing, 2014).

Facebook requires users to provide their date of birth when they establish a profile (although there is currently no process to verify the accuracy of this information). Alcohol brand pages, advertisements and posts are only made visible to those users whose profiles indicate that they are over the legal age in their country of residence. Twitter does not require age information to establish a profile but offers an age-screening tool for alcohol marketers, which activates a request for date of birth. The follow request is declined if the date entered indicates they are under the legal age in their country of residence. YouTube does not automatically control or block underage access but has a facility that enables brands to require date of birth entry information and/or to limit access to a channel to registered users. As at the time of writing, Instagram does not have an age verification process.

2.2.2. The Extent and Nature of Alcohol Marketing on Social Media

A 2011 analysis of Facebook walls and Twitter timelines of 12 UK alcohol brands found that all had a Facebook page (ranging from 1290 to 1,892,575 likes) and six had a Twitter feed (from 2211 to 27,078 followers) (Nicholls, 2012). Across the month of analysis, there were 701 brand-authored posts; with frequent use of strategies such as real-world tie-ins, interactive games, competitions and time-specific suggestions to drink. A 2012 study of five alcohol brands, also in the UK, found Facebook likes ranged from 70,024 to 183,091; Twitter followers from 47 to 3984; YouTube subscribers from 14 to 11,561 and YouTube video views from 14,837 to 9,351,097 (Winpenny et al., 2014).

An analysis of the Australian Facebook pages of 11 alcohol brands found they had an average of 75,000 likes (range 8,326 to 176,633), the majority of whom stated their age as 18–24, and an average of 33.5 albums and 1,828 photos (Jones, Robinson, & Barrie, 2013). Posts on the brand pages during the six-week study ranged from 4 to 23 by the brand and between 4 and 1,035 for followers. An earlier US study found 93 commercial Facebook pages with more than one million "friends" for top beer brands and 334 pages with more than three million for top spirit brands, with a vast array of applications and activities available through or promoted on these pages (Mart, Mergendoller, & Simon, 2009). A search of drinking-related content on Twitter identified 11,966,381 English-language tweets in a one-month period in 2014; the most common keyword was "drunk" (5,336,372), followed by "beer" (3,444,778) and "alcohol" (1,565,258) (Cavazos-Rehg, Krauss, Sowles, & Bierut, 2015). Analysis of a random sample of 5,000 of these tweets identified that 16% were commercially-generated marketing or promotion.

2.2.3. The Accessibility and Impact of Alcohol Marketing on Social Media

Researchers in the US explored the use of age restrictions on YouTube by creating fictitious profiles of users aged 14, 17 and 19 (Barry et al., 2015). All three (underage) profiles were able to subscribe to the YouTube channels for each of the 16 selected alcohol brands, and on average to view two-thirds of the brands' videos. The same researchers created fictitious Instagram user profiles aged 13, 15, 17, 19 and 21 (Barry, Olunfunto, Martin, & Jackson, 2015). For thirty days, they followed the official Instagram pages of 22 alcohol brands. In addition to being able to follow the pages, they received—direct to their smartphones—an average of 373 advertisements during the month of the study; and comments and requests posted by the underage profiles were responded to directly by the brands' representatives. In a UK study, researchers established fictitious profiles on Facebook, Twitter and YouTube for a 14-year-old and a 24-year-old user (Winpenny et al., 2014). Only the 24-year-old could ac-

[1] Some countries, such as the US, have a legal "drinking age" (consumption of alcohol below this age is an offence) whereas others have a legal purchase age (purchase or public drinking below this age is an offence but drinking per se is not). For simplicity, in this paper the terms "underage" and "over the legal age" are used to indicate being below/above the legal drinking or purchase age (as applicable) in the country of data collection.

[2] A full review of these is beyond the scope of the current paper. Thus, these examples are given for illustrative purposes

cess the Facebook pages of five alcohol brands, but both could access all of the YouTube channels and three of the five Twitter accounts.

A survey of US college students (mean age 21.4 years) found that almost all (96%) used social media (Hoffman, Pinkleton, Austin, & Reyes-Velazquez, 2014). Multivariate analyses showed that participants' interaction with alcohol-marketing on social media, but not their social media use per se, predicted both alcohol consumption and problem drinking. Consistent with these findings, a survey of 283 Australian Facebook users aged 16–24 years found no association between alcohol consumption and general Facebook usage. However, while only 20% of the users had actively interacted with an alcohol brand on Facebook, there was a significant association between active interaction (liking, posting, commenting, or uploading/tagging) and both alcohol consumption and problematic drinking (Jones et al., 2015). An experimental study with US college students (mean age 20.6 years) found an association between attitudes toward alcohol-marketing status updates and drinking intentions (Alhabash, McAlister, Quilliam, & Richards, 2015). Those who reported stronger viral behavioural intentions (such as intending to like, share or comment on the posts) reported higher intentions to consume alcohol; and the strength of this relationship increased when the post had more likes or shares.

2.3. Tobacco

Despite declines in adolescent smoking in developed countries such as the US and Australia, smoking among young adults (18–24 years) continues to be relatively high (16.7% in the US [Centers for Disease Control and Prevention, 2015]) and 23.2% in Australia (Australian Institute of Health and Welfare, 2014), and smoking initiation continues to occur primarily in adolescence or early young adulthood (Australian Institute of Health and Welfare, 2014; Bernat, Klein, & Forster, 2012). Given the depth of the evidence demonstrating the impact of tobacco promotion on tobacco use (National Cancer Institute, 2008), the WHO Framework Convention on Tobacco Control (FCTC) requires a comprehensive ban on tobacco advertising, promotion and sponsorship. The guidelines for Article 13 state that if only certain forms of advertising are prohibited, the tobacco industry inevitably shifts its expenditures to other areas of promotion, especially among young people (WHO Framework Convention on Tobacco Control, 2015). The continually evolving landscape of social media therefore offers a prime opportunity for tobacco companies when advertising in traditional media is prohibited.

Most social network sites have policies restricting the direct advertising of tobacco products. Facebook's advertising policies stipulate that ads may not promote or facilitate the sale or consumption of tobacco products (Facebook, 2015a), with advertisements and commercial content on Facebook fan pages also subject to these guidelines (Facebook, 2015b). Like Facebook, YouTube does not allow tobacco products to be advertised (Google, 2015), however the definition of advertising only applies to *paid* forms of promotion, such as advertisements embedded in videos or advertisements that appear for key word searches.

2.3.1. The Extent and Nature of Tobacco Marketing on Social Media

The most researched social media site in the tobacco control field is YouTube, with many studies describing the prevalence and type of tobacco-related imagery on the site, ranging from product reviews to smoking fetish imagery (Cranwell et al., 2015; Elkin, Thomson, & Wilson, 2010; Forsyth & Malone, 2010; Freeman & Chapman, 2009; Kim, Paek, & Lynn, 2010). An early study analysed the themes and content of the most viewed videos relating to the five leading cigarette brands (Elkin et al., 2010). A majority of the 163 videos had pro-tobacco content (71%), versus a small minority containing anti-tobacco content (3%). Most of these videos contained tobacco brand content (71%) or the brand name in the title (71%). A content analysis of UK Top 40 YouTube music videos showed that tobacco imagery appeared in 22% of the videos, and tobacco branding in 4% (Cranwell et al., 2015). A recent comprehensive analysis of the 70 most popular cigarette brands on YouTube revealed over 120,000 pro-tobacco videos (Liang et al., 2015). The YouTube videos focused on the features of tobacco products (79%), information about Web-based shops (49%), and sales promotion (64%).

Tobacco control researchers have also documented YouTube content related to other tobacco products popular with youth, such as hookah (Carroll, Shensa, & Primack, 2013), cigars and cigarillos (Richardson & Vallone, 2014), and smokeless tobacco or "dip" (Seidenberg, Rodgers, Rees, & Connolly, 2012). The videos featuring cigars and cigarillos had been viewed almost six million times at the time of the study, were most often viewed by males, and several of the videos were most often viewed by 13–17-year-olds. Of note, the analysis of YouTube "dip" videos showed no evidence of restrictions that would block youth viewing or creating the videos.

Fewer studies have analysed the extent of tobacco promotion on other social media sites. Liang and colleagues' comprehensive study of the top 70 popular cigarette brands found that 43 of the brands had created 238 Facebook fan pages, with 1,189,976 page likes and 19,022 posts (Liang et al., 2015). An early study demonstrated that British American Tobacco (BAT) employees were promoting BAT and BAT brands

on Facebook by joining and administrating groups, joining pages as fans and posting photographs of BAT events, products and promotional items (Freeman & Chapman, 2010). The authors noted that, while it is not possible to determine who created those Facebook pages, according to Facebook's policies, these pages should have been created by persons authorised by BAT. Even if they did not create the pages, the fact that BAT employees joined the pages means that the company cannot deny being aware of these promotional activities.

2.3.2. The Accessibility and Impact of Tobacco Marketing on Social Media

Studies of youth show that self-reported exposure to tobacco content on social media is common. Data from the 2011 National Youth Tobacco Survey showed that around 50% of US middle and high-school students had received tobacco ads or promotions via Facebook or MySpace in the past 30 days (Cavazos-Rehg, Krauss, Spitznagel, Grucza, & Bierut, 2014). Of the 32 most popular YouTube music videos containing alcohol or tobacco content, 81% of British adolsecents had seen at least one, and the average number of videos seens was 7.1 (Cranwell et al., 2015).

There is strong evidence that adolescent exposure to advertising and other tobacco media imagery in traditional media increases subsequent tobacco use (Lovato, Linn, Stead, & Best, 2003; National Cancer Institute, 2008). Smoking depictions in mass media can shape behavior through influencing social norms, behavioural modelling, and attitudes toward smoking (Wakefield, Flay, Nichter, & Giovino, 2003). The impact of smoking depictions in social media is likely to differ, given the fact that the content is user-generated and produced by an extended social network ostensibly connected to the viewer. The first known study to specifically assess the role of social media in maintaining or increasing tobacco behaviour among youth used a representative longitudinal panel of 200 young adults (18–24 years) (Depue, Southwell, Betzner, & Walsh, 2015). Smoking at follow-up was predicted by past 30-day exposure to social media tobacco depictions at the baseline survey, controlling for important covariates. The results suggested that social media depictions of tobacco were more important than exposure to TV and movie depictions of smoking in predicting subsequent smoking behaviour. This study did not differentiate exposure to peer-generated or brand-generated smoking depictions, so it is not known whether either of these types of content is more influential.

3. Social Media Campaigns to Promote Healthy Behaviours

Health promoting campaigns on social media offer unique opportunities to target youth, as social media interventions can target individuals within a certain age range. To date, however, there exists very little evidence on the effectiveness of such interventions. In the following section, we outline examples of youth-focused campaigns in this nascent area.

3.1. Healthy Eating

Fighting against the tide of unhealthy food and beverage marketing on social media is a herculean task when public heath budgets pale in comparison to those of international corporations. Social media platforms are also saturated with both content intended to inspire consumers to live healthier, fitter lives and advertisements promoting fad diets (Villiard & Moreno, 2012). A quick scan of Facebook also reveals numerous celebrity-endorsed (for example https://www.facebook.com/12WBT) or commercial (for example https://www.facebook.com/weightwatchers) weight-loss pages. A survey of 15–29-year-olds in Australia measured consumption of three types of health-related social media content on Facebook, Twitter and Instagram, and found that 31% consumed "fitspiration" (fitness inspiration) pages, 14% consumed detox pages, and 23% consumed diet/fitness plan pages (Carrotte & Vella, 2015). Teenage girls made up almost half of all consumers of this type of content. The quality, accuracy and helpfulness of this content varies widely and has just as much potential to be harmful as beneficial to health. Clearly, young people want to access healthy lifestyle content on social media, but in order for public health institutions to break through both the competing commercial voices of the obesity-promoting and weight-loss industries, creative content and resources will be required.

It is commonplace for public health organisations and social marketing campaigns promoting healthy eating behaviours to include a social media page in their outreach and communications efforts, but there is very limited published evidence on the cost, reach, and effectiveness of these efforts. Some small-scale social marketing campaigns to promote healthy eating that incorporate social media platforms have found that people exposed to such campaigns are willing to engage on sites like Facebook and Twitter (George, Roberts, Beasley, Fox, & Rashied-Henry, 2015; Tobey & Manore, 2014). A small study of a Facebook and text message based weight-loss intervention aimed at US college students showed preliminary efficacy and acceptability among users (Napolitano, Hayes, Bennett, Ives, & Foster, 2013). Conversely, a study to promote physical activity amongst students showed no differences in perceived social support or physical activity between those allocated to receive education resources only and those enrolled in a Facebook support

group (Cavallo et al., 2012). Systematic reviews of the effect of social media on changing healthy behaviours include few studies that make use of popular social networking platforms and generally assess adult behaviours (Korda & Itani, 2013; Williams, Hamm, Shulhan, Vandermeer, & Hartling, 2014). While there is enthusiasm and agreement that social media holds much promise for promoting healthy eating amongst young people, this has not yet been born out in the delivery of effective programs or campaigns.

3.2. Alcohol Harm Reduction

It is clear that health promoters lag far behind commercial marketers in the extent and sophistication of their use of social media to communicate with young people about alcohol. Australian researchers undertook a comparative analysis of the Twitter accounts of six alcohol companies and six advocates of safe drinking and/or abstinence in May 2011 (Burton, Clark, & Jackson, 2012; Burton, Dadich, & Soboleva, 2013). They analysed the most recent 200 tweets for each of the accounts and found that the alcohol companies' Twitter accounts had more followers (an average of 8,210) than the advocates (1,956); and that the alcohol company accounts were more likely to use hashtags, and to be re-tweeted. Not surprisingly, they also found in a thematic analysis that the alcohol company posts were more likely to be associated with positive stimuli. While these results should be interpreted with caution due to the differences between the two sets of accounts (such as the difficulty reported in identifying advocate accounts to follow, and the multi-national reach and large budgets of the alcohol companies), the authors' conclusion that pro-health tweeters could learn from the alcohol industry is clearly valid.

However, there are examples of the effective use of social media to bring about positive changes in alcohol-related behaviour, such as the successful "Hello Sunday Morning" (HSM) program. HSM, established in 2009 by Australian Chris Raine, is an online program that encourages people to commit to a period of non-drinking and to blog about their experiences. HSM provides participants with a community where they can share their experiences of not drinking, reflect on the role of alcohol in their lives and the broader society, and provide one another with support to remain "dry" (Pennay, MacLean, & Rankin, 2015). There is evidence that the nature of engagement in HSM makes this program far more than a temporary sobriety program (a limited-time challenge that people may participate in to raise funds or show support for a cause, such as FebFast and Dry July). An analysis of HSM blog posts found that participants start by posting about their goals, current drinking practices, hopes and anxieties about changing their drinking; but over the course of their involvement, move to reflecting on the role of drinking in their lives and their place in a drinking culture, and to providing advice to others commencing the journey (Carah, Meurk, & Angus, 2015). Importantly, research has shown that HSM is not just "preaching to the converted" and engaging those predisposed to oppose excessive alcohol consumption. An analysis of data on over 3000 HSM participants found that 95% engaged in risky or highly risky drinking (Carah, Meurk, & Hall, 2015), suggesting that the intervention has been successful in attracting those who need support to change their drinking.

3.3. Smoking Cessation

Tobacco control practitioners have long recognized the need to counter the prevalence of pro-smoking messages in traditional media with social marketing campaigns discouraging the uptake of smoking among young people and encouraging smokers to quit (National Cancer Institute, 2008). The use of social media platforms to deliver these types of campaigns, however, is in its infancy. Facebook is the social media site most commonly researched in regards to anti-smoking campaigns, with the majority of studies focusing on smoking cessation campaigns targeting young adults. Facebook, integrated into the lives of many young adults, represents a promising strategy to deliver smoking cessation interventions through the use of accessible technologies that enable user-driven participation and interaction (Ramo, Liu, & Prochaska, 2015).

Two Canadian campaigns have utilized social media campaigns integrated with a smart-phone app to encourage smoking cessation among young adult smokers. Visitors to the Break It Off (BIO) campaign website (www.breakitoff.ca) could upload a video of their "break-up with smoking" experience as well as announce their break-up status to friends via Facebook (Baskerville, Azagba, Norman, McKeown, & Brown, 2015). In the first four months of the campaign, total visits to the website were 44,172, there were 3,937 installations of the app, and 339 interactions via social media components (Facebook and YouTube). The evaluation of BIO compared quit rates among users of the campaign materials and users of the telephone quitline of the same age (Baskerville et al., 2015); BIO users had significantly higher 7-day and 30-day quit rates compared with users of the quitline. The Crush the Crave campaign was promoted through Google and Facebook ads from April 2012 to April 2013 (Struik & Baskerville, 2014). The campaign Facebook page had 34,690 likes and a total reach of 7,282 people. The total number of people who clicked on, liked, commented on, or shared Crush the Crave Facebook posts averaged 4000 per week. User engagement in terms of likes, comments, and shares averaged 70 per post. An analysis of the content posted to the Crush the Crave Facebook page suggested that people who commented on posts were highly engaged and that the majority of comments (77%) showed support for

cessation (Struik & Baskerville, 2014).

Finally, "Picture Me Smokefree" was a pilot study using Facebook for a "photo-group" for young adult smokers and quitters (Haines-Saah, Kelly, Oliffe, & Bottorff, 2015). Being enrolled in the study involved posting photos in a closed group in order to reflect on their smoking, their habits related to continued smoking, and the benefits of and reasons for quitting. Young adults' frequent use of mobile phones to access social networking permitted ease of access and facilitated real-time peer-to-peer support across a diverse group of participants. Nonetheless, considerable challenges with recruitment, participation, and retention were also highlighted.

4. Implications and Future Research

4.1. Methodological Challenges

It is clear that accurately measuring youth exposure to the marketing of unhealthy products on social media is a major challenge for researchers in this area. The tools available to track youth exposure to advertising in traditional broadcast media, such as Target Audience Rating Points, have not yet been adapted for digital advertising, and are not likely to be appropriate for studies measuring exposure to social media marketing. To date, studies have used data on marketing expenditure, number of Facebook pages, likes, shares, and comments as proxies for how many people are likely to be exposed, but each of these are likely to over or under-estimate actual levels of exposure. Additionally, since data on these metrics are usually aggregated, it is very difficult to ascertain the age of those exposed in this manner. The nature of online environments is such that age itself is very difficult to ascertain; for example, you are required to be aged 13 or over to have a Facebook page but there is currently no verification of the age of Facebook members.

Researchers in this field need to keep abreast of the development of tools to more accurately track exposure to social media marketing. Some studies have asked youth directly about how much marketing or promotion they are exposed to on social media, but given the nature of social media marketing (peer-to-peer, user-generated content that may not be recognised as "advertising"), youth are likely to underestimate their levels of exposure. One study has used the innovative methodology of creating fictitious Instagram profiles for youth and tracking their exposure to advertising on that platform (Barry, Olunfunto, et al., 2015). This methodology could be expanded to other platforms in order to provide "case-studies" of how and when youth are exposed to unhealthy marketing.

4.2. Policy and Regulation

Despite social media company policies that ban the promotion of tobacco products on their sites, and industry-based codes of conduct to restrict marketing of alcohol and unhealthy foods and beverages to youth, it is clear that youth exposure to innovative and enticing promotions for these products is common and increasing. These policies are failing to protect young people as they require constant social media monitoring; this, coupled with the explosive growth of content on social media, means such monitoring is near-impossible (Nicholls, 2012). It is evident that merely extending existing regulatory codes to include advertising on the Internet and social media is not an effective approach to reducing youth exposure to this increasing barrage of commercial messages. Further, extending existing guidelines that were developed for traditional media ignores the unique aspects and challenges of interactive digital marketing (Hastings & Sheron, 2013; Nicholls, 2012). Most notably, advertising messages in new media are not static communications passively received by their audience, but are co-created with and amplified by consumers (Jones et al., 2015).

Protecting young people from exposure to inappropriate promotion of unhealthy products should be a priority of governments, given the substantial evidence that early and cumulative exposure is associated with increased consumption and long-term harms. Given the challenges in enforcing self-regulation regimes, there have been calls for a complete ban on social media marketing for alcohol (Hastings et al., 2010), and calls for the development of WHO FCTC guidelines for effectively restricting tobacco promotion on social media (Freeman, 2012). Finland's unprecedented ban on alcohol branded social media communications is an example of the type of regulation that can be enacted.

One of the most crucial issues to be considered when regulating advertising of harmful products in social media is whether the content is commercial in origin or is genuinely generated by consumers acting independently (Freeman, 2012). The goal of any such regulation should be to prevent commercial companies from enticing new users, not to prevent consumers from voicing their authentic opinions. The Finnish legislation prohibits the promotion of mild alcoholic drinks with campaigns in which consumers are invited to participate in games, lotteries or contests (European Centre for Monitoring Alcohol Marketing, 2014). Additionally, while citizens' personal communications are not restricted, content produced or shared by consumers—including posts, photos, video clips or ads—are no longer allowed to be used in advertising. Evaluating whether the legislation reduces the exposure of Finish youth to attractive alcohol messages will be an important avenue of future research.

4.3. Social Marketing Campaigns

The extent of marketing on social media by commercial brands that threaten public health dwarfs that of public health agencies. This is due in part to the global scope of many of the most popular brands on social media, effectively leveraged to their advantage. These social media marketers are creating and curating fresh content on a near-daily basis that can then be adapted and broadcast across borders. Social media campaigns promoting health behaviours, on the other hand, are largely driven by local efforts that target an audience within a small jurisdiction. This narrow reach, and a tendency towards short-term campaigns, will clearly limit the ability of such campaigns to compete with global brands promoting unhealthy products with budgets in the millions of dollars.

The World Health Organization recently called for more research on the effectiveness of social media interventions for behaviour change (World Health Organization, 2011). While evidence for the impact of such campaigns is growing, much more research needs to be done on which types of social media campaigns are most likely to be effective, and for whom. Formative research should explore how social media is used by different target audiences. For example, if a campaign or intervention aims to recruit youth to an active social media group, formative research should also be conducted to determine the types of groups that youth are willing to join and remain engaged with. For some behaviours, such as smoking cessation, it appears that private groups might be more popular than open groups (Haines-Saah et al., 2015; Ramo et al., 2015).

Other questions for maximising the impact of social media campaigns relate to implementation; for example, what is the dose needed to produce the desired behaviour change, and what are the design features that encourage deeper engagement with a social media campaign? Some researchers have suggested that engagement and retention might be influenced by incentives for participation, gaming activities, or activities that emphasise socialising (Ramo et al., 2015). Others have suggested that engagement can be increased by encouraging target audiences to create their own campaign materials and post them on social media (Dooley, Jones, & Iverson, 2012). The supportive nature of social media groups also appears to be an important factor in the appeal and success of a campaign. This can be established through the tone of moderator posts and responses, positive reinforcement, and the encouragement of sharing personal experiences.

5. Conclusions

The digital age offers unprecedented opportunities to reach and engage with youth, for whom social media use has become a routine daily activity. The ability to target youth, and to create content that encourages them to engage with and share campaign materials, brings a new dimension to campaigns aimed at improving the health of adolescents and young adults. At the same time, the huge advertising budgets of global commercial brands allow them to experiment with new and exciting ways to entice youth to think about, share information about, and try products which are detrimental to their health. Adequate and effective regulation of social media advertising that may have a negative impact on young people, while possible, presents many challenges. In the absence of effective regulations, it is important that young people and their parents are educated about the extent and nature of marketing on social media so that adolescents can develop into media-literate consumers.

Acknowledgements

Sandra Jones is funded by an Australian Research Council Future Fellowship (FT120100932). Becky Freeman is funded by a fellowship from the Australian National Health and Medical Research Centre.

Conflicts of Interest

The authors declare no conflict of interests.

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Media and Communication (ISSN: 2183-2439)
2016, Volume 4, Issue 3, Pages 50-59
Doi: 10.17645/mac.v4i3.529

Review

Social Media and Alcohol: Summary of Research, Intervention Ideas and Future Study Directions

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Submitted: 14 December 2015 | Accepted: 16 March 2016 | Published: 16 June 2016

Abstract
Alcohol content is frequently displayed on social media through both user-generated posts and advertisements. Previous work supports that alcohol content on social media is influential and often associated with offline behaviors for adolescents and young adults. Social media may have a role in future alcohol intervention efforts including identifying those at risk or providing timely prevention messages. Future intervention efforts may benefit from an affordance approach rather than focusing on a single platform.

Keywords
adolescents; alcohol; college students; Facebook; social media; young adults

Issue
This review is part of the issue "Adolescents in the Digital Age: Effects on Health and Development", edited by Dan Romer (University of Pennsylvania, USA).

1. Introduction: Social Media and Adolescents

Social media are often described as media that are interactive, allowing exchange and modification of information between creators and consumers. Social media are defined as "forms of electronic communication through which users create online communities to share information, ideas, messages and other content" (Merriam-Webster, 2015). Social media include social networking sites such as Facebook, Instagram and Twitter, which are accessible via web-browsers or dedicated mobile applications (apps), as well as apps that promote interaction such as multiplayer games; these formats are diverse and yet share many similar features. The multi-directional nature of social media communication differentiates social media from traditional mass media, traditional video games, and from the earlier days of the internet when websites generally provided content in a one-directional manner (Kaplan & Haenlein, 2010).

Social media are hugely popular and frequently accessed by adolescents and young adults (Duggan, Ellison, Lampe, Lenhart, & Madden, 2014; Lenhart, 2015). Adolescents have been dubbed the "digital generation" or "digital natives" given that they have grown up with access to computers and the internet from an early age (Palfrey & Gasser, 2012). Today, over 90% of adolescents report going online every day and almost a quarter of teens report that they go online "almost constantly" (Lenhart, 2015). In most cases, a social media user creates an account, links to a network of other individual users or groups, and uses the site or app to share content with and access information from other users (Kietzmann, Hermkens, McCarthy, & Silvestre, 2011). Adolescents typically interact with several favorite social media sites, and thus maintain a "social media portfolio" including social networking sites such as Facebook, photo sharing sites such as Instagram and blogging sites such as Tumblr (Lenhart, 2015).

The evolution of social media over the past decade

has provided adolescents with numerous benefits, including access to information, social support and far-reaching communication tools (Ellison, Steinfield, & Lampe, 2007; Ellison, Steinfield, & Lampe, 2011; Valenzuela, Park, & Kee, 2009). Social media can provide enhanced opportunities to explore and experiment with one's identity and social networks. There are also risks to technology use which include overuse at the expense of offline activities, exposure to inappropriate content and negative social interactions such as cyberbullying (Collins, Martino, & Shaw, 2011; Mitchell, Sabina, Finkelhor, & Wells, 2009). Both these risks and rewards have been amplified over the past five years as it has become normative for most adolescents to access these spaces 24/7 from their pocket using mobile devices (Lenhart, 2015).

This paper will focus on the intersection of alcohol content and social media, as the majority of research regarding health risk behaviors and social media has been focused in this area.

2. Alcohol Content Displayed on Social Media

Social media are a source of exposure to two important sources of influence associated with youth alcohol use—peer alcohol behavior (Ali & Dwyer, 2010; Mundt, Mercken, & Zakletskaia, 2012) and alcohol advertising (Jernigan, 2006, 2011). Thus, adolescents may be exposed to alcohol content created by peers as social media users, or advertisements created by corporations and designed to be influential in the social media context.

2.1. User-Generated Alcohol Content

Content posted by adolescents and young adults is likely to be seen by peers as well as potentially viewed by younger users of these sites. Studies in this area have examined a variety of social media platforms, early studies in this area focused on MySpace and Facebook. Several studies have illustrated that adolescents' displays on these two sites frequently include portrayal of health risk behaviors related to alcohol, other substances, and sexual behaviors (Hinduja & Patchin, 2008; McGee & Begg, 2008; Moreno, Parks, & Richardson, 2007; Moreno, Parks, Zimmerman, Brito, & Christakis, 2009). Alcohol displays may include text (i.e. "got soooo drunk last night"), photographs depicting alcohol consumption, or links to alcohol-related groups or companies (Egan & Moreno, 2011; Moreno, Briner, et al., 2010).

Early studies in this area found that adolescents who displayed health risk behaviors on social media did so in patterns that were consistent with patterns of offline reporting by adolescents. For example, adolescents who display one health risk behavior on social media, such as sexual activity, are more likely to display other behaviors such as alcohol use (Moreno, Parks, et al., 2009). Further, a previous study found that adolescents were more likely to display references to sexual behavior if a peer displayed similar references (Moreno, Brockman, Rogers, & Christakis, 2010). Thus, risk behaviors may be displayed online within peer groups, just as offline peer groups commonly report engagement in similar behaviors. While displayed health risk behaviors are common on social media sites, negative consequences of these behaviors are not frequently noted. One study of older adolescents found that displays of negative consequences of alcohol use, such as hangovers or embarrassment, on social media were rare (Moreno, Briner, et al., 2010).

As new social media sites such as Twitter and Instagram have emerged, a small number of studies have examined alcohol-related content on these sites. A study of Twitter found that the majority of content was positive towards alcohol and that most content was generated by individual users rather than companies or corporations (Cavazos-Rehg, Krauss, Sowles, & Bierut, 2015). Previous studies in other health-related areas have illustrated that Twitter can be used to identify alcohol-related behaviors or intentions across populations (Chew & Eysenbach, 2010; Signorini, Segre, & Polgreen, 2011). One study examined keywords that are synonyms for the word *drunk* among a sample of over 5 million tweets from users selected to be geographically representative of the U.S. Tweets related to intoxication peaked between the hours of 10pm and 2am in the user's local time, and were more prevalent on Friday and Saturday nights (West et al., 2012). They also found the proportion of all tweets that were intoxication-related over the New Year's holiday weekend was 0.53% compared to 0.34% during non-holiday weekends. These findings parallel studies that emphasize the increased risk for alcohol problems that occur during holidays and other specific events (Neighbors et al., 2011). These studies illustrate that social media can be used to identify times in which high-risk behaviors are escalated, which may be valuable targets for interventions.

2.2. Unregulated Marketing on Social Media

In addition to user-generated content, young people are exposed to alcohol advertising on social media. There is growing concern about the extent to which adolescents and young adults are exposed to alcohol marketing on social media websites. Research from both the US and the UK indicate that the major alcohol brands maintain a presence on Facebook, Twitter, and YouTube (Jernigan & Rushman, 2013; Winpenny, Marteau, & Nolte, 2013).

Analysis of social media marketing for leading alcohol brands in the United Kingdom indicated certain tactics were most common, including promoting an

offline branded event (e.g. at a club or sporting event), interactive games, sponsored online events, and invitations to drink (Nicholls, 2012). Social media present a concerning new venue for alcohol advertisers given their ability to target messages to particular users and creating lasting connections with consumers (Jernigan & Rushman, 2013), which can lead to increased positive attitudes, intentions or behaviors towards alcohol. Software is available that could allow alcohol brands to ask for age verification before a user can become a follower of the brand account. Such software typically requires the user to enter a birth date, if the birth date shows that the user is not over the legal age to purchase alcohol then the user cannot access the site. However, a recent inquiry into alcohol-branded sites found that none used any third-party age verification beyond self-reported age (Jernigan & Rushman, 2013).

A recent study evaluated alcohol marketing on Twitter and Instagram using 20 fictitious profiles with ages between 13 and 21 years (Barry et al., 2015). In all cases, the user profiles could access, view and interact with alcohol industry content on both Twitter and Instagram. On Twitter, only the profiles that reported age 21 could "follow" an alcohol industry page, and these pages received almost 2,000 tweets in the month of evaluation from those companies. There were no age restrictions in following alcohol brand content on Instagram. Thus, the authors concluded that accessing industry-sponsored alcohol content on these two sites is easily available to youth of all ages.

2.3. Influence of Displayed Alcohol on Social Media

Decades of research rooted in observational theory have established strong links between what adolescents see and what behaviors they choose (Bandura, 1986). Equally strong are links between traditional media such as television or movies and health behaviors among adolescents (Dalton et al., 2003; Dalton et al., 2009; Gidwani, Sobol, DeJong, Perrin, & Gortmaker, 2002; Titus-Ernstoff, Dalton, Adachi-Mejia, Longacre, & Beach, 2008). Studies have shown that exposure to alcohol, tobacco or sexual behaviors in traditional media is associated with initiation of these behaviors (Dalton et al., 2009; Gidwani et al., 2002; Klein et al., 1993; Robinson, Chen, & Killen, 1998).

However, social media differs from traditional media in that the "stars" and role models presented in social media are usual everyday peers, and emulation of a peer may feel and be more achievable than emulation of a movie star. Thus, social media combines the influence of peers and that of media, and thereby represents a powerful motivator of behavior. A previous study found that adolescents who view alcohol references on their peers' Facebook profiles find these to be believable and influential sources of information (Moreno, Briner, Williams, Walker, & Christakis, 2009). Further, adolescents who perceive that alcohol use is normative based on Facebook profiles are more likely to report interest in initiating alcohol use (Litt & Stock, 2011).

The Facebook Influence Model was developed through a Concept Mapping Process involving adolescents and young adults as stakeholders (Trochim & Kane, 2005). This validated process includes several steps of data collection and synthesis applying stakeholder input. The final product is a Concept Map, a visual map showing key concepts and how they relate to each other. The Facebook Influence Model includes 13 clusters that illustrate ways in which Facebook is influential; clusters include "influence on identity", "connection to people" and "social norms." Table 1 describes the cluster names and example items within each cluster. One young adult participant described that "uploading photos contributes to setting the social norm. I don't think we upload photos to set social norms, we upload photos to share and connect with other people and a byproduct of that is setting social norms" (Moreno, Kota, Schoohs, & Whitehill, 2013). While more information is clearly needed to understand the influence of social media on health risk behaviors, these early studies provide support for further research.

3. Associations between Online Content and Offline Behaviors

An adolescent posts on Facebook: "Coors is my favorite beer!" The media practice model describes that youth seek out media that represent who they are, or who they wish to be (Brown, 2000). Thus, displayed alcohol content may reflect positive attitudes, intentions or behaviors. For the post regarding Coors, this may mean that an adolescent has engaged in alcohol use, hopes to engage in alcohol use, or wishes to impress peers. Previous studies have investigated the meaning of these posts to the youth who display them. In one study, older adolescents whose Facebook posts suggested problem drinking behaviors were more likely to score as at risk on a problem drinking screen (Moreno, Christakis, Egan, Brockman, & Becker, 2011). Another study examined college student posts on Facebook about attending an alcohol-themed event and found that these students were highly likely to attend that event and drink at levels above the binge drinking threshold (Moreno, Kacvinsky, Pumper, Wachowski, & Whitehill, 2014). Interestingly, in this study many college students displayed their intention to attend the event prior to the event taking place, suggesting that this displayed information could be used by universities to send targeted prevention messages to these students.

Table 1. Clusters and concepts within the Facebook Influence Model.

Key groups	Clusters	Example items within cluster
Connection	Accessible and adaptable	-Largest network in human history -Easy to use and navigate -Widely known and talked about
	Information and data	-Huge database of information -Compiled data from millions of individuals -News feature
	Promotion: Events, groups and networking	-Ability to plan influential events such as protests or sit-ins -Statuses provide a way to blog instantly about events or political topics -Every company uses it to promote business or provide deals
	"Everyone you know has it"	-Allows people to constantly stay updated with other's lives -Way to get to know acquaintances almost instantly -Keep in touch with people you wouldn't call or text
	Far reaching	-Ability to reach many people with one website -Can reach anyone, young and old, rich and poor -Bonding across cultures and distances
	Fast Communication	-Feel connected and in the loop constantly -Puts everyone you know and what they're doing in one place -Updates on people's lives faster than with a cell phone
Identification	Identity construction	-Freedom to express things and let it be heard -Present the best side of yourself -Show off accomplishments to everyone you are friends with on Facebook, not just close friends
	Identity reflection	-Provides others with pictures that can influence perceptions -Display aspects of yourself that you wouldn't share in offline life (sexuality, substance use) -Wonder if you should be doing what you see everyone doing in pictures
Comparison	Curiosity about others	-Can know what people are up to without asking them about it and without them knowing you know -Creep culture -See who associates with whom with pictures and comments
	Unique aspects of Facebook that impart social norms	-Reinforces beliefs or opinions by seeing that others hold same beliefs or opinions -Can see what is popular by observation -Can follow norms
Facebook as an experience	Distractions	-Procrastination -Addictive -Huge distraction
	Positive experiences	-Facebook is referenced in daily life -Provides entertainment at any time -Status updates can promote a good mood
	Negative experiences	-Changes the nature of communication from face-to-face to screen-to-screen -People willing to sacrifice privacy -Inspires competition in people

A recent study examined underage college students' initial, or first-time, alcohol displays on Facebook and found that location of a post on the Facebook profile mattered when interpreting its meaning (Moreno, Cox, Young, & Haaland, 2015). Displaying an initial alcohol reference as a cover photo or profile picture was associated with multiple binge drinking episodes in the past month. In contrast, displaying an initial alcohol reference as a Facebook "like" was less likely to identify a student engaging in binge or problematic alcohol use. In this study, photos were generally more likely to identify problem alcohol use compared to text-based information.

4. Potential Role for Social Media in Alcohol-Related Interventions

Despite the use broad reach of social media, the literature is scant on interventions using social media to reduce harmful alcohol consumption. Consideration of previous work can be used to suggest future directions for social media interventions.

4.1. Facebook

Based on previous work that illustrates links between displayed alcohol references and self-reported alcohol behaviors on Facebook (Moreno et al., 2011), one possible avenue for intervention could involve identifying individuals who may be at risk for alcohol-related problems based on the social media content they post. These displays may represent innovative means to identify at-risk individuals and prompt them to undergo further screening and intervention. Further, approaches could establish friending links with at-risk individuals so that ongoing monitoring and two-way communication is possible.

Few studies have been done in this area, a previous intervention using MySpace found that a message from a physician was successful in encouraging adolescents to remove sexual content from their public profiles, but did not affect substance use content (Moreno, Vanderstoep, et al., 2009). Important issues to consider for interventions targeting unique individuals include consideration of changing behaviors posted on social media, as in the previous intervention example, versus changing behaviors offline. Further considerations include how to identify individuals given variation in privacy settings and the fact that the identity of social media users is not always known.

Facebook also provide opportunities to link user-generated content to triggered Facebook advertisements. The Facebook Influence Model describes the influence of "identity development" on Facebook, and interventions could build upon this source of influence (Moreno, Kota, et al., 2013). Researchers could consider linking Facebook advertisements to a user's displayed alcohol content. The advertisement could provide messages for a user to consider whether they want alcohol content as part of their online or offline identity. For example, an advertisement could be triggered by keywords related to "intoxication" on Facebook, and could include a message such as "Do you really want being drunk to be part of your identity?"

4.2. Twitter

The relatively large volume of public content on Twitter raises the possibility of an automated search system that would identify tweets indicating risk of alcohol-related problems and respond with a link to resources or services. An ongoing study to determine feasibility of responding to tweets mentioning the words such as "drink," "drunk," "drunk drive," found that unless the sender of the tweets is already a follower (or followed by) the targeted user, any tweets with a link are blocked by Twitter's spam filter (Whitehill, Moreno, & Rivara, 2014). Thus, the possibility of a public health agency conducting such an effort may be limited. However, additional creative approaches may include enlisting influential Twitter users, such as musicians or celebrities, or even users with a wide social network, to promote public health efforts. Further efforts to understand and test the ability to use various social media sites for automated two-way communication to reduce alcohol risk are needed.

4.3. Social Media Advertisements

Another possible approach is to use social media for social marketing. In this way, social media could be used in a similar way that traditional media outlets have promoted responsible alcohol use and increased awareness alcohol-related harm. Advertisements could be pegged to the same keywords used by alcohol beverage advertising, with the goal of reaching the same target audiences and providing educational messaging or links to online interventions.

While the possibilities of achieving targeted, far-reaching and cost-effective interventions with social media is compelling, more research is needed to understand key factors that would make these intervention approaches acceptable to adolescents and young adults.

4.4. Partnering with Adolescents and Young Adults

The world of social media—including evolution of new sites, new hashtags and new adolescent slang terms—moves fast. Thus, partnering with adolescents and young adults in the design of studies and interpretation of findings is critical. A previous study examined young adults' preferences for use of social media in research and found that approximately three quarters of participants were supportive of using social media for research, and those who had concerns often cited privacy as a central issue (Moreno, Grant, Kacvinsky, Moreno, & Fleming, 2012). Another study found that young adults described communication style and approach as critical issues in acceptance of a social media alcohol intervention (Moreno, Grant, Kacvinsky, Egan, & Fleming, 2012). Partnering with adolescents and young adults in the design of studies and interventions is a crucial component of creating tools that are acceptable to the target population.

5. Future Research Directions

Adolescents and young adult are uniquely positioned

to be particularly vulnerable to the effects of social media: they are at once early adopters, nearly ubiquitous users, and highly susceptible to peer influences (Ellison et al., 2007; Lenhart & Madden, 2007; Lenhart, Madden, & Hitlin, 2005; Lenhart, Purcell, Smith, & Zickuhr, 2010). As the field of social media research is still in its infancy, further work is needed in several arenas.

First, studies that expand and deepen observational research on social media sites are needed. Past studies have described content and posting timing on sites such as MySpace, Facebook and Twitter (Hinduja & Patchin, 2008; Moreno, Briner, et al., 2010; Moreno, Parks, et al., 2009; West et al., 2012). However, studies that fully harness the social aspects of social media by studying interactions between peers, distribution of content through a social network, or interactions between adolescents and adults are needed. Previous work suggested that that "currently research is preliminary and descriptive, and we need innovative methods and detailed in-depth studies to gain greater understanding of young people's mediated drinking cultures and commercial alcohol promotion" (McCreanor et al., 2013). These types of studies would help deepen our understanding of how alcohol content is distributed and shared through networks, and potentially identify intervention partners who have access to and are willing to confront adolescents and young adults regarding displayed references to alcohol.

Second, the interactive nature of social media sites provides new opportunities for interventions. Such interventions must be developed with an understanding of the privacy settings within each network. Only individuals who are able to view the content and comfortable with communicating about it would be able to conduct such an intervention. Understanding whether parents, teachers, college resident advisors, and other influential adults are privy to young people's displays of alcohol content on social media is an area for future inquiry. For example, if a parent sees a reference to problem alcohol use on their child's Facebook profile, it is possible that reference is positively associated with engagement in problem drinking. It is likely that having parent-child communication prompted by that social media reference would be important at that time. Preliminary work has explored communication strategies for these encounters and potential intervention opportunities (Moreno et al., 2012; Park & Calamaro, 2013; Whitehill, Brockman, & Moreno, 2013). However, further work is needed to understand how this knowledge can be translated into clinical practice or educational interventions appropriate to different settings, such as schools, clinics or universities (George, Rovniak, & Kraschnewski, 2013).

Third, in considering future studies and interventions in particular, we need to move beyond focusing on a specific platform and better understand key aspects social media use that transcend these platforms. Affordances are often described as properties of artifacts that can be recognized by users and contribute to their function (Zhao, Liu, Tang, & Zhu, 2013). Perceived affordances can also be conceptualized as "design aspects of objects that suggest to the user how the object should be used," (Zhao et al., 2013). A simple example is that the design elements of a chair suggest to a person that the object could be used for sitting. An affordance approach can be useful for research and intervention design because while popular websites may change, issues that may arise with use of these websites can be predicted by considering key concepts such as anonymity that are inherent in the design of the website (Bazarova, 2011; Choi & Toma, 2014; Halpern & Gibbs, 2013; Steinfield, Ellison, & Lampe, 2008).

Using an affordances approach to understand aspects and functions of sites that cut across different platforms is a promising approach to creation of research studies and interventions that are not focused on a single site. Affordances may include *identity affordances* (Majchrzak, Faraj, Kane, & Azad, 2013), which include whether or not the social media site requires using a real name (or some version of it). Facebook requires a real name, while Twitter and Instagram do not. *Social affordances* include whether the site promotes a sense of belonging to a group, such as a group focused on a particular interest, experience, social group or religion (Lundby, 2011). Further, some social media sites provide specific tools which allow the user to identify members of their group and enhance a feeling of belonging, such as "tagging" (Cook & Pachler, 2012). Hashtags (i.e. content labeled with a # sign) are commonly used on Twitter and Instagram and enhance belonging. *Cognitive affordances* may include using social media tools to expand one's learning. Examples may include increasing awareness of news events using Twitter, seeking out homework-related information on Wikipedia or learning how to play a piano piece using YouTube. These affordances may be particularly useful for adolescents who may not traditionally get exposed to this information offline (Zhao et al., 2013). Using an affordance approach, researchers can identify what types of affordances their intervention approaches utilize, and identify appropriate social media sites for the intervention that feature these affordances.

Finally, in all future studies involving social media sites, attention to two factors will be critical. One is attention to privacy settings on sites and users' expectations for protection of their confidentiality. Previous work has illustrated that older adolescents are willing to interact with others regarding their displayed health risk behaviors on social media sites (Moreno et al., 2012), however, social media sites may vary in users' expectations for privacy. A second critical factor is attention to approaching social media sites with the same ethical and regulatory rigor that is expected in of-

fline studies involving human subjects. Several guidelines have been published that identify best practices in study design and working with institutional research boards (Moreno, Fost, & Christakis, 2008; Moreno, Goniu, Moreno, & Diekema, 2013; Sixsmith & Murray, 2001; Zimmer, 2010).

This paper has focused on the intersection of alcohol content and social media, as the majority of research regarding health risk behaviors and social media has been in this area. However, research on other areas of substance use, such as the legalization of marijuana in two US states, newer substance use practices such as edible marijuana and potentials for participant recruitment and online interventions in the area of drug use also represent important and promising areas of research. Social media can be used to track epidemiologic trends in the growth of new substances using social media chatter as a proxy. A previous study used Twitter to track trends in a viral outbreak (Chew & Eysenbach, 2010). It is exciting to consider the rapid growth in social media and alcohol studies over the past ten years, and the multidisciplinary researchers involved in these efforts. Social media have the potential to enhance our observational studies of alcohol behaviors, and the facilitate creation and dissemination of effective interventions to reduce the harms associated with alcohol use.

Conflict of Interests

The authors declare no conflict of interests.

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Media and Communication (ISSN: 2183-2439)
2016, Volume 4, Issue 3, Pages 60-70
Doi: 10.17645/mac.v4i3.524

Article

Social Media in the Sexual Lives of African American and Latino Youth: Challenges and Opportunities in the Digital Neighborhood

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Submitted: 8 December 2015 | Accepted: 11 March 2016 | Published: 16 June 2016

Abstract
There has been significant interest in the role of social media in the lives of adolescents, particularly as it relates to sexual risk. Researchers have focused on understanding usage behaviors, quantifying effects of social media exposure and activity, and using social media to intervene. Much of this work has focused on college students and non-minority youth. In this paper, we examine the growing body of literature around social media use among US minority youth and its intersection with sexual risk behavior. We introduce the concept of the "digital neighborhood" and examine the intersection of social media and sexual health in two domains: 1) sexual content in social media and 2) evidence of social media effects on sexual behavior. Finally, we discuss the opportunities and challenges for researchers and practitioners engaging youth of color.

Keywords
African-American; digital neighborhood; health disparities; Latino; sexual health; social media; youth

Issue
This article is part of the issue "Adolescents in the Digital Age: Effects on Health and Development", edited by Dan Romer (University of Pennsylvania, USA).

1. Introduction

Despite continued intervention efforts, African American and Latino youth report considerably younger ages of sexual debut and face significantly greater risk for Human Immunodeficiency Virus (HIV) and other sexually transmitted infections (STIs) when compared to their white peers. Health disparities are especially pronounced within the African American adolescent population. In 2011, African American youth accounted for 15% of the US population aged 13 to 19 years, yet they represented 67% of HIV diagnoses in this age demographic (Centers for Disease Control and Prevention [CDC], 2013). African American adolescents are more likely to contract an STI (e.g., Gonorrhea, Chlamydia, or Syphilis) than white adolescents, even when controlling for socio-demographic variables and risky sexual behavior (Centers for Disease Control and Prevention, 2012; Dariotis, Sifakis, Pleck, Astone, & Sonenstein, 2011). While Hispanic youth face a lower risk of HIV/STI infection than African American adolescents, the risks for Hispanic adolescents are still higher than that of white youth (CDC, 2012). Though African American youth are at an elevated risk for HIV/STIs, they also report higher levels of condom use and lower sexual frequency than their white counterparts (Aral, Adimora, &

Fenton, 2008; Hallfors, Iritani, Miller, & Bauer, 2007). These statistics suggest that sexual health disparities are driven not solely by individual behavior, but also by social determinants that shape the context in which youth make sexual decisions (Adimora, Schoenbach, & Floris-Moore, 2009; Aral et al., 2008; Hallfors et al., 2007).

One strategy for addressing health disparities experienced by youth of color is to identify and address the social determinants of sexual health, particularly related to the social context in which sexual decision-making occurs. One prominent yet understudied social determinant is an adolescent's online community, which we term the "digital neighborhood" (Stevens, Gilliard-Matthews, Dunaev, Woods, & Brawner, 2016). We emphasize the digital neighborhood, rather than social media use generally, to reflect the digital space that is instrumental in the lives of adolescents. This digital space serves as a nexus for social relationships, entertainment, and geographic neighborhoods. In this paper, we discuss the digital neighborhood as a source of information about sex and sexual health, as well as the prevalence and types of sexual content in the digital neighborhood, and evidence of social media effects on sexual behavior. We also outline opportunities and challenges for working in the digital neighborhood to conduct public health initiatives for youth of color.

2. Methods

An extensive search of the literature was conducted using a number of academic databases (e.g., Google Scholar, PsychINFO, PubMed). The following search terms were used: teen, adolescent, youth, African American, Black, Hispanic, Latino, minority, race, media, online, internet, social media, Facebook, Twitter, Instagram, social networking, pornography, sex, sexual health, sexual health information, sex behaviors, and sexual health interventions. Studies were included if they: 1) centered on adolescents/young adults, 2) addressed the topics of sex or sexual health and internet or social media use, and 3) were conducted relatively recently (i.e., in the past decade). In addition, we explicitly sought out papers with substantial minority adolescent samples in the United States.

3. Social Media Use and the Digital Neighborhood

Social media are a dominant force in the lives of adolescents. Generally defined, social media are the creation, sharing, and/or communication of content among individuals through digital technologies. It is situated as a unique space where normative influences via social interactions and media influences converge. An estimated 71% of teens use more than one social media site, with Facebook being the most used site (71%), followed by Instagram (52%), Snapchat (41%), and Twitter (33%) (Lenhart, 2015). There are demographic differences in social media use, with female adolescents reporting greater use than their male counterparts (Lenhart, 2015). While use of Facebook is approximately the same across racial/ethnic groups, African American youth report more frequent use of Instagram (64%) compared to white (50%) and Latino (52%) youth. Further, African American youth also report higher Twitter usage (45%) than their Latino (34%) and white (31%) peers (Lenhart, 2015).

Beyond frequency of usage, the role of social media in the lives of minority youth is greatly understudied. The few extant studies on this topic suggest youth of color may use social media in ways that are different from white youth. While most adolescents may use the same social media platforms (e.g. Twitter, Facebook), their activities on these sites and the content to which they are exposed can differ vastly. For instance, recent qualitative findings suggest that low income minority teens report behaviors on social media related to aggression, violence, and sexuality that mirror community level risk factors (Patton, Eschmann, & Butler, 2013; Stevens, Gillard-Matthews, Nilsen, Malven, & Dunaev, 2014). Thus, risk factors in adolescents' offline worlds may be amplified in their online communities, and vice versa. Based on our own work with minority youth, we developed the concept of the "digital neighborhood" to describe these complex online environments and interactions (Stevens et al., 2016).

The digital neighborhood is the online community that adolescents cultivate and are exposed to through their use of various social media platforms. The digital neighborhood parallels that of their built geographic environment and offline social relationships, yet is not completely bound by geography. Unlike the geographic neighborhood, the digital neighborhood is distinct for every youth. Further, just as the built environment can affect health through a variety of mechanisms, the digital neighborhood also influences attitudes, beliefs, sexual opportunities and behaviors. The digital 'hood' functions as a space where youth share and seek out sexual information, as well as a space where people model sex–related behaviors, and where norms are depicted, circulated, and amplified or weakened. As such, we consider the digital neighborhood to be a social, albeit digital, determinant of health. Considering the aforementioned sexual risks (e.g., HIV, STIs) faced by minority youth, it is of vital importance to understand the role of the digital neighborhood in their sexual decision making processes.

4. Sexual Content in Social Media

Adolescents seek out and encounter sexual content online in a number of forms including sexually explicit material, information about sex, sexual health, and sexual norms, and sexual communications via social networking sites. This sexual content may take the

form of text, images, or videos, and the content itself ranges from humorous memes and information about birth control to graphic pornography. The amount, variety, and explicitness of this sexual content varies based on each youth's online behavior and specific digital neighborhood. Considering this miscellany of content, it is important to discuss what types of sexual content adolescents are accessing online, particularly minority adolescents.

The internet serves as an important space for adolescents to obtain information about sexual health. While parents and friends have traditionally been cited as the most common sources of information about sex, the internet is becoming an increasingly popular information source (Bleakley, Hennessy, Fishbein, & Jordan, 2009; Dolcini, 2014; Stevens, Gilliard-Matthews, Dunaev, & Todhunter-Reid, 2015). A recent review found that youth most commonly sought information on the following topics: HIV/AIDS/STIs, pregnancy/childbirth, sex acts/behavior, contraception/protection, information about the body, relationships/social issues, and sexual identity and orientation (Daneback, Sevcikova, Mansson, & Ross, 2013; Kanuga & Rosenfeld, 2004; Simon & Daneback, 2013). Adolescents also used the internet to obtain information that is not traditionally included in sexual education such as pleasure-based sex, masturbation, and sex positions (Daneback et al., 2013). One study using semi-structured interviews with African American adolescents living in low-income neighborhoods in Chicago found that 47% of participants had obtained sexual health information online. Specifically, teens in the study reported seeking out information about HIV/STIs (e.g., testing, treatment, general information), condoms, birth control methods, and sexual communication/relationships (Dolcini, Warren, Towner, Catania, & Harper, 2015).

The internet may serve as a space for adolescents to access sexually explicit material. Sexually explicit websites (SEWs), as defined by Braun-Courville and Rojas (2009), are "X–rated or pornographic websites that either: describe people having sex, show clear pictures of nudity or people having sex, or show a movie or audio that describes people have sex" (p. 157). While general data on adolescents shows that 42% of internet users aged 10 to 17 years report being exposed to online pornography in the past year, these estimates may be higher among minority youth (as cited in Braun-Courville & Rojas, 2009). In a survey among urban Hispanic and African American adolescents (*N*=433), 55.4% of the participants reported having ever visited a sexually explicit website (Braun-Courville & Rojas, 2009).

Third, the proliferation of social media platforms in recent years has given youth new means for sex-related communication and self-expression. A youth's digital neighborhood may be particularly important, considering that it can be a space free from adult surveillance in which youth can experiment with their identities and express themselves in varied ways (Livingstone, 2008). Youth may engage online in a number of ways, including by posting or sharing sexual images or content and by joining groups or relevant discussions. Based on recent studies, it is estimated that between 25%–33% of youth collect and distribute content and information pertaining to sex online (Bobkowski, Brown, & Neffa, 2012; Doornwaard, Moreno, van den Eijnden, Vanwesenbeeck, & Ter Bogt, 2014; Moreno, Briner, Williams, Walker, & Christakis, 2009; Moreno, Briner, Williams, Brockman, Walker, & Christakis, 2010; Moreno, Parks, Zimmerman, Brito, & Christakis, 2009). This content may communicate idealized images, peer norms or model behavior (De Ridder & Van Bauwel, 2013).

The *amount* of sexual disclosure or sexually–explicit material shared on social media also varies substantially between samples of American adolescents. Jordán-Conde, Mennecke, and Townsend (2014) found that of the social media posts made by adolescents during a study, only 4.6% pertained to sexual behavior. In contrast, Moreno, Briner, Williams, Brockman, Walker, & Christakis, (2009) reported that nearly 25% of adolescent social media posts contained sexual references. Further, research suggests females are considerably more likely to self-disclose sexual information than males, both on social media and offline contexts (Allison et al., 2012; Brown & Bobkowski, 2011; Moreno, Parks, et al., 2009). Although African American and Latino adolescents were represented to some degree in the majority of studies under review, these groups typically made up fewer than 25% of participants. Thus, less is known about the behaviors of minority youth in particular on this topic.

Multiple studies also demonstrate that teens are hyper–aware of the public nature of their social media profiles, with users frequently commenting on sexual attractiveness, or lack thereof, when peers post provocative photos (Manago, Ward, Lemm, Reed, & Seabrook, 2015; Ringrose & Renold, 2012; Stevens et al., 2014). This anticipation of appreciative or negative feedback causes some adolescents to avoid posting photos of themselves, while others post sexually suggestive image to gain "likes," in what Magano deems "self-commodification" online (Manago, Graham, Greenfield, & Salimkhan, 2008; Manago et al., 2015; Stevens et al., 2016).

Finally, social media provide youth with a tool for seeking out romantic partners. There are a number of platforms that facilitate these interactions, including online dating sites (e.g., MyLOL.com; bebo.com), geo-social networking sites (e.g., Skout, Blendr, Grindr), sites where youth can engage in sex-based role playing, and apps for sharing sexually–explicit images online (e.g., Snapchat, sexting, emailing nude photos) (Gabarron, Serrano, Wynn, & Lau, 2014; Holloway, Dunlap,

Del Pino, Hermanstyne, Pulsipher, & Landovitz, 2014; Jordán-Conde, Mennecke, & Townsend, 2014; Moreno, Parks, et al., 2009; van Oosten, Peter, & Boot, 2015). While many of these sites are relatively new and thus less is known about adolescent users, there is some preliminary evidence to suggest they are important points for future study. In a sample of youth (*N*=273), Buhi et al. (2013) found that 15% of teens reported meeting someone first online before later having sex with them. Among these teens, 57% reported having met more than one sex partner online. Continued investigation into social media uses is therefore needed as new sites appear, platforms change, and youth usage behaviors evolve, particularly with diverse samples of youth, as these behaviors likely differ based on social and demographic subgroups.

5. Theoretical Paradigms and Mechanisms of Influence

Adolescents' sexual decision making is impacted by various sociocultural influences, including their social environment, parents, peers, neighborhood, and new and traditional media (Bleakley, Hennessy, Fishbein, & Jordan, 2008; Brown et al., 2006; DiClemente, Salazar, Crosby, & Rosenthal, 2005; Stevens et al., 2014). Social media are positioned at the intersection of traditional broadcast media, the social environment, and interpersonal communication between significant others (e.g., peers, sexual partners, and parents), and as such may have a particularly powerful influence. One way that social media may influence adolescents' attitudes and behaviors is by acting as a 'super peer' (Brown, Halpern, & L'Engle, 2005; Cookingham & Ryan, 2015; Moreno, Briner, et al., 2009). Similar to the way one's peers may influence attitudes and behaviors, a "super peer" also conveys social norms and models behaviors, with "super" suggesting an influence that may exceed the influence of traditional peers. Social media sites can act as a super peer, as they are used by youth to create, seek, and share sex-related information and content with known and unknown peers.

The Reasoned Action approach is another useful framework to explain the mechanisms through which the digital neighborhood may influence sexual behavior (Fishbein & Ajzen, 2010). Sexual behaviors (both risky and safe) are influenced by intentions to engage in those behaviors, attitudes toward the behaviors, self-efficacy, and normative beliefs about the behavior. All of these classes of psychosocial predictors—attitudes, norms and self-efficacy—can be influenced through messages and behaviors received via social media.

More recently, Doornwaard, Bickham, Rich, Ter Bogt, and van den Eijnden (2015) proposed a model that integrates receptive (e.g., sexually–explicit material) and interactive (e.g., social media) online behaviors with perceived peer norms (e.g., perceptions of peers approving of sexual behavior or peers being sexually active) for predicting adolescents' sexual behaviors (Doornwaard et al., 2015). According to this model, sexually explicit internet material and social media use affect sexual behaviors both directly and indirectly through perceived peer norms. Also, adolescents' sex-related online behaviors, and their perceived peer norms, are associated with adolescents' levels of sexual experience (Doornwaard et al., 2015). While not extensively tested, this model could prove useful in examining the multiple routes and interrelated influences between sex-related online content and offline sexual behaviors.

6. Social Media Influence on Adolescent Behaviors and Attitudes

A substantial number of studies have examined the influence of the internet on sexual attitudes and behaviors. Several studies have demonstrated associations between exposure to sexual content and a variety of adolescent sexual attitudes and behaviors (e.g., risky sexual behaviors, casual sex, aggressive sexual behaviors) (see Ybarra, Strasburger, & Mitchell, 2014). For instance, Bleakley et al. (2009) found that youth who learned about sex from the internet held stronger self-efficacy beliefs (i.e., belief in one's ability to have sex). However, this study also provides evidence of a reciprocal relationship between sex-related content in media and risky sexual behaviors, whereby sexually experienced adolescents seek out sexual content in their media diets, and more sexualized media exposure is associated with increased sexual activity (Bleakley et al., 2009). Thus when considering these effects, it is important to consider the potential for recursive relationships and reverse causality.

The vast majority of research examining associations between online sexual content and adolescent attitudes and behaviors has focused on sexually explicit material (e.g., internet pornography). Exposure to sexually explicit websites was significantly associated with several sexual risk behaviors including multiple sexual partners, anal sex in general, and sexual intercourse with substance use (Braun-Courville & Rojas, 2009; for review see Owens, Behun, Manning, & Reid, 2012). However, these findings are not without challenge, as other studies have failed to find any association between viewing sexualized online material and age at first intercourse or having ever had intercourse, and condom use (Braun-Courville & Rojas, 2009; Ybarra et al., 2014). While these data are surely important, and exposure to sexually explicit content constitutes an important part of an adolescent's digital neighborhood, the focus of this review is on studies examining the effects of social media sexual content on adolescent sexual attitudes and behaviors.

Experimental and network studies suggest that so-

cial media are particularly influential on perceived norms. In a study of late adolescents (M_{age}=19.2), Young and Jordan (2013) had participants (*N*=49) view profile pictures of their Facebook friends within their college network. These photos had been rated as being low in prevalence of sexually–suggestive content prior to the study. Participants in the control condition completed a questionnaire without viewing any photos. Results indicated that—compared to a no-photos condition—participants who viewed low prevalence profile photos estimated that a larger proportion of their peers both use condoms and intend to use condoms in the future (Young & Jordan, 2013). In the second study of late adolescents (M_{age}=19.6) also conducted by Young and Jordan (2013), participants (*N*=154) were randomly assigned to view sexually-suggestive or non-sexually-suggestive photos taken from Facebook. Results indicated that participants in the sexually-suggestive photo condition, when compared to the nonsexually-suggestive photo condition, estimated that a greater number of their peers engaged in unprotected sex and had sex with strangers. Additionally, participants in the sexually–suggestive photo condition reported greater intentions to engage in these types of behaviors. Taken together, these studies demonstrate that the level of sexual content on social media may affect perceived norms and behavioral intentions (Young & Jordan, 2013). It would be useful to apply similar study methods to understand the ways in which social media may affect normative perceptions related to sex and sexual health among minority youth in particular.

In a study with an ethnically diverse sample, Black, Schmiege and Bull (2013) analyzed the social networks of 1,029 adolescents in 162 non-overlapping networks. They found that adolescents perceived their peers to be engaging in more risky sexual behaviors than they actually were. Adolescents in the study tended to overestimate the prevalence of high-risk behaviors among peers, while under-estimating the prevalence of protective behaviors among peers (Black et al., 2013). Though the study participants were ethnically diverse, potential moderating effects of race were not reported. While this study importantly demonstrates the discordance between adolescents' perceptions of peers' behaviors and peers' actual behaviors, it fails to shed light onto how minority youth's digital neighborhoods may impact their normative perceptions. Research related to normative perceptions suggests that the effects of norms are, in part, determined by perceptions of similarity to the reference group. Given that one's social network is self-constructed, group identity may be particularly strong for youth of color in the context of social media.

A limited number of studies have also examined associations between internet use, including social media use, and actual behaviors. In a sample of African American adolescents, greater general frequency of internet use (which included social media) was associated with a history of oral, vaginal, or anal sex, and sensation seeking (Whiteley et al., 2011). It should be emphasized, however, that this study did not examine the influence of social media independent of other online sources. In another study using an ethnically diverse sample of adolescents (58% white, 16% Hispanic, 15% African American), Buhi et al. (2013) found that meeting a sexual partner online (through social media or other means), compared to adolescents who had not had sex with a partner met online, was associated with increased sexual risk behaviors (e.g., higher number of vaginal sex partners, lower age of sexual initiation) but not incidence of STIs. Thus research should continue to investigate these paths from internet and social media use to sex-related beliefs, norms, attitudes and behaviors, especially among minority youth.

7. Social Media Based Sexual Health Interventions

To the best of our knowledge, there are very few published sexual health interventions that utilize social media as part of the intervention rather than as a recruitment tool. More frequently, interventions incorporate mobile phones, SMS (text) messaging, and web-based components to recruit and retain youth. Of the social media-based interventions that are evaluated, most focus on adults, men who have sex with men, and white or international populations.

Based on the emergent evidence, there is clear potential for effective sexual health promotion interventions that leverage social media. In a systematic review of the impact of social media or text-based sexual health interventions, Jones, Eathington, Baldwin and Sipsma (2014), found that interventions were effective at increasing sexual health knowledge, as well as some evidence of increased condom use (Jones et al., 2014). However, the behavioral effects were mixed and typically short term. Only three of the eleven studies reviewed utilized social media in the interventions while the rest focused on text messaging. Yonker, Zan, Scirica, Jethwani and Kinane, (2014) also conducted a comprehensive review of social media interventions to improve adolescent health (Yonker et al., 2014). Three interventions included significant minority populations (above 50%) and three evidenced short-term increases in sexual risk-reduction behaviors including seeking information about STI testing and increased condom use (Bull, Levine, Black, Schmiege, & Santelli, 2012; Moreno, VanderStoep, et al., 2009; Young et al., 2014). In Young et al's (2014) Project HOPE study, 112 predominately African American men who have sex with men participated in a peer-delivered cluster randomized control trial via a private Facebook page. The intervention was designed to utilize social networks to strengthen connections. The intervention group was significantly more likely to increase their sexual risk–

reduction behaviors. Though this study was conducted with adults, the findings suggest promise for conducting similar work with youth. In a second Facebook-based intervention, Bull et al. (2012) targeted diverse youth utilizing a private Facebook page and a randomized control trial design. There was significant attrition in both the control and intervention groups over the six months post intervention. Participants who received the intervention increased their condom use at two-month follow-up, though the intervention effects waned at six-month follow-up (Bull et al., 2012). In an HIV prevention intervention with homeless youth, Rice, Tulbert, Cederbaum, Adhikari and Milburn (2012) used peer leaders to reach a hard to reach population, utilizing social media to activate and strengthen social networks. These studies highlight the potential for using social media to improve sexual health among youth of color.

8. Opportunities and Challenges

The digital neighborhood is a youth context that offers great promise for conducting both descriptive and intervention research. Social media can be used to describe performance culture, youth norms, and behaviors related to sex and sexual health. It can also be used as a vehicle for recruitment, retention, engagement and intervention. However, working in this domain is not without challenges. The following points enumerate the key opportunities and challenges for work in the digital neighborhood:

8.1. Methodological Challenges

Conducting social media-based research among potentially hard to reach and/or minority populations can present several challenges. The first is determining the appropriate, rigorous, and *feasible* methodological approach. For example, should we adapt social network analyses, socio–linguistic analysis or natural language processing methods for use in this type of research? The evolving nature of social media offers exciting opportunities for researchers from a variety of disciplines to apply their expertise to measuring content, exposure, and potential mechanisms of influence on behavior, as well as the interplay between the digital and offline world.

8.2. Recruitment and Retention

Social media interventions give researchers the opportunity to work with youth across the country and the ability to disseminate information on a large scale. As such, it is an increasingly popular recruitment and retention tool (Allison et al., 2012). Researchers will have to balance the challenges of working in this environment, which include participant verification, target population access, and differential attrition rates. In her sampling strategy, Moreno, VanderStoep et al. (2009) recruited high-risk youth by using residence in high-poverty neighborhoods as a recruitment strategy, treating geography as a proxy for risk. Sampling strategies should be designed with potentially elevated attrition in mind.

8.3. Authenticity of Participants

Social media offer the research and practitioner community relatively low-cost access to youth. The price of this access is the challenge of verifying the authenticity of potential participants. Studies have tried to decrease non-eligible enrollees by 1) enrolling people face-to-face, 2) requiring identification or other forms of authentication (i.e. PayPal accounts), or 3) by removing monetary incentives for participation to dissuade imposters from enrolling (for a detailed description, see Yuan, Bare, Johnson, & Saberi, 2014). An additional challenge arises when analyzing exposure to social media content in a network if network members do not consent to be in the study. It may also be difficult to navigate human subjects protections and institutional review board protocols to conduct sexual health research online with minors, where parental consent may not be feasibly obtained.

8.4. Analysis and Interpretation

Once a sample is obtained, it may be too large for traditional content analysis. Computerized content analysis utilizing techniques such as natural language processing (NPL) show great promise (Wong et al., 2015). However, these techniques focus on social media language in isolation of conversation. Social media posts are often extended dialogues within youth culture and popular culture. It is important to understand the evolving cultural context in order to correctly interpret social media messages. Interpreting social media messaging outside of the social media conversations where such postings occur can lead to "context collapse." Context collapse occurs when the message intended for a small audience loses meaning when interpreted by an outside audience out of context (boyd, 2008). Qualitative coding of a subsample can limit the likelihood of context collapse and provide rich description of the digital neighborhood, but this approach is difficult to execute with large-scale data sets (Patton et al., 2013).

8.5. Intervention

Social media are an important tool in the interventionist's toolbox. They may serve as a complementary component to a face-to-face intervention, a stand-alone intervention, or a method to gather participant feedback on acceptability and feasibility. The aforementioned Bull et al. (2012) and Young et al. (2014)

studies were effective even though they employed a closed social network strategy and did not fully capitalize on the dynamism and social networking. Rice et al. (2012) effectively leveraged the social networks and peer leaders using social media to promote HIV prevention among homeless youth. Though more difficult to test, future interventions that can integrate the unique qualities of social media, including extended networks, super peers, and user–generated content, may be particularly innovative and effective.

8.6. Native Use

Rather than using social media as a message-delivery tool, the next stage of research that leverages native or naturalistic use of these technologies among youth of color is needed. In addition, finding ways to leverage user-generated content into messages that affect behavior change may be particularly persuasive and relevant (Broaddus et al., 2015; Lelutiu-Weinberger et al., 2014).

8.7. Multidisciplinary

Utilizing these dynamic platforms will require the scientific community to work in multidisciplinary teams that include social scientists, practitioners, clinicians, technologists and the youth communities we aim to serve.

8.8 Youth Engaged

To be effective, members of the study population should be integrated into research teams, to help interpret the social media content and to inform the team about cultural norms in the digital environment. Community-based participatory research or youth action research approaches may be particularly useful in this context.

8.9. Digital Neighborhoods Differ

To develop effective interventions, novelty and innovation will be required as well as integration of the target population at the onset to understand native or intrinsic use of new media, the dynamics of particular social networks, and the intersections of race and gender in the digital neighborhood. Social media are not one-size-fit-all, and intersectionality plays a large part in determining the content and quality of one's digital neighborhood. This will affect the amount of risk messaging and health promotive features that youth are exposed to when they log on.

9. Conclusion

Although some progress has been made, more must be done to meet minority youth where they are and improve adolescent sexual health for African American and Hispanic populations in the US. It is important to examine the influence of the digital neighborhood on sexual risk behavior and resilience among youth of color, particularly as we consider best practices using technology for intervention. This focus is particularly relevant in light of the paucity of research on social media-use among youth of color, the pervasive use of social media among the population, and the persistent racial disparities in HIV/STI infection. As can be seen, the data on associations between social media usage and adolescent sexual norms and behaviors is limited. Though the research is nascent, existing interventions suggest promise for utilizing social media to improve sexual health among youth of color. With its great popularity among youth, social media—particularly as used by youth of color—are an understudied youth environment where, implicitly or explicitly, beliefs and attitudes are shared, norms transmitted, and behavior modeled. Given its potential impact on the sexual health behavior of youth, it is important to identify how sex is discussed on social media and to measure the association between social media behavior and sexual risk behaviors among minority youth in order to provide insight to improve adolescent health in communities of color.

Acknowledgments

The authors would like to acknowledge Dr. Dan Romer's helpful comments on an earlier draft of this manuscript.

Conflict of Interests

The author declares no conflict of interests.

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Media and Communication (ISSN: 2183-2439)
2016, Volume 4, Issue 3, Pages 71-78
Doi: 10.17645/mac.v4i3.525

Review

Cyberbullying, Race/Ethnicity and Mental Health Outcomes: A Review of the Literature

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Submitted: 10 December 2015 | Accepted: 12 April 2016 | Published: 16 June 2016

Abstract
Cyberbullying is a relatively new phenomenon associated with the widespread adoption of various digital communication technologies, including the internet and mobile phones. As of 2013, nearly 20% of youths in grades 9–12 in the US reported being traditionally bullied in face-to-face encounters while almost 15% reported being cyberbullied (Kann et al., 2014). Bullying victimization is associated with a variety of behavioral and psychological effects, from becoming bullies themselves (i.e., bully-victims), to poor academic performance, depression and suicidal ideation (Nansel et al., 2001; Wang, Nansel, & Iannotti, 2011; Willard, 2007). Research on these phenomena has focused primarily on white youth, leaving a void in our understanding of how cyberbullying has affected youth of color. This narrative literature review addresses this oversight by providing an overview of recent cyberbullying research that focuses on Hispanic, Asian and black adolescents (k=15). We found that youth of color appear to be less likely to experience cyberbullying than white youth but they experience suicidal ideation and attempts at about the same rates when they do experience cyberbullying.

Keywords
bullying; cyberbullying, mental health; race; youth

Issue
This review is part of the issue “Adolescents in the Digital Age: Effects on Health and Development”, edited by Dan Romer (University of Pennsylvania, USA).

1. Introduction

Cyberbullying is a relatively new phenomenon, a concept with roots in traditional, face-to-face bullying and no indication of disappearing any time soon (Davison & Stein, 2014; Olweus, 1993). As of 2013, nearly 20% of youths in grades 9–12 in the US reported being traditionally bullied and almost 15 % reported being cyberbullied; recent reports estimate these numbers to be slightly higher (Kann et al., 2014). As a result of bullying victimization, many of these teens exhibit a variety of behavioral and psychological effects, from becoming bullies themselves (i.e., bully-victims), to poor academic performance, depression and suicidal ideation (Nansel et al., 2001; Wang, Nansel, & Iannotti, 2011; Willard, 2007). But these data and the research behind it don’t tell us whether youth of color experience cyberbullying and its mental health effects the same way as their white peers (Hamm et al., 2015; Kowalski, Giumetti, Schroeder, & Lattanner, 2014; Selkie, Fales, & Moreno, 2015). This current study addresses this oversight by providing a narrative review of recent cyberbullying research that focuses on Hispanic, Asian and African American adolescents.

2. Cyberbullying Research

Cyberbullying is the use of email, cell phones, text messages, and Internet sites by an individual or group of individuals to repeatedly threaten, harass, embarrass, or socially exclude someone of less power (Li, 2007; Olweus, 1993; Raskauskas & Stoltz, 2007; Sampasa-Kanyinga, Roumeliotis, & Xu, 2014; Wang, Iannotti, & Nansel, 2009). Cyberbullying is similar to traditional bullying in several ways. First, both share a power imbalance between bullies and victims or bully-victims (bullies who have also been victimized) and second, both cyberbullying and traditional interpersonal bullying acts have the potential to destroy victims' relationships with others (Li, 2007; Olweus, 1993; Raskauskas & Stoltz, 2007).

Willard's (2007) typology of cyberbullying acts demonstrates their similarity to traditional bullying while also reflecting both the escalating intensity of cyberbullying and the narrowing of the relational distance between bullies and victims. Flaming is a heated, short-lived argument that occurs between two or more protagonists who may or may not know each other. Similarly, harassment (the repeated, ongoing sending of offensive messages to an individual target) can occur between strangers or friends. However, intimate knowledge is required for impersonation or outing. Impersonation occurs when the cyberbully gains the ability to impersonate the victim and potentially interfere with his or her friendships. Bullies with access to the victim's personal communications can share intimate secrets that are potentially embarrassing (Willard, 2007, pp. 5-11). These increasingly personal violations are frequently made possible by teens' habit of sharing their passwords with friends (Lenhart, Smith, Anderson, Duggan, & Perrin, 2015). However, the defining characteristic of cyberbullying is the use of digital technology, which allows cyberbullies to attack their victims in front of a much larger, often virtual audience for extended periods of time behind a veil of anonymity (Dempsey, Sulkowski, Nichols, & Storch, 2009; Holfeld & Leadbeater, 2015; Menesini et al., 2012; Raskauskas & Stoltz, 2007; Schneider, O'Donnell, Stueve, & Coulter, 2012). For these reasons, perpetrators may feel reduced responsibility and accountability when online compared with face-to-face situations (Horowitz & Bollinger, 2014; Kowalski et al., 2014; Schneider et al., 2012).

Given its pervasiveness, researchers have explored bullying and cyberbullying from a variety of indicators and effects. Most traditional bullying occurs on school grounds and for girls, is frequently interpersonal (Maher, 2008; Willard, 2007). Lower income and family resources, and previous bullying experiences are predictors of bullying behaviors (Williams & Peguero, 2013; Shojaei, Wazana, Pitrou, Gilbert, & Kovess, 2009). However, other research has found that school bullying and cyberbullying overlapped very little (Barboza, 2015; Holfeld & Leadbeater, 2015; Li, 2007; Kubiszewski, Fontaine, Potard, & Auxoult, 2015; Raskauskas & Stoltz, 2007; Schneider et al., 2012).

Youth who are socially isolated and rejected by peers may also be more likely targets for being bullied (Campfield, 2006; Hodges & Perry, 1999; Nansel et al., 2001; Olweus, 1993; Wolak, Mitchell & Finkelhor, 2007). Victimized children may be weaker or less psychologically confident than their peers (Hinduja & Patchin, 2010; Hodges & Perry, 1999; Nansel et al., 2001; Olweus, 1993; Smith & Monks, 2008). Typical victims are more anxious and insecure; they also suffer from low self-esteem (Kubiszewski et al., 2015; Storch, Masia-Warner, Crisp, & Klein, 2005).

Several studies have found gender differences between males and females with respect to involvement in bullying. Boys are more likely than girls to be cyberbullies and traditional bullies, whereas girls are more likely to be victims (Dempsey et al., 2009; Juvonen, Graham, & Schuster, 2003; Klomek, Marracco, Kleinman, Schonfeld, & Gould, 2007; Wang et al., 2009). When girls bully, they are more involved in indirect bullying (e.g., spreading rumors) compared to boys, who are more involved in direct, face-to-face and physical bullying (Dempsey et al., 2009; Nansel et al., 2001; Olweus, 1993; Wang et al., 2009).

2.1. Mental Health Effects

One of the biggest concerns about cyberbullying, however, is the effects on victims' mental health outcomes, particularly suicide and depression. Bullying victims, bullies, and bully-victims are at risk of a number of mental health, social, and interpersonal problems (Bhatta et al., 2014; Juvonen et al., 2003; Kubiszewski et al., 2015; Nansel et al., 2001; Price, Chin, Higa-McMillan, Kim, & Frueh, 2013). More than half of youth who qualified as traditional bullies and cyberbullies had clinically significant anxiety scores and clinically significant depression (Price et al., 2013). Youths who are bullied are more likely to report depression, low self-esteem, poor school performance, and suicide attempts; being bullied is also associated with higher odds of suicidal ideation, regardless of an adolescent's gender, race/ethnicity, or sexual orientation (Bhatta, Shakya, & Jefferis, 2014; Mueller, James, Abrutyn, & Levin, 2015; Sampasa-Kayinga et al., 2014).

Gender differences persist in mental health effects, too. Girls reported with greater frequency that they felt their reputation was affected by the cyberbullying they experienced, that their concentration was affected, that it influenced their ability to make friends, and that it induced suicidal thoughts (Cassidy, Faucher, & Jackson, 2013). Traditional bullies are more likely to be male and report lower levels of depression compared to girls; however, bullies are also more at risk for sui-

cidal ideation than non-bullies and non-victims (Klomek et al, 2007).

As noted earlier, findings are often contradictory. For example, several studies report that bullies have the best self-concepts and the most global self-worth, while other research shows bullies are at a significantly higher risk for serious suicidal ideation and suicide attempts compared with youth who were never bullies (Houbre, Tarquinio, Thuillier, & Hergott, 2006; Juvonen et al, 2003; Klomek et al., 2007). Bully-victims experience a great amount of psychological issues as well, including the risk of developing multiple psychopathologies, being socially ostracized by their peers, and experiencing elevated levels of depression and loneliness (Juvonen et al., 2003; Nansel et al., 2001; Shojaei et al., 2009). However, other research found that cyber victimization was only weakly associated with symptoms of social anxiety, not depression (Dempsey et al., 2009).

There have been several reviews of this literature, however, very little research has explored the role of race/ethnicity in cyberbullying. In the only literature review (thus far) to explore the role of race in bullying, Albdour and Krouse (2014) reviewed research that focused specifically on African American youth and traditional (non-cyber) bullying. In the 23 studies they reviewed, authors reported consistent findings that black teens are more involved in bullying events than their non-black peers; however, the nature of their involvement as bully, victim or bully/victim was not always clearly reported. Environmental factors like poverty and family support or abuse were significant factors in bullying involvement.

Aside from the Albdour and Krouse review, however, reviews of bullying and cyberbullying research are problematic in that they tend to exclude research that focuses on youth of color (Selkie et al., 2015), struggle to find studies about youth of color (Hamm et al., 2015) or simply fail to report findings about youth of color in their review (Kowalski et al., 2014). Hamm et al. (2015) explored the frequency and impact of cyberbullying on youth in 36 studies that focused on health-related effects of cyberbullying. Authors reported that only seven studies explored the relationship of ethnicity and cyberbullying behavior, with only two studies examining ethnic populations (Hispanic, African American, Hawaiian, Filipino, and Samoan) in the United States.

In their review of 81 cyberbullying studies, Selkie, Fales and Moreno (2015) intentionally excluded research that focused solely on "special populations", such as students with disabilities or who identified as lesbian, gay, bisexual, transgender queer/questioning (LGBTQ). Although the authors did not specifically mention race or ethnicity as a special population, they also did not report findings about members of these communities, either as specific populations or sample subgroups within the general samples. Chisohlm (2014) reviewed the status of cyberbullying research and prevention strategies, once again focusing on findings about gender difference, platform differences and called for additional research on age, gender and class diversity among bullying and cyberbullying participants but fell short of seeking racial diversity. Finally, in one of the most extensive reviews of cyberbullying research to date, Kowalski et al. (2014) reviewed and conducted a meta-analysis of 131 studies about cyberbullying and youth. Among other things, their review reported on the prevalence and antecedents of cyberbullying, including demographic factors like gender and age; however, the authors neglected to review or report the role of race/ethnicity in cyberbullying.

2.2. Youth of Color and the Digital Divide

As noted earlier, the use (and abuse) of technology is the defining characteristic of cyberbullying, therefore an exploration of racial and ethnic differences in cyberbullying should begin with an exploration of these differences in the everyday digital lives for youth of color. Youth today are regularly immersed in digital technologies, with 92% of teens going online daily and 76% using social media to connect with friends and peers. Teens are also heavy texters, sending and receiving an average of 30 texts per day on a variety of digital platforms (Lenhart et al., 2015). The time that youths spend online can best be described as pleasant, with nearly 70% of social network using teens saying that most of their peers are kind to each other online (Lenhart et al., 2011). This finding is consistent with reported rates of cyberbullying ("unkindness") of 20%.

But there are some racial differences in youths' online practices and experiences. According to data from the PEW Research Center, 92% of youth go online daily, with 24% of youth reporting that they go online "almost constantly". In comparison, 34% of black teens and 32% of Hispanic teens are online almost constantly; only 19% of white teens report this much usage (Lenhart et al., 2015; Tynes & Mitchell, 2014). And there are differences in where youth spend their time online, too. Seventy-one percent of all youth report using Facebook regularly, but black teens report using Instagram in significantly higher percentages (64%) than their white peers (50%). Thirty-three percent of all youth use Twitter, but 45% of black teens prefer this site compared to 31% of Hispanic youth and 30% of white youth (Lenhart et al., 2015). It should be noted that despite sharing the "social media" label, Twitter, Instagram and Facebook have distinctly different discursive cultures, with Facebook being more about sharing, exchanging, and interacting with "friends" in a predominantly two-way model of communication; Twitter and Instagram are more about posting brief statements and being read by "followers" in an essentially one-way model.

The most marked difference, however, is in tech-

nology ownership with 85% of black youth owning smartphones, compared to 71% of white and Hispanic youth (Lenhart et al., 2015); however, black teens are significantly less likely (40%) than their white and Hispanic peers (61% and 62%, respectively) to use their smartphones to communicate with friends on a daily basis.

Aside from these general usage patterns, very few researchers have explored the role or significance of race and ethnicity in cyberbullying experiences (Hinduja & Patchin, 2010; Juvonen et al., 2003; Low & Espalage, 2013; Wang, Iannotti, Luk, & Nansel, 2010; Wang et al., 2009). This current review, therefore, will begin with the studies of online and offline bullying and youth of color that we were able to find and then we move on to research about mental health outcomes.

3. Methods

Articles were obtained from searches on PsychInfo, PubMed, and CommAbstracts using search terms: cyberbullying, race, ethnicity, African American, black, Asian, and Hispanic. This returned a total of 165 articles. Articles were included for analysis if the sample consisted of youth with ages from 10-18 and if race or ethnicity was identified as a variable (or the sample consisted of at least 50% non-white youths). Only English-language studies were included; duplicate studies, critical essays, literature reviews, book reviews, and opinion pieces were excluded. These constraints resulted in a total of 15 studies for this review. Given the predominance of studies that analyzed bullying in conjunction with cyberbullying (k=14), findings for both traditional and cyberbullying are reported. In a majority of these studies (k= 12), participants completed online surveys administered in classroom settings. Participants were primarily middle school students with sample sizes that ranged from 370–671 for Asian, 571–2227 for Hispanic, and 1350–2760 for black youth.

4. Results

4.1. Bullying and Youth of Color

Youth of color share some commonalities with each other in their cyber-bullying and offline bullying experiences, but there are also some notable differences, as shown in Table 1. Youth of color report lower levels of cyber-victimization than their white peers; indeed, black and Hispanic youth are more likely to be cyber-bullies and offline bullies than victims of bullying. Black and Hispanic teens report levels of cyberbullying victimization similar to the national average (from 16% to 30%); however, black and Hispanic rates are at the lower range of national averages, and they report levels of offline bullying perpetration similar to white peers (Carter & Wilson, 2015; Low & Espelage, 2013; Wang et al., 2009).

Offline (or traditional) bullying includes physical acts of aggression, verbal aggression and relational attacks designed to disrupt victims' interpersonal relationships (Willard, 2007). Hispanic and black adolescents were found to be more likely to be physical bullies than their white, black and Asian peers (Nansel, et al., 2001; Wang, Iannotti, & Luk, 2012; Wang et al., 2009). Although black youth were significantly less bullied than any of their peers, they do experience racial bullying like Asian and Hispanic youth, an area often overlooked in cyber-bullying research (Arat, 2015; Fisher et al., 2015; Goldweber, Waasdorp, & Bradshaw, 2013; Nansel et al., 2001; Stone & Carlisle, 2015; Williams & Peguero, 2013). When looking at co-occurrence of traditional, non-physical bullying and cyberbullying, there were no differences among Hispanic, black, and white teens. Victims of traditional bullying were also often victims of cyberbullying (Nansel, et al., 2001; Wang et al., 2009; Wang et al., 2010).

There are gender differences in cyber-victimization experiences among male and female youth of color, similar to their white peers. Black and Hispanic males were less likely to report cyberbullying victimization than their female counterparts (Merrill & Hanson, 2016; Romero, Wiggs, Valencia, & Bauman, 2013; Wang et al., 2009; Wang et al., 2010; Wang et al., 2011; Wang et al., 2012). Black girls experience more online sexual harassment and solicitation than their black and Hispanic male peers (Tynes & Mitchell, 2014).

Table 1. Rates of offline bullying and cyberbullying participation for youth of color.

Race/ ethnicity	Offline bullying[a]	Cyber Bullying	Offline victimization	Cyber victimization
	%	%	%	%
Black	18–46	7–11	7–30	4–17
Hispanic	18–37	16–18	10–17	6–13
Asian	-	-	20-24	15-57[b]
White	11–23	4–42[b]	10–22	18–30

Note: These ranges reflect the best available data we have, rounded up to the nearest whole number; (-) denotes absence of available data from studies reviewed for this article. [a]=Offline bullying ranges include physical, verbal, and relational bullying; [b]= The upper range appeared in only one study. The upper range of cyber-victimization for Asian youth is 18% when the additional study is omitted and the upper range for cyber-bullying for white youth is 35% without the additional study.

In summary, Hispanic and black youth are more likely than white and Asian youth to engage in offline, rather than online, bullying perpetration. The inverse is true regarding victimization, with black and Hispanic youth experiencing less online and offline victimization than

white and Asian youth. The only similarity was found in the victimization experienced by black and Hispanic girls and white females—all teen girls experienced more online and offline victimization than their male counterparts.

4.2. Mental Health Outcomes

As shown in Table 2, the data about mental health effects for youth of color are spotty; several studies failed to even report mental health outcomes for youth of color in their samples (Merrill & Hanson, 2016; Wang et al., 2010; Wang et al., 2011). Luk, Wang and Simons-Morton (2012) found no racial difference in cyber- or offline victimization and association with substance use or depression. Hispanic youth appear to be particularly vulnerable to depressive effects, although Asian youths' adverse mental health outcomes were associated with lower levels of cyberbullying than other youth of color (Arat, 2015; Goebert, Else, Matsu, Chung-do, & Chang, 2011). Suicidal ideation is also significantly related to race among youth involved in cyberbullying, particularly for Hispanic females (Hinduja & Patchin, 2010; Romero et al., 2013). In sum, based on these findings, there do not appear to be large racial-ethnic differences in suicidal ideation or attempts for youth exposed to cyberbullying.

Table 2. Types of mental health outcomes for youth of color who are involved in offline and cyberbullying as bullies and/or victims.

Race/ ethnicity	Depressive symptoms	Suicidal ideation	Suicide attempt	Other
	%	%	%	%
Black	-	8–25	8–16	25–27
Hispanic	33–49	14–23	10–12	32–34
Asian	8–27	19–22	-	-
White	-	17–20	6–11	-

Note: These ranges reflect the best available data we have, rounded up to the nearest whole number. (-) denotes absence of available data from studies reviewed for this article.

5. Discussion

From technology ownership to social media engagement, youth of color interact differently with technology and with each other compared to their white peers (Lenhart et al., 2011; Lenhart et al., 2015; Tynes & Mitchell, 2014; Wout, Murphy & Steele, 2010). As noted earlier, 85% of black youth own smartphones but are significantly less likely (40%) than their white and Hispanic peers (61% and 62%, respectively) to use their smartphones to communicate with friends on a daily basis (Lenhart et al., 2015). This difference suggests, at the least, that these communities may also experience cyberbullying differently. In particular, although these communities appear to experience cyber-victimization at lower rates than white youth, they report levels of suicidal ideation and attempts associated with such victimization at about the same rates as white youth.

On one hand, there is evidence to suggest that there is little significant difference between youth of color and their white peers in terms of cyberbullying perpetration or in terms of gender differences in victimization (Low & Espelage, 2013; Romero et al., 2013; Tynes & Mitchell, 2014). However, research also indicates that black and Hispanic youth are more likely to bully others (offline) than to cyberbully others and are less likely to be victims (Merrill & Hanson, 2016; Romero et al., 2013; Wang et al., 2009; Wang et al., 2010; Wang et al., 2011; Wang et al., 2012). These findings are consistent with previous research detailing teacher perceptions of black youth aggression and bullying behavior in school (Albdour & Krouse, 2014; Tynes & Mitchell, 2014).

The lower rates of cyberbullying for black youth may be related to their differing levels of technology ownership. Black households are less likely to own computers and have Internet access than their white peers, making it more difficult to cyberbully anyone. Black youth also report preferring Twitter (Lenhart et al., 2015), which means more anonymous audience members (and, therefore, fewer readily identifiable victims). However, black youth are more likely to own smartphones, but not necessarily use them for connecting with friends. One reason may be that face-to-face interactions may be valued over using technology to interact with friends in the black community, a community that is already characterized by cultural communication differences from other racial and ethnic groups (Neu, 2008; Saloy, 2013; Williams & Peguero, 2013). Finally, given the lower rates of computer and Internet use in home, it is possible that black youth are financially responsible for their smartphones. If individual phone plans set usage limits, black youth may be particularly diligent (or frugal) with their phones which makes using smartphones to keep in touch with their friends (or to cyberbully anyone) a costly proposition.

6. Limitations

There are several limitations to this study. First, the small number of studies reviewed (k=15) makes it difficult to draw firm conclusions. This may have been caused by the limitations imposed by search terms; if "Cyberbully" wasn't in the article keyword, then the study may have been missed. Also gender differences among youth of color weren't clearly discernable in this literature, with one or two exceptions (Messias, Kindrick, & Castro, 2014; Romero et al., 2013). Second,

the findings were difficult to synthesize because researchers reported their findings in a variety of formats, despite the majority of the studies utilizing a similar instrument (survey). Finally, approximately one-third of the research reviewed here was conducted by members of the same research team, using one sample of participants (Wang et al, 2009; Wang et al, 2010; Wang et al, 2011; Wang et al., 2012). Future research should attempt to expand the diversity of the samples used to increase the potential for significant findings about youth of color and, more importantly, researchers should consistently report all findings regarding racial and ethnic minorities in their studies.

7. Conclusions

Cyberbullying continues to be a serious issue for youth of all races, especially given the adverse mental health effects suffered by some victims. This review of cyberbullying research shows that although whites are bullied online more than non-whites, the rates of suicidal ideation are comparable. This is particularly interesting given the differences between youth of color and their white peers in terms of technology ownership, social media preferences, and socioeconomic backgrounds. This would suggest that the digital divide may shield youth of color from cyberbullying somewhat; however, the divide can't shield them from cyberbullying effects.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant Nos. 0916152 and 1421896. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Conflict of interests

The authors declare no conflicts of interests.

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COGITATIO

Media and Communication (ISSN: 2183-2439)
2016, Volume 4, Issue 3, Pages 79-89
Doi: 10.17645/mac.v4i3.536

Review

Adolescent Cellphone Use While Driving: An Overview of the Literature and Promising Future Directions for Prevention

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Submitted: 17 December 2015 | Accepted: 11 March 2016 | Published: 16 June 2016

Abstract
Motor vehicle crashes are the leading cause of death in adolescents, and drivers aged 16–19 are the most likely to die in distracted driving crashes. This paper provides an overview of the literature on adolescent cellphone use while driving, focusing on the crash risk, incidence, risk factors for engagement, and the effectiveness of current mitigation strategies. We conclude by discussing promising future approaches to prevent crashes related to cellphone use in adolescents. Handheld manipulation of the phone while driving has been shown to have a 3 to 4-fold increased risk of a near crash or crash, and eye glance duration greater than 2 seconds increases crash risk exponentially. Nearly half of U.S. high school students admit to texting while driving in the last month, but the frequency of use according to vehicle speed and high-risk situations remains unknown. Several risk factors are associated with cell phone use while driving including: parental cellphone use while driving, social norms for quick responses to text messages, and higher levels of temporal discounting. Given the limited effectiveness of current mitigation strategies such as educational campaigns and legal bans, a multi-pronged behavioral and technological approach addressing the above risk factors will be necessary to reduce this dangerous behavior in adolescents.

Keywords
accidents prevention; adolescent; cell phones; distracted driving; text messaging

Issue
This review is part of the issue “Adolescents in the Digital Age: Effects on Health and Development”, edited by Dan Romer (University of Pennsylvania, USA).

1. Introduction

Cellphones, and the connectivity they provide, have become a part of everyday life. In recent years, cellphone use, in particular communication by text messaging, has dramatically increased in prevalence and popularity across the world. In 2014, an estimated 169.3 billion text messages were sent worldwide, compared to 110 billion in 2009 (CTIA, 2013). Adolescents report that texting is the most common way that they stay in contact with friends (Lepp, Barkley, & Karpinski, 2014), sending an average of 100 texts per day (Nielson, 2010). Problematic cellphone use and texting has been likened to other addictive behaviors, and may have negative effects on both academic performance and mental health (Lee, Chang, Lin, & Cheng, 2014; Lepp, et al., 2014; Walsh, White, & Young, 2008). However, texting has also become a way that adolescents forge social bonds, and texting between adolescents often serves to promote social cohesion in peer groups (Ling, 2012). More than half of adolescents text their friends every day, and many of them are texting their friends multiple times a day (Lenhart, Smith, Anderson, Duggan, & Perrin, 2015).

The phenomenon of distracted driving from cellphone use has caught the attention of the national

media in the United States (U.S.). There have been numerous reports on its dangers (CNN, 2014; DePalma, 2014; Muskal, 2015), prevalence (Richtel, 2015), and possible solutions (Richtel, 2014). The U.S. federal government's *Healthy People 2020* objectives pinpoints distracted driving related to cellphone use as the top emerging cause of injury and highlights the need for future research (Office of Disease Prevention and Health Promotion, 2015). Several prominent public awareness campaigns have been aimed at promoting safety while driving, and in 2010 there was a national summit that brought together safety experts, senators, and industry leaders, to focus on this issue (AAA, 2013). Given the gravity of the problem of distracted driving, and in concert with this special issue on "Adolescents in the Digital Age: Effects on Health and Development," the objectives of this paper are to provide an overview on the incidence, crash risk, risk factors for engagement, and the effectiveness of current mitigation strategies. We conclude by proposing promising future approaches to prevent crashes due to cellphone use in adolescents.

2. Public Health Magnitude of Distracted Driving in Adolescents

Motor vehicle crashes (MVCs) are the leading cause of death and disability in adolescents in the U.S. and globally (World Health Organization, 2013). Based on police crash report data collected by the U.S. National Highway Traffic Safety Administration (NHTSA), in 2013, 2,650 adolescents, aged 16–19, died as a result of a motor vehicle collision (MVC), making this the number one cause of death in the U.S. for this age group; another 292,000 were treated for injuries (CDC, 2013). A disproportionate amount of MVCs related to distracted driving involve teenagers: although they comprise 6% of all drivers killed in MVCs, teenagers account for 10% of all drivers determined to be distracted at the time of a crash and 11% of all drivers killed in crashes related to documented cellphone use (NHTSA, 2015b). NHTSA reports that there were a total 45 teenage drivers and 161 drivers (aged 20–29) killed in cellphone distraction crashes in 2013. These numbers underestimate the true magnitude of the problem since the statistics are based on documented cellphone use while driving as measured through police reports.

3. Incidence of Cellphone Use While Driving in Adolescents

The majority of evidence on the proportion of the adolescent population that uses their cellphone while driving has been obtained through population-level self-report surveys. In 2014, 94% of U.S. drivers aged 18–29 reported owning a smartphone (State Farm, 2014). A Centers for Disease Control and Prevention survey of 8,505 students 16 years of age and younger, found that 42% of U.S. high school students admit to engaging in texting while driving, which included both text messaging and emailing while driving, at least once per month (Olsen, Hanowski, Hickman, & Bocanegra, 2009). A more recent nationally representative survey of 1,243 high school students, funded by the National Institutes of Health (NIH), found that 83% reported engaging in electronic device use while driving at least once in the last 30 days (Ehsani, Li, & Simons-Morton, 2015). Specifically, 71% made or answered a phone call, 64% read or sent a text message, 20% read or sent an email, 29% checked a website, 71% changed music, 12% used a tablet, and 53% looked at directions or a map. Young drivers reported using electronic devices while driving on 19% of the days they drove. Males were more likely to use a tablet or a computer while driving, teens from moderate and high affluence households were more likely to check websites, and rural participants were less likely to look at directions or a map than urban participants (Ehsani et al., 2015).

It appears that social media use while driving is increasing among adolescents and young adults based on a survey, conducted annually since 2009 by the State Farm insurance company, of 1,000 drivers, aged 18 and older. According to this survey, the proportion of young drivers, aged 18–29, who read social media websites while driving doubled from 21% in 2009 to 41% in 2014 (State Farm, 2014). Likewise, the proportion of this population who actually post to social media while driving increased from 20% in 2009 to 30% in 2014. This form of communication may eventually supplant text messaging, as the same survey found the proportion of young adults age 18–29 who texted while driving was 58% in 2014, down from 71% in 2009.

NHTSA's National Occupant Protection Use Survey (NOPUS) provides the only nationwide probability-based observed data on driver electronic device use in the U.S. Data are collected by trained observers standing at the roadside of probabilistically sampled intersections, who are observing drivers while stopped at the intersection. The overall percentage of drivers who are text-messaging, or visibly manipulating handheld devices while driving, increased from 1.7 % in 2013 to 2.2% in 2014. However, among the 16–24 year old age group, this proportion was much higher, and increased from 2.9% in 2013 to 4.8% in 2014 (NHTSA, 2015a). These statistics likely underestimate the true incidence of handheld cellphone use since the below eye-level view beneath the windows and windshield is not captured.

Local roadside observation based studies suggest a higher prevalence of cellphone use while driving. A study conducted at 11 intersections in the Birmingham Alabama metro area found that among drivers presumed to be less than 30 years olds (N=853), 8.4% were observed to be texting and another 11.7% were observed to be talking on the phone (Huisingh, Griffin,

& McGwin, 2015). Among drivers of all ages who were witnessed to be texting, 49% of these episodes were at estimated speed of more than 25 miles per hour. A similar study conducted in one intersection in Pennsylvania in 2014 of 2,000 observed drivers, found 3% of drivers in motion were texting or visibly manipulating handheld devices and 5% were engaged in handheld phone calls. Among the stopped drivers, 14.5% were texting and 6.3% were talking (Bernstein & Bernstein, 2015). Further work is necessary to describe the proportion of time individual drivers use their phone while the car is in motion.

Naturalistic studies using non-obtrusive video event recorders installed in drivers' cars can provide a much more nuanced incidence of cellphone use and other distracted driving behaviors. Typically, the recorder runs continuously, it only saves information when a vehicle movement (decelerating, accelerating, or turning) produces a g-force that exceeds a predetermined threshold. Lower thresholds can be set such that clips can be recorded intermittently during normal periods of driving. A naturalistic study using event-triggered recording in 52 high-school aged drivers found that cellphone use was present in 6.7% video clips, followed by adjusting vehicle controls (6.2%) and grooming (3.8%) (Foss & Goodwin, 2014). Of episodes of cellphone use, one third involved holding the phone to the ear, with the rest involving handheld manipulation. Only 1% of these recorded episodes involved hands-free talking. Interestingly, cellphone use while driving was much less likely to occur if there was a passenger in the vehicle.

A naturalistic study using continuous video recording of young drivers 20–30 years old (n=36) for 4 weeks in 2006–2007 found that these drivers had a mean 2.1 phone conversations per hour for drive time for a mean average conversation duration of 2.6 minutes (Funkhouser & Sayer, 2012). They also had a mean average of 4.0 visual-manual cellphone use task per hour of drive time with a mean average duration of 0.51 minutes. When data from all drivers aged 20–70 years old was analyzed (n=108), it was found that 23% of all visual manual tasks were initiated when stopped and another 5% were initiated at 5 miles per hour or less. Of concern, this indicated that nearly three quarters of handheld phone use episodes occurred while moving. In fact, more than 45% of these episodes were initiated at speeds of more than 25 miles per hour, consistent with the estimated 49% of texting episodes witnessed in the roadside observation study from Alabama (Huisingh et al., 2015). Given that speed is the biggest predictor of injury severity in motor vehicle collisions (Kockelman & Kweon, 2002), these findings suggest that the riskiness of cellphone use episodes in terms of causing serious crashes is likely to be heterogeneous, and needs further clarification in future research (see Knowledge gaps).

4. Safety Risk of Engaging in Cellphone Use While Driving

The first large scale study to evaluate the safety risk of cellphone use while driving was published in the *New England Journal of Medicine* in 1997 (Redelmeier & Tibshirani, 1997). This epidemiologic study compared detailed time-stamped phone bill usage records of individuals, moments before a motor vehicle crash as well as records one week before the crash. The risk of collision was found to be 4 times higher during a phone call. However, subsequent research has suggested a bias to this design; study subjects were less likely to have been driving during the control period, reducing their potential exposure to a crash (Young, 2012). Since then, dozens of studies with more robust designs have been published evaluating the risk of cellphone use while driving, and in particular texting while driving, in adult drivers. A meta-analysis of 28 epidemiologic, driving simulator, and naturalistic studies, which use vehicle instrumentation to measure actual driving, found that texting while driving increases the risk of crashing by at least 3 to 4-fold (Caird, Johnston, Wilness, Asbridge, & Steel, 2014).

Fewer studies have examined the crash risk of cell phone use among adolescent drivers. Klauer et al. (2014) recently conducted a systematic review of quantitative epidemiologic, driving simulator, and naturalistic studies examining secondary task engagement while driving with adolescents; they identified 15 studies that met inclusion criteria (Klauer et al., 2014). Although this systematic review investigated more than just cell phone use (secondary task was defined as eating, using a cellphone, inserting a compact disc), their findings about the common mechanism that increases crash risk is notable. Overall, this systematic review found that secondary tasks while driving, where eyes were not on the forward roadway, increased crash risk (e.g. looking down at a phone while texting) (Fitch, Hanowski, & Guo, 2014; Klauer, Dingus, & Neal, 2006; Olsen et al., 2009); however, secondary tasks where eyes were not required to be off the forward roadway (e.g. talking on a cell phone) did not significantly increase crash risk (Harbluk, Noy, Trbovich, & Eisenman, 2007; Klauer, Ehsani, McGehee, & Manser, 2015).

One of the most rigorous studies included in Klauer et al.'s review followed 42 newly licensed adolescent drivers for 18 months immediately after licensure with in-vehicle event-triggered cameras (Klauer et al., 2014). This study found that dialing the phone was associated with the highest risk of a crash or near crash event (Odds Ratio [OR] 8.32), followed by reaching for the phone (OR 7.05), and texting or using the Internet (OR 3.87); talking was not associated with the crash risk (OR 0.61). Secondary analysis of these data revealed that the duration of glancing away from the forward roadway steadily increases the risk of a crash beginning

with glances longer than 1 second. Glances of 2 seconds or more while engaging in handheld cellphone use were associated with a 5.5-fold increase in the risk of crash or near crash event (Simons-Morton, Guo, Klauer, Ehsani, & Pradhan, 2014). These important findings imply that interventions and policies to reduce the crash risk of distracted driving, and in particular distraction from cellphone use, need to focus on maintaining the driver's eyes on the forward roadway.

5. Knowledge of the Risks of Cellphone Use

Generally, adolescents report that texting or talking on a handheld phone while driving is dangerous. A survey found that the 97% of U.S. adolescents know texting and driving is dangerous based on a survey of 1,200 teenagers aged 15–19 years old (AT&T, 2012). However, knowledge of safety risks does not necessarily indicate adolescents will not engage in the behavior. In a focus group study of 16–18 year olds with less than 1 year of licensure, participants indicated that they understand the dangers of cellphone use while driving, however, they still reported driving while engaging in talking, texting and social media app use (McDonald & Sommers, 2015). This suggests that simply continuing to raise awareness of the risks of cellphone use while driving may not be very effective for reducing this behavior, given that most adolescents are aware of the risks. A recent survey of college students found they were much more likely to text behind the wheel than drink and drive, despite perceiving that the risks of texting were similar to drinking (Terry & Terry, 2015). Furthermore, participants perceived their peers as being more accepting toward cellphone use while driving than themselves, suggesting that one factor underlying the discrepancy between perceived risk and risk exposure may be the weakness of social norms opposed to texting while driving.

6. Risk Factors for Engagement: Development, Peers and Families

Adolescents are a particularly vulnerable group at risk for crashes. Adolescent drivers are at greatest risk for a crash in the first 6–12 months of licensure (Mayhew, Simpson, & Pak, 2003; McCartt, Shabanova, & Leaf, 2003; Williams & Tefft, 2014). As adolescents drive, they acquire more experience and skill; this skill acquisition for newly licensed drivers strongly influences crash risk reduction in the first year of driving (McKnight & McKnight, 2003). However, experience is not the only contributor to crashes, as the developmental changes during adolescence can influence crash risk.

Major changes in the brain occur throughout adolescence that can lead to increased risk taking and sensation seeking, and a movement towards a greater affiliation with their peers (Giedd, 2012). This is not to indicate that adolescents are taking risks with their cell phones while driving simply to challenge safety limits. Rather, adolescents may drive with incomplete maturation of cognitive and motor skills, and decision-making may be modulated by emotional and social factors.(Romer, Lee, McDonald, & Winston, 2014) The adolescent pre-frontal cortex has not fully matured; adequate experience in risk assessment may not have occurred, nor may adolescents fully exert control over those risks—and all the while, there is a rise in sensation seeking (Giedd, 2012). Impulsivity and present biased preferences (Atchley & Warden, 2012), the tendency to place more weight on benefits realized now and less weight on costs realized in the future, is associated with a higher likelihood of engaging in texting while driving (Hayashi, Russo, & Wirth, 2015). Adolescents are more present-biased than adults indicating a greater cognitive difficulty with delaying gratification (Romer, Duckworth, Sznitman, & Park, 2010), and in this context, delaying checking their phone and/or responding to a text message until they have stopped driving.

A 2014 systematic review of 29 papers identified several other psychological factors associated with cellphone use while driving in young drivers. These included the importance of an incoming or outgoing call, social acceptance, possession attachment, and a positive attitude toward cellphone use while driving (Cazzulino, Burke, Muller, Arbogast, & Upperman, 2014). The importance of answering or making the call while driving was found to have greater weight than the perceived risk associated with cellphone use while driving.

The proximity of relationship of the individual who is communicating with the adolescent influences cellphone use (Atchley & Warden, 2012; LaVoie, Lee, & Parker, 2015). In a focus group study, adolescent participants indicated that context mattered; the individual involved in the communication, and the reason behind it, would influence whether they would use the cell phone while driving (McDonald & Sommers, 2015). A survey study of 395 adolescent drivers found that adolescents most often spoke to parents while driving (50%), rather than a significant other (16%) or friend (21%) (LaVoie et al., 2015). This indicates that reducing check in calls from parents may reduce cellphone use while driving. However, adolescent drivers were more likely to text a significant other (30%) or friend (27%) rather than their parents (16%) (LaVoie et al., 2015). Social norms strongly influence texting behavior, as 89% of adolescents expect a response to a text message within 5 minutes (Bowen et al., 2009). Together these findings indicate that interventions to reduce texting should alleviate the urge to respond immediately to close social contacts, such as setting up automated responses to incoming text messages.

Carter, Bingham, Zakrajsek, Shope and Sayer (2014) also conducted a survey with adolescent–parent dyads and found that actual and perceived distracted driving behaviors of parents, and perceived distracted driving

behaviors of peers, were predictive of adolescent distracted driving behavior. Finally, there is increasing evidence for compulsive cellphone use as a diagnosable behavioral addiction, given the behavioral and neurobiological characteristics of this behavior (Billieux, Maurage, Lopez-Fernandez, Kuss, & Griffiths, 2015). Use in dangerous situations, such as while driving, is measured as a factor in scales of problematic cellphone use (Merlo, Stone, & Bibbey, 2013). More research is needed to better determine the correlation between measures of general problematic or compulsive phone use and risky cellphone use while driving.

7. Social and Logistical Barriers to Reducing Cellphone Use While Driving

Understanding why adolescents may not want to abstain from in-vehicle cellphone use provides insights into behavioral strategies that may be more effective for reducing use while driving. Dominant disadvantages of abstaining from in-vehicle cellphone use among adolescents include: the inability to communicate location or letting others know their time of arrival, the inability to get help if the driver got lost or forgot something, and increased difficulty for parents to get in touch with the driver (Hafetz, Jacobsohn, García-España, Curry, & Winston, 2010). Other disadvantages of abstaining from in-vehicle cellphone use are giving up the ability to call for emergency help. This may include calling 911 if being followed by a potential stalker, calling to report a drunk driver on the road, or calling for emergency medical care in the case of a MVC. In fact, in the landmark 1997 *New England Journal of Medicine* study on drivers who owned cellphones and were involved in MVCs, 39% of drivers called 911 from the scene of the crash on their cellphone (Redelmeier & Tibshirani, 1997). Therefore, interventions to reduce risky cellphone use while driving should make allowances for calls in emergency situations and should safely balance needs related to navigation and trip communication.

8. Effectiveness of Current Mitigation Strategies

8.1. Legal Bans

In the U.S., states have enacted policies to help decrease cellphone use while driving. For example, according to the Insurance Institute of Highway Safety (2015), as of the end of December 2015, talking on a hand-held cellphone while driving has been banned for all drivers in 14 states and the District of Columbia; additionally, the use of all cellphones by novice drivers is restricted in 37 states and the District of Columbia. Text messaging has been banned for all drivers in 46 states and the District of Columbia. In addition, novice drivers are banned from texting in Missouri and Texas (Insurance Institute for Highway Safety, 2015).

There are mixed results on the effectiveness of cellphone restrictions. One of the earliest studies examining the effect on the general population investigated the relationship between collision claim frequencies and texting bans in 4 states (Highway Loss Data Institute, 2010). This study found that texting bans were actually associated with *increased* frequencies of collision claims. The authors posited that this increase may have stemmed from the unintended consequence of drivers lowering their phones from view to avoid citations and fines and, in doing so, taking their eyes off the road more than they did before the implementation of the bans. Two other studies using observation and self-report outcomes in the adolescent driver population showed that laws restricting cellphone use have not had long-term effects on adolescent drivers' cellphone use while driving (Ehsani, Bingham, Ionides, & Childers, 2014; Goodwin, O'Brien, & Foss, 2012).

Studies examining the effect of cell phone bans on MVC fatalities and hospitalizations have demonstrated modestly positive outcomes. Primary enforced laws banning all drivers from texting was associated with a 3% reduction in fatalities in all age groups; banning only young drivers from texting had the greatest impact on reducing deaths among those aged 15 to 21 years (Ferdinand et al., 2014). A similar study found an 8% decrease in fatalities in states that universally banned texting while driving and made it a primary offense. However, this effect was only apparent for the law's first three months (Abouk & Adams, 2013). The study also found that this loss of effect was lessened in states that had universal bans against handheld use of cell phones. The authors suggest that the lack of effectiveness of texting bans was due to poor enforcement; drivers refrained from texting immediately after the law's announcement and implementation but returned to texting if they believed the law was not being enforced (Abouk & Adams, 2013). Finally, texting bans were also significantly associated with reductions in hospitalizations among those aged 22 to 64 years and those aged 65 years or older, but did not significantly reduce hospitalizations for adolescents (Ferdinand et al., 2015). While in these analyses it cannot be determined whether the crashes and hospitalizations analyzed were caused by distracted driving or not, these studies suggest that bans with primary enforcement can reduce the burden of injury from cellphone use. This is further supported by the results of a high visibility law enforcement campaign "Phone in One Hand, Ticket in the Other" implemented in Connecticut and New York, which was shown to have a modest reduction in observed handheld cellphone usage rates over the course of a year (Chaudhary, Cassanova-Powell, Cosgrove, Reagan, & Williams, 2012). Given the logistical difficulty needed to enforce bans, such as catching a driver using a phone out of view, additional mitigation strategies may be necessary.

8.2. Education to Increase Awareness

Several national public health campaigns have emerged aimed at the prevention of distracted driving. For example, NHTSA's distraction.gov is a national campaign to increase awareness of distracted driving through informational videos, facts, and personal narratives (Distraction.gov, 2015). There have been several industry sponsored campaigns aimed at the prevention of distracted driving, such as AT&T's "It Can Wait" wait campaign, which encourages individuals to reach out to friends and family and to pledge to abstain from texting and driving (AAA, 2013; AT&T, 2012). These campaigns consist of online pledges, where individuals can pledge to abstain from texting and driving, and educational videos with the goal of increasing awareness of the dangers of distracted driving. Despite these major investments, there are no data to suggest that these campaigns have had any effect on cellphone use while driving. Given 97% of adolescent drivers already know that cellphone use while driving is dangerous (AT&T, 2012), solely increasing awareness of risks is unlikely to lead to wide scale behavior change.

There are few published studies of more targeted educational interventions in the adolescent driver population. One effective intervention led by staff from a pediatric trauma center hospital invited 61 student leaders from a local high school for a half-day educational session. The student leaders then went back to their two high schools to implement a yearlong peer-to-peer campaign focused on a clear no texting while driving campaign (Unni, Morrow, Shultz, & Tian, 2013). There was a decrease in unannounced observation of actual texting and driving (from 17% to 8%, $p<0.001$) among high school students driving on roads near the school a year after the intervention compared to just prior to the intervention (Unni, et al., 2013).

8.3. Technological Interventions

Over the last decade, in-vehicle technologies have been developed and tested with the aim of improving adolescent driving behavior through monitoring and feedback. Feedback on g-force events, recorded using an in-vehicle event triggered video recording device in which parents were involved in the feedback loop, has been shown to be effective in reducing the occurrence of these near-crash events (Simons-Morton et al., 2013). Some auto insurance companies have moved to offer use of event-triggered video monitors and parental feedback on recorded driving errors and distracted driving behavior (American Family Insurance, 2016).

More recently, in the last five years, smartphone applications have been developed to directly measure cellphone use while driving. "Software only" applications rely on the phone's sensors (e.g. accelerometer and GPS) to determine whether the phone is traveling at a speed consistent with driving (e.g. >25 mph). If traveling over a certain speed threshold, the application can be set to disable the phone unlock screen and block incoming and outgoing text messaging and calls. Most of these applications have been developed for the Android platform and there are currently dozens of such applications available in the Google Play store. Because of the more stringent developer restrictions of the iOS, there are fewer such applications available in the iTunes store. The major barriers to adoption of "software only" applications are the current inability to detect whether the phone is being used on a car vs. another vehicle such as a bus or train, and battery drain from continuous use of GPS in the background. "Software–Hardware" applications have also been developed to overcome some of these limitations. This involves the instillation of a device in the car that pairs with a smartphone application via Bluetooth technology. These devices were developed to be installed in the car's OBD-II (On-board diagnostics-II) data port and more recently have included solar powered designs that can be installed on the windshield.

To our knowledge there are three completed studies of smartphone applications to block cellphone use while driving, with all three demonstrating a reduction in cellphone use while driving at non-zero speeds (Creaser, Edwards, Morris, & Donath, 2015; Ebel et al., 2015; Funkhouser & Sayer, 2013). For example, in the largest study to date, involving 274 novice teen drivers followed for 1 year, the rate of text messages sent per mile driven for each given month post licensure was at least 5 to 10 times higher in the control group (0.05 to 0.20 texts per mile driven) than in the blocking group (0.0 to 0.02 texts per mile driven) (Creaser et al., 2015). The number of text messages sent tripled by one year since licensure in the control group compared with the first 8 months of driving. On the other hand, the rate remained stable in the blocking group (Creaser et al., 2015). However, behavioral engagement strategies will likely be necessary to enable the success and sustainability of cellphone blocking indicating a low likelihood of use beyond the study. In the above mentioned study, 15% of the teen drivers in the treatment group were caught trying to game the system either by finding ways to bypass the blocking system or by borrowing a phone (Creaser et al., 2015). In one study of adult drivers, after an intervention period of blocking was disabled, there was no lasting behavior change as cellphone use while driving returned to baseline levels (Funkhouser & Sayer, 2013). Furthermore, when surveyed, the adult participants had overall not very positive views of the blocking technology.

9. Knowledge Gaps in the Science

Despite the widespread emergence of cellphone use while driving among adolescent drivers over the last

decade, and the associated research activity on this behavior, several critical knowledge gaps persist. One of the major challenges in understanding the prevalence of this behavior and measuring effectiveness of intervention strategies is a lack of readily collectable, reliable, and valid measures of cellphone use while driving. Despite the ease of collection of survey data on magnitude of self-reported cellphone use while driving, there is scant evidence to support its validity. Based on the comparison between self-reported general smartphone use episodes and actual recorded episodes, survey self-report methods likely underestimate the number of cellphone use episodes (Andrews, Ellis, Shaw, & Piwek, 2015). The biggest problem with widely accepted survey self-report measures of cellphone use while driving is that there is no distinction between use while stopped vs. use while the car is in motion (Olsen, Shults, & Eaton, 2013). Only one study to our knowledge measured self-reported cellphone use and actual cellphone use while driving using a cellphone app and in vehicle monitoring device, but these measures were not directly compared (Creaser et al., 2015). There is a need for future naturalistic studies to clarify the correlation between self-reported cellphone use and actual cellphone use as well as the frequency and duration of use given the transient risks of the exposure on crash risk.

The association between driving context in which cellphone use is initiated and crash risk has also not been well elucidated. For example, it is not known if handheld use while stopped or in very low speed traffic actually poses risk of injury. Additionally, it is not known how type of handheld cellphone use (e.g. texting vs. checking email vs. looking at GPS directions) affects level of risk in terms eye glance duration, real driving performance, and near crash and crash events. These knowledge gaps are difficult to fill because they would require naturalistic studies with large sample sizes. Leveraging smartphone apps that can track type of phone use while driving may be a cost-effective way to study these questions in larger and broader populations than have been studied to date in instrumented vehicle naturalistic studies.

Furthermore, there is a great need to better understand the effectiveness of current countermeasures and assess why many countermeasures have failed to reduce this behavior. Specifically, it should be determined whether cellphone bans have led to the unintended consequence of drivers holding their phone below window-level view to avoid detection when texting thereby taking their eyes off the road longer. If confirmed, this could undermine the effectiveness of enforcing cellphone bans. Additionally, further qualitative research with adolescent drivers and their parents would shed light on addressable barriers to the adoption of several available smartphone based apps and settings that limit the temptation to text while driving. Finally, as smartphone and in-vehicle technology rapidly evolves, there is an urgent need to determine whether hands-free features actually reduce cognitive distraction and keep the drivers eyes on the road. Studies to date suggest that most of these features, such as voice to text functions, do not reduce distracted driving and may even increase the risk of distraction (Strayer, Turrill, Coleman, Ortiz, & Cooper, 2014).

10. Promising Future Directions

Given the limited effectiveness of current isolated mitigation strategies, a multi-pronged regulatory, behavioral, and technological approach addressing the above risk factors will be necessary to reduce this dangerous behavior in adolescents. For legal bans to be effective, they must be aggressively enforced. As evidenced by prior research, bans lose effectiveness shortly after implementation, likely due to lack of enforcement (Highway Loss Data Institute, 2010). As demonstrated in a pilot program in two northeastern U.S. states, high visibility law enforcement campaigns that increase awareness of the legal and financial repercussions of texting in addition to actually enforcing the bans, improve the effectiveness of the legal ban (Chaudhary, et al., 2012). It is also likely that increasing the financial and legal repercussions of getting caught using a cellphone while driving would further increase the effectiveness of legal bans. The combination of these approaches are theoretically sound given that individuals value and are more sensitive to losses than equivalent gains based on the behavioral economic phenomenon of loss aversion (Tversky & Kahneman, 1991). Nevertheless, the logistical challenges of enforcing bans, particularly the accurate detection of the behavior (holding and manipulating phone in hand vs. holding another object or looking down in car) will continue to limit the overall effectiveness of bans, necessitating other strategies to reduce use.

Educational interventions aimed at reducing texting while driving and distracted driving in general should focus on targeting the mechanism by which distraction causes crashes—by getting drivers to keep their eyes on the forward roadway. Furthermore, efforts to reduce cellphone use while driving in adolescents may be more successful if the intervention also addresses the parents' behavior. There is promising evidence that active parental involvement enhances the effectiveness of adolescent driving interventions (Curry, Peek-Asa, Hamann, & Mirman, 2015). Furthermore, given the strong correlation between parental engagement with texting and driving and their child's behavior, strategies that enable parents to be better role models for their children are highly promising (Carter et al., 2014). Educational interventions that can be delivered online would increase the scalability of these efforts and potential adoption in driver's education classes.

While smartphone applications that disable handheld use while driving are effective in research settings, it is questionable whether individuals will continue to use such applications without a behavioral strategy to sustain use. This is evidenced by the fact that a significant proportion of adolescent drivers tried to bypass cellphone blocking in one study (Creaser et al., 2015). In the short term, the apps can be designed to be more user friendly by allowing automated responses to incoming messages and hands free navigation, enabling emergency calls, and balancing functionality with maintaining battery life. Incorporating adolescents and young adults into the design process would like also increased adoption. In the long term, as with all mobile devices and apps, sustaining use will require behavioral engagement strategies (Patel, Asch, & Volpp, 2015). Feedback loops could be better designed to sustain engagement with cellphone blocking apps using concepts from behavioral economics. Given that some of those who engage in texting while driving overweigh immediate benefits (Hayashi et al., 2015), promising intervention would be to provide frequently delivered (e.g. daily) rewards to make the cognitive appraisal of abstaining from handheld phone use more attractive than the urge to engage in texting while driving (Loewenstein, Asch, & Volpp, 2013). Making a portion of parental weekly allowances contingent on good behavior may be one way to operationalize this through the use of smartphone based apps that monitor cellphone use behavior while driving (e.g. $1/day of allowance given for each day with no measured texting while driving). In the future, financial rewards could be scaled up and implemented on a large scale through repurposing existing auto-insurer teen driver discounts into discounts or rewards based on actual driving performance, as measured by in vehicle devices and smartphone applications (Cambridge Mobile Telematics, 2014). Auto insurance and car rental companies are already providing in-vehicle devices and associated smartphone applications to reduce cellphone distraction (Insurance and Technology, 2013; Jackson, 2016).

11. Conclusions

Cellphones are a mainstay of connectivity in most adolescents' daily lives, as a form of entertainment, information and communication. The pervasiveness of adolescent cellphone use can have negative effects on driving behavior and increase crash risk. Current strategies to decrease adolescent cellphone use while driving fall short of what is needed to curb teen driver crashes and improve adolescent health. Interdisciplinary approaches show promise, and those that integrate cellphone policies, technology, and individual and family behaviors will be necessary to reduce this dangerous behavior in adolescents.

Acknowledgments

This work was supported by Research Career Development Program in Emergency Medicine of the National Institutes of Health under award number K12HL109009 (Delgado), as well as the Penn Roybal Center for Behavioral Economics under award number P30AG034546 (Delgado). Catherine C. McDonald was supported by the National Institute of Nursing Research under award number R00NR013548. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Conflict of Interests

The authors declare no conflict of interests.

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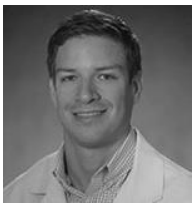

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Media and Communication (ISSN: 2183-2439)
2016, Volume 4, Issue 3, Pages 90-94
Doi: 10.17645/mac.v4i3.659

Editorial

Afterword to the Issue "Adolescents in the Digital Age: Effects on Health and Development"

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Submitted: 19 April 2016 | Published: 16 June 2016

Abstract
The articles in this thematic issue suggest both opportunities and hazards for the health and development of adolescents in the digital age. We place these concerns in the context of improving health for young people in the US and elsewhere, and suggest that based on evidence uncovered to date, increasing digital connection may be having no less favorable than adverse effect on adolescents.

Keywords
adolescents; behavioral health; development; digital communication; mental health

Issue
This editorial is part of the issue "Adolescents in the Digital Age: Effects on Health and Development", edited by Dan Romer (University of Pennsylvania, USA).

This thematic issue highlights both opportunities and hazards for adolescents in the digital age. Although it is common to emphasize the hazards more than the benefits (see George & Odgers, 2015), it is also important to recognize that on a variety of health indicators, young people are healthier today than before the digital age. Looking at recent trends in the US, use of major drugs of dependence has declined since their peak in the 1970's (Figure 1). Adolescent birth rates have declined (Figure 2), and deaths due to all forms of violence have remained the same for females and declined for males (Figure 3). Deaths from motor vehicle crashes have been on the decline (Figure 4). Although adolescent suicide rates have risen since 2007 in concert with the 2008 economic crisis (Figure 5), this trend has affected a wide age range in the US, suggesting that adolescents do not appear to be at unique risk (Curtin, Warner, & Hedegaard, 2016).

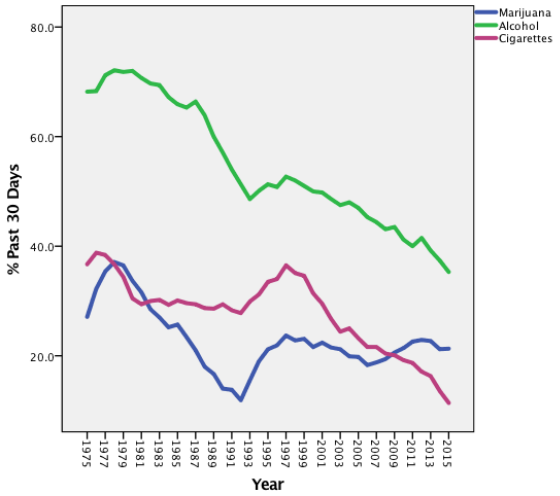

Figure 1. Rates of drug use by US high school 12th graders based on the Monitoring the Future study. Source: Johnston, O'Malley, Miech, Bachman and Schulenberg (2016).

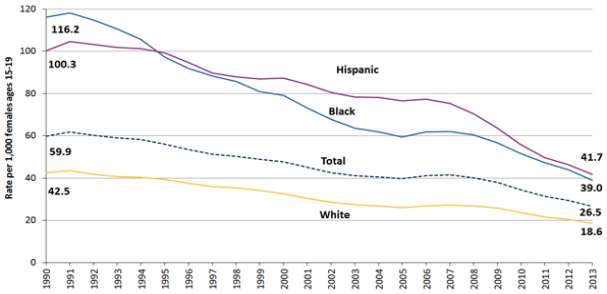

Figure 2. Birth rates to adolescents ages 15–19 in US from 1990–2013. Source: Office of Adolescent Health (2016).

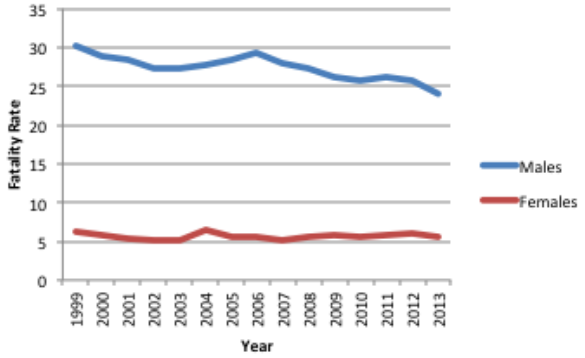

Figure 3. Rates per 100,000 of violent fatalities, including homicide and suicide from 1999 to 2013 in US. Source: Centers for Disease Control and Prevention (2016).

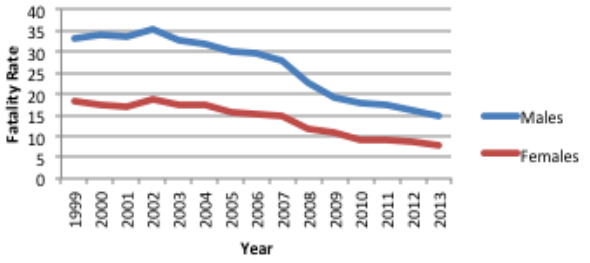

Figure 4. Rates per 100,000 of motor vehicle deaths in adolescents from 1999 to 2013 in US. Source: Centers for Disease Control and Prevention (2016).

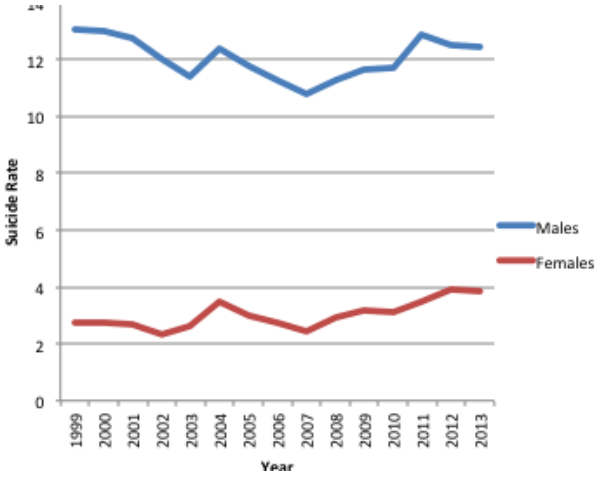

Figure 5. Rates per 100,000 of suicide deaths in adolescents from 1999 to 2013 in US. Source: Centers for Disease Control and Prevention (2016).

At this broad level, there is little to suggest that enhanced digital connectivity has altered the mostly favorable trajectories of adolescent health in the US. A recent review of the health of children and adolescents in the UK similarly found that indicators of mental and behavioral health problems have either remained the same or declined in recent years (Hagell, Coleman, & Brooks, 2016). According to the Good Childhood Report (Pople, Rees, Main, & Bradshaw, 2015), adolescents in the UK have reported steady levels of overall wellbeing from 2009 to 2013. Thus, in both the US and the UK, epidemiological trends in adolescent health do not correlate significantly with greater digital connectivity over the past 20 years. This finding is consistent with the observation that, while greater digital connectivity has dramatically changed adolescents' lifestyles, those changes may not have affected health for the better or for the worse.

As noted in the review by Mills (2016) adolescents today are using digital communication to enhance their connection with friends in the offline world. In a national study of US adolescents conducted by Dunlop, More and Romer (2011), they found that although users of social networking sites were more likely to be exposed to stories about someone they knew who either attempted or died by suicide, increased awareness of suicide did not lead to greater suicidal ideation. It is conceivable that the social support provided by others on social media can be protective against self-harm and suicide. Use of online forums, however, predicted increases in suicidal ideation. This is consistent with Mills' review (2016) suggesting that users of social networking sites are, on average, better adjusted than those who shun such sites, but that users who are troubled are at greater risk for bad experiences in online interactions with strangers. Nevertheless, some health promoting uses of the internet and social media have allowed previously marginalized or isolated youth to connect, communicate, and build community, as has been seen with sexual minorities (e.g., Rattan & Ambady, 2014; Tropiano, 2014). At the same time, the rise of pro-ana and pro-mia eating disorder sites illustrates how some uses of the internet have supported dysfunctional behavior (Borzekowski, Schenk, Wilson, & Peebles, 2010; Peebles et al., 2012; Wilson, Peebles, Hardy, & Litt, 2006). As dramatically as digital media have changed how adolescents live and communicate with peers and the world, it is possible that those changes have not translated into overall greater risks to health. We may be witnessing how adolescent behaviors that previously played themselves out in the offline world are now migrating to the digital environment, which may increase some health risks and attenuate others

Again on the positive side, the internet has provided adolescents with greater opportunities to access health information in a private, controllable setting. As

documented by Wartella and colleagues (2016), adolescents are using digital resources to access information about their bodies, health, and wellbeing. What is less clear is whether the information they are acquiring is leading to improvements in their health. Poor youth continue to experience barriers to accessing health information as well as health care in the US, reflecting the persistence of the digital divide and adding further urgency to the need to close the gap between the "haves" and the "have-nots". Recent efforts by the US Federal Communication Commission to close the digital information gap may serve to redress this important need.

The study by Bleakley and colleagues (2016) regarding the phenomenon of internet addiction shows that for adolescents who have unsupportive families and problems with social adjustment, the 24/7 lure of the internet may be difficult to resist. Youth with impulse control or attention problems are more likely to overuse the internet for either escape (game playing) or attempts to connect with others (social networking). As the review by Mills (2016) also suggested, these youth are unlikely to benefit from their retreat to the online world. Given the similarities in risk factors and our growing understanding of addictive personalities that move from one "high" to another, it would be interesting to examine whether drug dependence declines with the increase in overuse of interactive media.

Adolescent behavior is strongly influenced by peer networks. The effects of peer involvement in bullying, drug use, and risky sexual behavior have long been observed in the offline world. It is no surprise that such problems have migrated online. The reviews by Stevens and colleagues (2016) and Edwards and colleagues (2016) highlight how youth of color in the US use some social media, such as Twitter and Instagram, more than others, and how more needs to be known about the effects of online communication in these communities. The concept of a digital neighborhood suggested by Stevens et al. (2016) invites consideration of how the online world may both mirror and deviate from what has traditionally occurred offline. Of particular importance, the ability to reach such networks efficiently online opens the possibility of intervening to reduce harmful and enhance helpful peer effects.

Consistent with this opportunity, Moreno and colleagues (2016) present an interesting analysis of the various uses that social media afford for youth, not only to communicate but also to form identities. They suggest that with greater understanding of these affordances, we may be better able to develop mechanisms that protect youth from the potentially harmful peer effects that can occur online.

It is particularly concerning that advertisers have found ways to leverage adolescent engagement with the influential power of digital media to market potentially unhealthy products, such as alcohol, tobacco, and high energy-low nutrition food (Dunlop et al., 2016). These trends call for greater efforts to restrict this marketing or to counteract it with social marketing as has been conducted in traditional media.

Perhaps the most direct link between digital communication and potential harm to adolescents is the concerning evidence on texting while driving (Delgado, Wanner, & McDonald, 2016). While the digital age has introduced smartphones, global positioning systems (GPS), and digital screen entertainment in cars, all of which can distract while driving, greater digital connectivity between adolescents may actually have reduced their need to drive. Although obtaining a driver's license has been a traditional adolescent rite of passage, adolescents can now connect and socialize with the swipe of a finger. While car manufacturers advertise that their vehicles are more connected and feature more screens, the risks of distracted driving, whether due to texting, using GPS, or tuning the radio, are elevated. Public health efforts to make the driver less distracted while driving are surely an agenda item for the future.

There is no question that today's adolescents are growing up in an environment so different from that of their parents as to be almost unrecognizable. It is certainly changing the way that they learn, communicate, and socialize. Time will tell if their brains are developing differently due to the transformed psychosocial environment in which they are embedded. But at this time, there is scant evidence that the digital revolution has placed them at increased overall health risk.

There are concerns, nevertheless, that should be taken seriously. Today's youth may be the first generation in history with a lower life expectancy than their parents (Olshansky et al., 2005), and some educators' have suggested that easy access to communication and information has impeded the development of in-person communication (e.g., Turkle, 2015) and reflective thinking (e.g., Carr, 2010). What we must be cautious about is the connections that we draw. Just because we may see positive and negative changes in behavior and health risk during the digital revolution does not mean that they are caused or contributed to by digital connectivity. Health outcomes in many of the traditional areas of concern are actually improving, as we have seen, but we must remain alert for similar problems emerging in areas where we are not yet looking. Human nature has not changed—we will make the same mistakes as we always have—but the outcomes of those mistakes may be different in the digital age.

In conclusion, despite areas of concern, there is also reason for optimism. Ubiquitous and affordable digital connectivity is giving adolescents greater freedom and more opportunities to exert their independence and autonomy. Adolescents today have greater access to information about their bodies, their selves, and the world in which they are living, all of which may lead to

effects not seen in their predecessors. It is what they do with this enhanced connectivity that will most powerfully influence their health and wellbeing.

Conflict of Interests

The authors declare no conflict of interests.

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Media and Communication (ISSN: 2183-2439)

Media and Communication is an international open access journal dedicated to a wide variety of basic and applied research in communication and its related fields. It aims at providing a research forum on the social and cultural relevance of media and communication processes.

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