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Is it Too Soon to Meet? Examining Differences in Geosocial Networking App Use and Sexual Risk Behavior of Emerging Adults

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Abstract Location-based geosocial networking smartphone applications (GSN apps) have become a popular way to meet romantic and casual sex partners. Although first used primarily by men who have sex with men (MSM), GSN apps are now commonly used in the population at large, particularly among emerging adults. Although, these apps may potentially contribute to increases in STI/HIV incidence, previous research linking GSN app use to sexual risk behavior has been mixed, with some suggesting app users report greater sexual risk behavior and others suggesting less. The present paper details findings of two studies with independent samples of emerging adults. The first, a pilot study, examined GSN app use among young MSM ($n = 64$) to identify possible within-group factors relating dating app use to sexual risk behavior. Results indicated that the time app users spent talking to each other through the app before meeting in person (time before meeting) was related to engagement in sexual risk behavior. Those who talked less before meeting in person engaged in more sexual risk behaviors than those who spent more time talking before meeting in person. The second study sought to expand upon this finding in a more representative sample of GSN app users ($n = 129$) and compared sexual risk behavior and impulsivity to non-users ($n = 88$). There were no differences in sexual risk behavior between GSN app users and non-users. However, when examining app users by time before meeting, those with a shorter time before meeting were more impulsive and more likely to report sexual risk behavior. These findings highlight the importance of understanding GSN app use in the spread of STIs/HIV among emerging adults.

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Introduction

In recent years, geosocial networking smartphone applications (GSN apps) have introduced a cultural shift in the way individuals find and meet romantic and casual sex partners. GSN apps—commonly referred to as dating or "hookup" apps—connect users based on geographic location and provide a private chat platform that allows individuals to communicate, making it easier to meet potential partners (Rice et al. 2012). According to a Pew Research Poll, one in every ten American adults have used an app or online site to find a partner, and GSN app users tend to be younger than non-users (Phillips et al. 2014; Smith and Duggan 2013).

Emerging adults, or individuals between the ages of 18–24, engage in higher rates of sexual risk taking than older adults, and therefore have higher rates of STI transmission and acquisition (Victor and Hariri 2016). Since this age demographic is also more likely to use GSN apps, it is especially important to understand the potential link between GSN app use and sexual risk behavior in this population. Fifty percent of all new STIs are contracted by adolescents and emerging adults, and HIV contraction is especially prevalent among these age groups (CDC 2016b, c). This disparity may be related to factors including need for instant gratification (including for sexual rewards), use of technology which facilitates this need (e.g., GSN apps), increased opportunity, lack of knowledge about and concern for contracting an STI/HIV, and inconsistent use of condoms (Camacho-Gonzalez et al. 2016; Warren et al. 2015). The popular media has implicated GSN app use in increased engagement in sexual risk behavior and poor sexual health outcomes among emerging adults (Sales 2015; Schumaker 2015). Thus, for early detection and prevention purposes, it is essential to identify emerging adults who are at high risk for contracting or spreading STIs/HIV, such as GSN app users.

Although GSN apps were originally used exclusively by MSM, they have now become popular among many emerging adults as an avenue to meet partners (Grov et al. 2014). Tinder, which caters to individuals of all sexual orientations, is the most widely used GSN app, with millions of daily users (Sumter et al. 2017). Before being able to speak directly with each other, Tinder users are shown photos and selective descriptive information of other users who fit previously specified preferences including gender, age, and geographic proximity (from <1 to 100 miles away). Users are then prompted to either accept or reject the person shown on the screen. If both parties have accepted each other, Tinder notifies the users that they have "matched" and communication can begin (Sumter et al. 2017). As with Tinder and other GSN apps, users can talk to each other through an in-app chat platform, schedule to meet in person and, if desired, engage in casual sex.

Despite the widespread and growing use of GSN apps by emerging adults, previous research has largely focused on its use in men who have sex with men (MSM; Holloway et al. 2014a). Although some MSM report that they use a GSN app to find friends or for dating, the majority of users also report using the app to

find partners for casual sex (Beymer et al. 2014; Grosskopf et al. 2014). Prior research on the impact of these apps on sexual health remains limited and mixed. MSM were more likely to use a condom with a partner met through Grindr, a popular GSN app catering to MSM, than a partner met through other means (Rice et al. 2012). However, another study found that MSM using GSN apps were twice as likely to report unprotected anal intercourse (UAI) with their last partner met through any dating medium, and four times more likely to report UAI with their last app met partner (Holloway et al. 2015). A recent systematic review highlighted the inconsistencies and variations in rates of sexual risk behavior linked to GSN app users as a whole (Choi et al. 2016). Due to these mixed findings, understanding individual level factors among GSN app users which may facilitate sexual risk is important.

Impulsivity, a multifaceted behavioral construct that describes lack of behavioral self-regulation, less planning of actions, and reduced concern for future consequences, is frequently linked to health risk behaviors (Logan et al. 1997; Reynolds et al. 2008; Semple et al. 2006). Specifically, impulsivity has been linked to sexual risk behaviors in youth, including not refusing unsafe sex, engaging in risky sexual encounters (i.e., sex with a stranger), not using contraceptives or condoms, having a greater number of lifetime partners, and a history of STI diagnosis (Donohew et al. 2000; Hoyle et al. 2000; Kahn et al. 2002). Although not specific to GSN apps, a link between impulsivity traits, sexting, and sexual behavior was also found (Dir and Cyders 2015).

Additionally, because there are many different motivations for using a GSN app (Beymer et al. 2014; Grosskopf et al. 2014), it is likely that individuals with different reasons for using the app act differently. For example, an individual looking for casual sex partners may prefer to meet quickly in person rather than talking at length through the app, while an individual seeking a romantic or committed relationship may prefer to get to know someone by chatting through the app before investing time to meet in person.

There is a lack of research on GSN app use in populations other than MSM, even though heterosexual males and females have become the largest groups of GSN app users. Prior research has also focused on differences between GSN app users and non-users, with mixed-findings. This highlights the need to understand within-group differences among GSN app users that may contribute to why some users are more likely to engage in sexual risk behaviors than others. Therefore, our first study was an exploratory study of young MSM GSN app users, with the objective of identifying within-group differences of GSN app users that might be related to sexual risk behavior. This study examined whether the time individuals talk through the app before meeting in person (time before meeting) is indicative of engagement in sexual risk behavior. Because individuals use GSN apps for different reasons, time before meeting may be a behavioral characterization of someone's intentions for use of an app (e.g., for casual sex, making friends, or dating).

The second study was designed to build upon the findings of Study 1, examining a larger sample of emerging adults, including both heterosexual and sexual minority men and women, to (1) investigate differences in sexual risk behaviors between GSN app users and non-users, (2) to examine sexual risk behavior in GSN app users

based on time before meeting, and (3) to examine group differences in impulsivity by time before meeting. Based on the mixed associations of GSN app use and sexual risk behavior in past studies, we hypothesize that GSN app users will not differ from non-users in sexual risk behavior, but that differences will emerge among users based on time before meeting. Specifically, users who spend less time talking before meeting a partner in person would be more impulsive and report more sexual risk behaviors.

Study 1

This study was approved by the Institutional Review Board and informed consent was obtained from all participants. Emerging adult MSM (ages 18–24) who use GSN apps ($n = 64$, $M_{age} = 22.65$, SD = 1.38) were recruited through Amazon Mechanical Turk (MTurk). MTurk is an online crowdsourcing platform that allows researchers or other individuals to post studies, surveys, or other "Human Intelligence Tasks" (HITs) for compensation (for details about the use of MTurk in research, see, e.g., Mason and Suri 2012). This platform is particularly useful for recruiting special populations (Shapiro et al. 2013), and has been used in previous studies of sexual risk behavior among MSM (e.g., Herrmann et al. 2015). In the present study, a posting was made advertising the study as "an examination of sexual behavior within the context of social networking app use." Potential participants were able to view the study posting if they resided in the United States and if at least 95% of their previous HITs had been approved. Qualifying participants were directed to the online questionnaire, which took approximately 30 min to complete, and were compensated $10 their time. The majority of participants were White ($n = 39$, 59%), and there were equal numbers of homosexuals ($n = 26$, 39.4%) and bisexuals ($n = 26$, 39.4%, Table 1). Individuals who identified as heterosexual ($n = 10$, 15.6%) or questioning ($n = 2$, 3.1%) but also endorsed having sex with men were included in the present study.

Measures

HIV Risk Behavior

An author-constructed sexual risk behavior questionnaire included age of initiation for the following behaviors: kiss, touching underneath clothing, touching genitals, sexting, oral sex, and intercourse. These ages were recoded, based off of categories used by Coker et al. (1994), as age 13 or younger, 14–15, 16 or older, and never engaged in the respective behavior, to reflect early, mid and late adolescence. Also queried was the number of lifetime oral sex and intercourse partners, condom use frequency over the past year (ranging from "never" to "always"), and ever having unprotected sex outside of a committed relationship (yes or no). Attitudes towards casual sex were also assessed via the following two questions (1) having had or a willingness to have multiple oral sex or intercourse partners in the same week or (2) having had or willingness to have oral sex or intercourse with someone met recently

Table 1 Study 1 participant demographics grouped by time before meeting

	A few days or less		About a week		A few weeks or more		Total	
	n	%	*n*	%	*n*	%	*n*	%
Sample size	21	38.75	18	26.25	25	35.0	64	
Ethnicity								
White	14	66.7	11	61.1	14	56.0	39	60.9
African American	3	14.3	4	22.2	8	32.0	15	23.4
Hispanic	2	9.5	2	11.1	–	–	4	6.3
Asian	1	4.8	1	5.6	1	4.0	3	4.7
Mixed race/other	1	4.8	–	–	2	8.0	3	4.7
Sexual orientation								
Homosexual	10	47.6	5	27.8	11	44.0	26	40.6
Bisexual	7	33.3	9	50	10	40.0	26	40.6
Heterosexual (and have sex with men)	3	14.3	4	22.2	3	12.0	10	15.6
Questioning	1	4.8	–	–	1	4.0	2	3.1
Geographic region								
South	7	33.3	7	38.9	7	28.0	21	32.8
West	5	23.8	5	27.8	6	24.0	16	25.0
North	4	19.0	5	27.8	6	24.0	15	23.4
Midwest	5	23.8	1	5.6	6	24.0	12	18.8
Relationship status								
Dating	12	57.1	17	94.4	16	64.0	45	70.3
Single	7	33.3	1	5.6	4	16.0	12	18.8
Monogamous	2	9.5	–	–	5	20.0	7	10.9
	m	*S.D.*	*m*	*S.D.*	*m*	*S.D.*	*m*	*S.D.*
Age	22.52	1.57	22.44	1.14	22.82	1.38	22.65	1.38

for the first time. Finally, the frequency of substance use before sex ("e.g., alcohol, marijuana, poppers, ecstasy, etc.") was assessed from "never" to "always."

Geosocial Networking App Use

To determine current GSN app use, participants were asked if they used a smartphone application to meet people in their area (e.g., Tinder, Grindr). The present study modified previously published questionnaires assessing GSN app use (Landovitz et al. 2013; Rice et al. 2012). Questions included the duration and frequency of GSN app use (less than a month, 1–6 months, 6 months-1 year, more than 1 year), as well as the number of partners (from 0 to 6 or more) that were (1) talked to and met, (2) kissed/fondled (touched penis), (3) had oral sex with, and (4) had intercourse through the app with in the past month. Also assessed was the

likelihood of condom use and willingness to have sex with a partner met through an app (from "definitely" to "not likely").

The amount of time an individual talked to someone on a GSN app before meeting them in person, or time before meeting, was measured using a five-point scale, ranging from "same day," "a few days," "about a week," "a few weeks," "a month or more." This variable was recoded into three groups: (1) a few days or less, (2) about a week and (3) a few weeks or more.

Statistical Analysis

One-way ANOVA analyses were used to examine whether HIV risk behaviors and other sexual behaviors differ by ethnicity, relationship status, and sexual orientation. Based on the results of these analyses, ethnicity, relationship status, and sexual orientation were included as covariates in all ANCOVA analyses in which each dependent variable of interest differed according to one of the selected covariates (see Table 2). Finally, one-way ANCOVA analyses were conducted to detect between-group differences in HIV risk behavior and GSN app use based on time before meeting. The Bonferonni correction (Dunn 1961) was utilized in all analyses in order to control for increased risk of Type I error due to the use of multiple statistical analyses.

Results and Discussion

HIV Risk Behavior

In terms of age of initiation of various sexual behaviors, initiation of sexting [$F(2,61) = 5.60$, $p = .006$] and oral sex [$F(2,60) = 5.53$, $p = .006$] differed by time before meeting, such that individuals spending a few days or less before meeting reported engaging in sexting behavior and oral sex at a younger age than individuals with longer time before meeting. Both lifetime oral sex partners [$F(2,57) = 18.87$, $p < .001$] and lifetime intercourse partners [$F(2,59) = 11.71$, $p < .001$] differed by time before meeting, such that individuals who met in person after a few days or less of talking reported having more lifetime oral sex and intercourse partners than individuals who met after a week or more. There were no differences in condom use frequency by group ($p > .05$). See Table 3 for means and standard deviations.

GSN App Use

GSN app users with whom the participant met in person [$F(2,61) = 8.56$, $p = .001$] and engaged in oral sex [$F(2,60) = 12.49$, $p < .001$] differed by time before meeting, such that individuals who waited a few days or less before meeting met more people in person than individuals who waited a few weeks or more. Also, the former engaged in oral sex with more app-met partners than the latter. The self-reported likelihood of having oral sex with an app-met partner also differed by time before meeting [$F(2,59) = 8.71$, $p < .001$]. Individuals with a time before meeting

Table 2 ANOVA for identification of potential covariates for inclusion in later ANCOVA analyses

	Ethnicity		Relationship status		Sexual orientation	
	F	*p*	*F*	*p*	*F*	*p*
Sexual risk behaviors						
Kiss[a]	3.67	.010*	.39	.679	4.22	.009*
Touch under clothing[a]	4.40	.004*	.14	.868	1.34	.269
Touch genitals[a]	4.98	.002*	.54	.587	1.28	.290
Sexting[a]	.61	.656	.96	.388	.30	.826
Oral sex[a]	3.13	.022*	.35	.707	2.38	.079
Sexual intercourse[a]	2.26	.074	.48	.621	1.28	.290
Lifetime oral sex partners	.97	.432	.82	.445	.29	.829
Lifetime intercourse partners	.93	.453	1.65	.201	.44	.724
Condom frequency	.31	.868	.29	.751	.32	.810
Drugs before sex	.44	.782	.98	.382	1.10	.358
GSN App use						
Length of GSN use	.28	.890	.98	.382	1.78	.160
Talked to app	.99	.420	2.15	.125	.95	.421
Meet app	2.08	.095	3.03	.055	1.32	.276
Kiss app	2.07	.096	1.87	.163	1.22	.310
Oral app	2.93	.028*	1.64	.203	.79	.504
Sex app	.83	.512	4.60	.014*	.66	.581
Proportion of partners met through app	1.24	.302	2.56	.084	1.02	.392
Change in partners since downloading app	.33	.859	8.07	.001*	1.54	.214
Likelihood oral app[b]	4.81	.002*	3.32	.043*	1.10	.355
Likelihood sex app[b]	3.46	.013*	3.64	.032*	2.15	.103

[a] Values recorded as level of risk based on age of initiation of specified sexual activity, organized into the following categories where higher scores reflect greater HIV risk: 0 = never engaged in activity, 1 = initiation at age 16 or older, 2 = initiation at age 14 or 15, 3 = initiation at age 13 or younger

[b] Values recorded as a likelihood out of 100 to have sex with someone met through a GSN app

* Denotes significance at .05 level and inclusion in later ANCOVA analyses as a covariate with identified variable of interest

of a few days self-reported a greater likelihood of having oral sex with an app-met partner than individuals who waited a few weeks or more before meeting in person. See Table 4 for means and standard deviations.

Study 2

The first study identified time before meeting as a variable related to sexual risk behavior of young MSM who use GSN apps. Because this study was focused only on sexual minority men, we conducted Study 2 to determine if this finding was

Table 3 Study 1 HIV risk behaviors by time before meeting

	A few days or less		About a week		A few weeks or more		Time before meeting		Post hoc comparison[c]
	m	*SD*	*m*	*SD*	*m*	*SD*	*F*	*p*	
Sexual risk behaviors									
Kiss[ab]	2.24	0.19	1.56	0.20	1.96	0.17	3.10	0.052	–
Touch under clothing[ab]	1.95	0.16	1.22	0.18	1.72	0.15	4.81	0.012*	–
Touch genitals[ab]	1.72	0.15	1.17	0.16	1.52	0.13	3.23	0.046*	–
Sexting[a]	1.33	0.58	1.00	0.49	0.88	0.33	5.60	0.006**	1 > 3
Oral sex[ab]	1.62	0.14	0.95	0.15	1.23	0.13	5.53	0.006**	1 > 2
Sexual intercourse[a]	1.48	0.68	0.94	0.24	1.40	0.65	4.801	0.012*	–
Lifetime oral sex partners	15.71	8.87	6.00	3.52	4.61	5.03	18.87	<0.001**	1 > 2; 1 > 3
Lifetime intercourse partners	14.60	10.25	5.17	4.59	4.92	5.81	11.71	<0.001**	1 > 2; 1 > 3
Condom frequency	3.38	1.12	4.00	1.28	4.00	1.19	1.90	0.16	–
Drugs before sex	2.76	0.89	2.39	1.09	1.84	1.03	4.92	0.01*	–

[a] Values recorded as level of risk based on age of initiation of specified sexual activity, organized into the following categories where higher scores reflect greater HIV risk: 0 = never engaged in activity, 1 = initiation at age 16 or older, 2 = initiation at age 14 or 15, 3 = initiation at age 13 or younger

[b] Estimated marginal mean values reported due to inclusion of covariates in analyses

[c] Post hoc comparisons of group means according to time spent talking on GSN app before meeting, where 1 = few days or less, 2 = about a week, and 3 = few weeks or more

* Denotes significance at .05 level, but no longer significant after controlling for excess Type I error due to multiple analyses using the Bonferroni correction

** Denotes significance after controlling for excess Type I error due to multiple analyses using the Bonferroni correction

generalizable to a broader population including heterosexuals and sexual minority women. In addition, Study 2 examined if there were differences in sexual risk behavior or impulsivity between GSN app users and non-users and time before meeting in relationship to impulsivity and sexual risk behavior.

Participants

A total of 229 emerging adults between ages 18–21 were recruited from Amazon Mechanical Turk (MTurk) and were paid $8 for their participation. Similar to Study 1, a posting advertising this study was listed on MTurk as, "An examination of sexual behavior within the context of social networking." Potential participants were able to view the study posting if they resided in the United States and if at least 95% of their previous HITs had been approved. Participants then clicked a link directing them to the online survey, and if they met the inclusion criteria they were

Table 4 Study 1 GSN app use behaviors by time before meeting

	A few days or less		About a week		A few weeks or more		Time before meeting		Post hoc comparison[d]
	m	*SD*	*m*	*SD*	*m*	*SD*	*F*	*p*	
GSN app use									
Length of GSN use	3.05	0.92	2.72	0.75	2.72	0.74	1.16	0.32	–
Talked to app[a]	3.81	0.93	3.33	0.77	3.08	1.12	3.30	0.04*	–
Meet app[a]	2.48	0.93	2.00	0.59	1.60	0.58	8.56	0.001**	1 > 3
Kiss app[a]	1.90	0.70	1.78	0.55	1.48	0.59	2.90	0.06	–
Oral app[ab]	2.05	0.11	1.62	0.12	1.32	0.10	12.49	<0.001**	1 > 2; 1 > 3
Sex app[ab]	1.86	0.12	1.56	0.12	1.40	0.12	4.27	0.018*	–
Proportion of partners met through app	4.10	0.89	4.22	1.22	4.76	1.27	2.21	0.12	–
Change in partners since downloading app[b]	2.15	0.13	2.38	0.14	2.45	0.12	1.77	0.18	–
Likelihood oral app[bc]	74.51	6.10	53.49	6.50	39.70	5.57	8.71	<0.001**	1 > 3
Likelihood sex app[bc]	61.12	6.07	55.46	6.47	45.46	5.54	1.84	0.17	–

[a] Denotes the number of individuals met through a GSN app that the participant engaged in each respective behavior with, coded as 1 = 0 individuals, 2 = 1–2 individuals, 3 = 3–5 individuals, and 4 = 6 or more individuals

[b] Estimated marginal mean values reported due to inclusion of covariates in analyses

[c] Values recorded as a likelihood out of 100 to have sex with someone met through a GSN app

[d] Post hoc comparisons of group means according to time spent talking on GSN app before meeting, where 1 = few days or less, 2 = about a week, and 3 = few weeks or more

* Denotes significance at .05 level, but no longer significant after controlling for excess Type I error due to multiple analyses using the Bonferroni correction

** Denotes significance even after controlling for excess Type I error due to multiple analyses using the Bonferroni correction

allowed to continue to the full survey. Participants were excluded for random responding ($n = 3$), as determined by missing "attention check" questions (e.g., "click 'strongly agree'"). Participants were also excluded for multiple attempts at meeting eligibility ($n = 9$), in which these participants attempted the pre-screening survey several times using their same unique MTurk Worker ID and changed their demographic information until they met inclusion criteria. This resulted in a final sample of 217 ($M_{age} = 20.23$, SD = 0.85). There were roughly equal numbers of males ($n = 105$, 48.4%) and females ($n = 112$, 51.6%). The majority of participants identified as white ($n = 143$, 65.9%), while other races and ethnicities included Asian ($n = 27$, 12.4%), Black ($n = 19$, 8.8%), Hispanic ($n = 16$, 7.4%), and mixed race/other ($n = 12$, 5.5%). In addition, most participants were heterosexual ($n = 149$, 68.7%), followed by bisexual ($n = 47$, 21.7%) and

Table 5 Study 2 participant demographics grouped by time before meeting

	Do not use GSN		A few days or less		About a week		A few weeks or more		Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Sample size	87	40.1	48	22.1	35	16.1	47	21.7	217	
Gender										
Male	37	42.5	28	58.3	19	54.3	19	40.4	103	47.5
Female	50	57.5	20	41.7	16	45.7	28	59.6	114	52.5
Ethnicity										
White	66	75.9	26	54.2	22	62.9	30	63.8	144	66.4
African American	4	4.6	4	8.3	3	8.6	7	14.9	18	8.3
Hispanic	4	4.6	4	8.3	3	8.6	5	10.6	16	7.4
Asian	8	9.2	8	16.7	7	20	4	8.5	27	12.4
Mixed race/other	5	5.7	6	12.5	–	–	1	2.1	11	5.1
Sexual orientation										
Heterosexual	63	72.4	28	58.3	24	68.6	32	68.1	147	67.7
Homosexual	6	6.9	5	10.4	3	8.6	7	14.9	21	9.7
Bisexual	16	18.4	15	31.3	8	22.9	7	14.9	46	21.2
Other	2	2.3	–	–	–	–	1	2.1	3	1.4
Geographic region										
West	17	19.5	9	18.8	8	22.9	6	12.8	40	18.4
Midwest	21	24.1	16	33.3	9	25.7	8	17	54	24.9
Southwest	3	3.4	3	6.3	2	5.7	5	10.6	13	6
Southeast	25	28.7	9	18.8	5	14.3	12	25.5	51	23.5
Northeast	21	24.1	11	22.9	11	31.4	16	34	59	27.2
Relationship status										
In a relationship	64	73.6	24	50	22	62.9	35	74.5	145	66.8
Not in a relationship	23		24	50	13	37.1	12	25.5	72	33.2
	m	*S.D.*	*m*	*S.D.*	*m*	*S.D.*	*m*	*S.D.*	*m*	*S.D.*
Age	20.17	.88	20.10	.95	20.34	.76	20.47	.65	20.25	.84

exclusively homosexual (gay or lesbian, $n = 21$, 9.7%). Full demographic data is presented in Table 5. To maintain independent samples, individuals who participated in Study 1 (based on their independent Amazon Worker IDs) were unable to see the advertisement for Study 2 on MTurk, and were therefore unable to participate in Study 2.

Measures

Participants completed a survey assessing demographics, sexual risk behavior, geosocial networking application use, and other measures not immediately relevant to the present analysis, as part of a larger study on sexual risk behavior and technology use. Total survey completion took approximately 30 min.

Sexual Risk Behavior

Sexual behavior was assessed using the Safer Sex Behavior Questionnaire (SSBQ; DiIorio et al. 1992) and the HIV Risk Behavior Scale (HRBS), sexual behavior subscale (Darke et al. 1991).

The SSBQ is a 24-item questionnaire (Cronbach's $\alpha = .80$ for males and .83 for females) used to measure safe sex behaviors that reduce the rates of STI/HIV transmission and unplanned pregnancy. This measure uses a 4 point Likert-type scale ranging from "never" to "always" to query four areas of sexual behavior: using protection during intercourse, avoiding risky behaviors (i.e., anal sex), avoiding bodily fluids, and asking partners about their sexual history/negotiating to practice safe sex behaviors. Therefore, it is designed such that higher scores reflect safer behavior, with scores ranging from 27 (riskiest behavior) to 108 (least risky behavior). In addition to heterosexual participants, the original validation study of the SSBQ included non-heterosexual participants (DiIorio et al. 1992) and it has been used with sexual minority populations (De Santis et al. 2011).

The HRBS is an 11-item questionnaire assessing HIV-specific risk behaviors with two subscales: injection drug use and sexual risk behavior (Cronbach's $\alpha = 0.70$). For the present study, only 3 individuals (1.4%) endorsed injection drug use in the past month; therefore, the injection drug use subscale was not used in the present analyses. The 5-item sexual risk behavior subscale assesses past-month: condom use, number of sexual partners, and anal sex. Higher scores indicate riskier behavior.

Impulsivity

Impulsivity was measured using the Barratt Impulsiveness Scale (BIS-11; Patton and Stanford 1995). This measure consists of 30 questions on a 4-point Likert scale from "rarely/never" to "almost always/always," with higher scales indicating more impulsivity. The BIS-11 assesses personality and behavioral variables associated with impulsivity: attentional impulsivity, or the inability to focus on present tasks; motor impulsivity, or acting without forethought; and non-planning impulsivity, or a disregard for future consequences (Stanford et al. 2009).

GSN App Use

An author-constructed questionnaire, based on questions used in previous studies of GSN app users, assessed behaviors specifically related to the use of GSN apps (Landovitz et al. 2013; Rice et al. 2012). First, participants were asked if they "currently use a location-based smartphone dating application such as Grindr or Tinder" (yes or no). Participants who endorsed current use of a GSN app were also asked their main reason for using the app, including networking, making friends, dating, casual sex, boredom, or other. Participants also reported how their number of sexual partners has changed since downloading the app (decreased, stayed the same, or increased), and how willing they would be to have sex with someone met through

the app (on a continuous scale from 0, "not willing at all" to 100, "completely willing").

Time before meeting was defined as the amount of time an individual talks to someone on a GSN app before meeting in person. It was measured using a four-point scale including "a few days or less," "a week," "a few weeks to a month," and "a month or more." The latter two response choices were combined to create three groups for analysis: Those with a time before meeting of a few days or less, about a week, and a few weeks or more.

Statistical Analysis

The SSBQ and BIS total scores were normally distributed (Shapiro–Wilks' = .99, $p > .14$), whereas HRBS was extremely positively skewed and transformation could not correct non-normality issue (Shapiro–Wilks' = .90, $p < .001$). Therefore, an appropriate nonparametric test was used to compare HRBS scores between GSN user and non-user groups. Univariate analyses of variance were conducted with SSBQ and BIS scores. Levene's test was used to test homogeneity of variance. Analysis of covariance (ANCOVA) was conducted to examine whether impulsivity would account for the group difference in unsafe sexual practices. All results were considered significant at $p < 0.05$, two-tailed tests.

Results and Discussion

Pearson Chi square test indicated no gender difference in using versus not using GSN apps, χ^2 (1) = 0.92, $p = .34$ and time before meeting, χ^2 (2) = 3.41, $p = 0.18$. Additionally, sexual orientation was not significantly different between users and non-users, χ^2 (1) = 1.20, $p = 0.27$ and time before meeting, χ^2 (2) = 1.32, $p = 0.52$.

Sexual Risk Behavior Between GSN App Users and Non-users

First, we examined whether people using GSN apps would engage in more sexual risk behavior than non-users. GSN app use was very common, with the majority ($n = 131$, 59.5%) endorsing current use of a GSN app. The results of one-way ANOVA indicated that SSBQ scores were not different between users and non-users, $F(1, 215) = 1.24$, $p = 0.29$, Levene's test = 1.01, $p = 0.30$. Therefore, safe sex behaviors were comparable between the users ($M = 67.2$, $SD = 10.9$) and the non-users ($M = 68.9$, $SD = 11.26$). Similarly, the results of pairwise two-tailed Mann–Whitney U test indicated that there were no differences between users and non-users on the HRBS scale ($p = 0.19$), suggesting no group difference in HIV-related health risk behaviors.

Second, we examined whether levels of sexual risk behavior differed by time before meeting. Four groups were compared on time before meeting: those who do not use GSN apps, those who talked a few days or less, those who talked about a week, and those who talked a few weeks or more before meeting in person. The results of a one-way ANOVA indicated that sexual risk behavior differed among the

four groups on the HRBS, $F(3, 214) = 2.74$, $p = 0.04$, $\eta^2 = .04$, Levene's test = 1.56, $p = 0.20$. The result of Bonferroni post hoc analysis indicated that individuals with a time before meeting of a few days or less engaged in more unsafe sexual practices ($M_{SSBQ} = 64.2$, $SD = 12.2$) than individuals with a time before meeting of about a week ($M = 70.4$, $SD = 10.0$), $p = 0.02$. The results of bootstrap analysis with 1000 samples indicated minimal bias (-0.03) in the group mean difference. There were no group differences for other groups ($p > 0.05$). Therefore, GSN app users who reported a time before meeting of a few days or less were found to engage in less safe sex, or more sexual risk behavior when compared to non-app users and app users who had a time before meeting of more than a few days (Fig. 1).

An examination of group differences for the HRBS sexual behavior subscale found similar results, with a Kruskal–Wallis Test revealing group differences ($p = 0.03$). The results of a pairwise two tailed Mann–Whitney U Test indicated that those with a time before meeting of a few days or less engaged in more sexual risk behavior than those with a time before meeting of a few weeks or more ($p = .003$, Fig. 1). In addition, individuals with a time before meeting of about a week also were significantly more likely to engage in sexual risk behavior than those who waited a few weeks or more ($p = 0.02$).

Sexual Risk Behavior and Impulsivity

Next, BIS score was entered as a covariate to examine whether impulsivity would account for the group difference in unsafe sexual practices. When entering BIS total scores as covariate, the originally significant group difference disappeared ($p = 0.20$) and the effect size was reduced (η^2 changed from .04 to .02). Therefore, impulsivity would account for 43% of the group difference in frequent safe sex. BIS total scores were different between groups, $F(3, 214) = 2.74$, $p = 0.04$, $\eta^2 = 0.04$ (Fig. 2). On average, individuals with a time before meeting of a few days or less reported the highest scores ($M = 68.8$, $SD = 11.6$), followed by those who talked

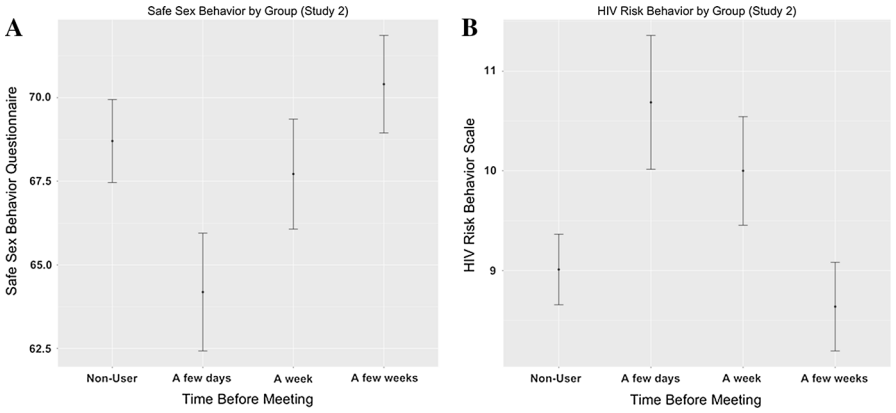

Fig. 1 Save sex behavior (**a**) and HIV risk behavior (**b**) in Study 2 grouped by time before meeting. Data are presented as mean and standard error of the mean

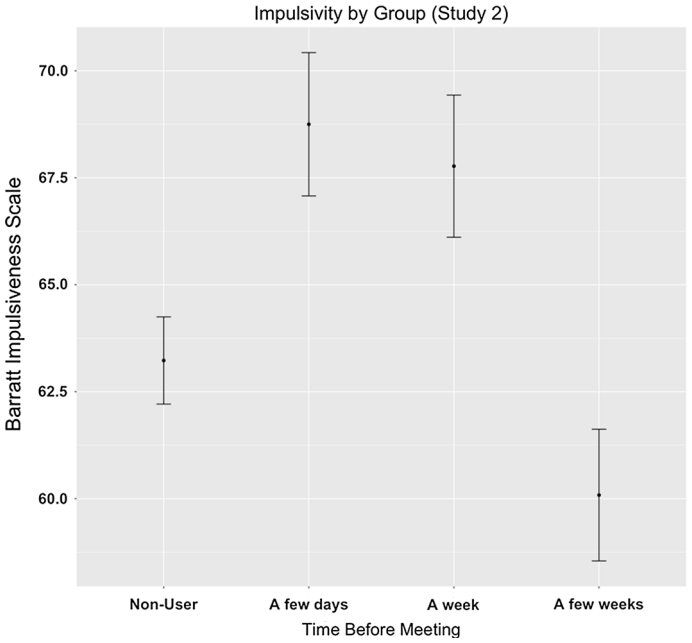

Fig. 2 Impulsivity in Study 2 grouped by time before meeting. Data are presented as mean and standard error

about a week ($M = 67.9$, $SD = 9.45$), non-users ($M = 63.3$, $SD = 9.45$), and those with a time before meeting of a few weeks or more ($M = 60.1$, $SD = 10.6$). The result of Bonferroni adjusted post hoc comparison indicated that those with a time before meeting of a few days or less were significantly more impulsive than both non-users ($p = 0.02$) and users with a time before meeting of a few weeks or more, ($p < 0.001$). Taken together, individuals who spent only a few days or less talking on an app before meeting in-person were more impulsive and engaged in more sexual risk behavior than individuals who spent at least a few weeks and those who did not use GSN apps.

GSN App Use

Current GSN app use was endorsed by the majority of participants ($n = 129$, 59.4%). An ANOVA revealed that individuals with a time before meeting of a few days or less were significantly more willing to engage in sex with someone met through a GSN app ($M = 68.3$, $p < 0.01$) than those with a time before meeting of a few weeks or more ($M = 46.7$). Among those with a time before meeting of a few days or less, the main reason for using a GSN app was "casual sex" ($n = 18$, 37.5%). Of participants with a time before meeting of about a week, the two main reasons for use were "casual sex" ($n = 13$, 37.1%) and "dating" ($n = 13$, 37.1%). Most individuals with a time before meeting of a few weeks or more reported the main reason for use as "boredom" ($n = 15$, 31.9%). Finally, a majority of

participants with a time before meeting of a few days or less reported an increase in sexual partners since downloading a GSN app ($n = 26$, 54.2%). Individuals with a time before meeting of about a week reported an increase ($n = 17$, 48.6%) and no change ($n = 18$, 51.4%) in the number of sexual partners. The large majority of individuals with a time before meeting of a few weeks or more reported no change in the number of sexual partners since downloading a GSN app ($n = 34$, 72.3%). See Table 6 for a full list of GSN app use behaviors.

Discussion

The present studies examined (1) within-subject factors of GSN app use related to sexual risk behavior by young MSM and (2) the relationship between GSN app use, impulsivity, and sexual risk behavior in a broad sample of emerging adults. The first study found that sexual risk behaviors of young MSM differed according to the time individuals talked to each other through an app before meeting in person, or time before meeting. Study 2 found no overall differences in sexual risk behavior or impulsivity between GSN app users and non-users. However, Study 2 replicated and extended the findings of Study 1, and group differences emerged when examining app users based on time before meeting, such that those with a time before meeting

Table 6 Study 2 GSN app use behaviors by time before meeting

	A few days or less		About a week		A few weeks or more	
	n	%	*n*	%	*n*	%
Main reason for using a GSN app						
Networking	2	4.2	2	5.7	3	6.4
Making friends	7	14.6	1	2.9	9	19.1
Dating	8	16.7	13	37.1	14	29.8
Casual sex	18	37.5	13	37.1	4	8.5
Boredom	11	22.9	6	17.1	15	31.9
Other	2	4.2	–	–	2	4.3
More likely to use a condom with partner met first through an app or in person?						
App	7	14.6	4	11.4	8	17.0
In person	3	6.3	2	5.7	1	2.1
Both the same	38	79.2	29	82.9	38	80.9
Number of sexual partners since downloading the app						
Increased	26	54.2	17	48.6	12	25.5
Decreased	1	2.1	–	–	1	2.1
Stayed the same	21	43.8	18	51.4	34	72.3
	m	SD	*m*	*SD*	*m*	SD
Willingness to have sex with app-met partner	68.3	31.1	63.26	27.9	46.7	33.4

of a few days or less were most impulsive and engaged in more sexual risk behavior than those with longer times before meeting and non-users. These results demonstrate the need to examine within group differences of GSN app users, as broad comparisons between users and non-users may be insufficient in identifying high-risk individuals.

Because there were no significant differences in sexual risk behavior scores between users and non-users, it appears that GSN apps do not increase risk behavior, but simply provide an environment that may facilitate engagement in sexual risk behavior. In other words, due to the large numbers of GSN app users, it may be that the cultural landscape of dating has changed from a mainly in person, traditional interaction to an online platform. A similar change was seen in the early 2000s when online dating became popular, and now hundreds of millions of individuals use online dating websites (Finkel et al. 2012). Online dating, which now includes GSN apps, has been described as fundamentally different than traditional, in person dating, particularly because it allows individuals access to a much greater number of potential partners than through offline means (Finkel et al. 2012). Therefore, GSN apps allow greater access to a number of potential sex partners who the individual may not have met otherwise. Thus, as the results highlight, it may not be the use of GSN apps that increases sexual risk, as these apps are now prevalent in the current dating landscape. Instead, it may be the intentions and how GSN apps are used that facilitate risk.

Although most GSN apps are not marketed specifically as "hookup apps" used to find casual sex partners, nearly half of the GSN app users in the present study reported an increase in sexual partners since downloading the app, similar to what has been found by MSM GSN app users (Rice et al. 2012). This clearly indicates that these apps are being used as a means to meet sexual partners. Not surprisingly, a larger number of lifetime sexual partners is linked to engagement in sexual risk behavior (Valois et al. 1999). GSN apps facilitate the initiation of sexual relationships with more individuals, thus expanding the likelihood to come in contact with someone who has an STI/HIV. Therefore, individuals who take advantage of the GSN app technology in order to find more sex partners—such as those with a shorter time before meeting—increase their risk for contracting and subsequently spreading STIs. Specifically, when compared to those with a time before meeting of a few weeks or more, those with a time before meeting of a few days or less were most likely to report an increase in sexual partners since downloading a GSN app, followed by those with a time before meeting of a week.

Both studies showed that there were no differences in condom use between groups, consistent with past findings that found similar rates of condom use between app users and non-users (Rice et al. 2012). This is striking, because although individuals with a shorter time before meeting scored higher on measures of sexual risk behavior, it appears that they use condoms at similar rates to objectively "less risky" groups, including non-users. This is encouraging, as it appears that although some groups are engaging in more risk behavior than others, they are still using condoms. In other words, individuals with a shorter time before meeting are more likely to report risk behaviors including casual sex and substance use before sex, but

the risk of contracting an STI/HIV that these behaviors could cause is mitigated by condom use.

Importantly, GSN apps have the potential to increase an individual's sexual network, which describes individuals who are "linked by sequential or concurrent sexual partners" (Healthy People 2020, 2016). Therefore, individuals who are considered low risk and have only one sexual partner may be exposed to HIV/STI risk if their partner engages in high-risk behaviors outside of or previous to their current relationship (Nordvik and Liljeros 2006). For example, if a lower-risk GSN app user has an unprotected sexual relationship with another GSN app user with a larger, riskier sexual network, they place themselves at increased risk for STI contraction. In addition, studies have shown that a large majority of HIV/STI transmissions occur between partners in serious relationships due to a decreased frequency of condom use between couples (Corbett et al. 2009; Greene et al. 2014; Hock-Long et al. 2013; Newcomb et al. 2014). This is especially relevant if individuals using GSN apps to find romantic partners are having more unprotected sex with a partner from a riskier sexual network. Future work should explore sexual networks within the context of GSN app use.

GSN app users were shown to have different motivations for using an app, which is important when considering the role these apps play in sexual risk behavior. Similar to findings from past studies, GSN app users in the present studies indicated a wide variety of reasons for using a GSN app, including making friends, dating, boredom, and finding casual sex partners (Beymer et al. 2014). This self-report data provides further insight into differences between users based on time before meeting. Most users with a time before meeting of a few days or less reported casual sex as their main motivation for using a GSN app, while the those with a time before meeting of about a week and a few weeks or more are more likely to report dating as the main reason for using the app. In addition, those with a time before meeting of about a week also frequently reported casual sex as a main reason for using the app. Not surprisingly, casual sex is linked with engagement in sexual risk behavior (Baldwin and Baldwin 1988). Individuals have been shown to engage in casual sex with people they are acquainted with more frequently than with strangers (Grello et al. 2006). Therefore, although individuals who have talked through a GSN app exclusively may be considered strangers by some, many people, especially adolescents and emerging adults, form friendships through online media (Amichai-Hamburger et al. 2013). This initial connection through a GSN app, through which users can see pictures and information about each other, may promote a sense of comfort after which individuals will be more likely to have casual sex with their app-met partner.

Furthermore, impulsivity was found to account for a large portion (43%) of the differences in sexual risk behavior by group in Study 2. This finding adds to the large body of literature linking impulsivity with sexual risk behavior (Baldwin and Baldwin 1988; Charnigo et al. 2013; Dir et al. 2014; Donohew et al. 2000; Hoyle et al. 2000). This was particularly relevant for individuals with a time before meeting of a few days or less, the most impulsive group. This suggests that individuals with a short time before meeting may be less able to delay gratification (e.g., sexual pleasure) until less risky behaviors are possible, such as discussing past

sexual histories. GSN apps enable rapid connections of individuals seeking "sex on demand," which allows impulsive app users the chance to have rash, unplanned sexual encounters (Beymer et al. 2014). Impulsivity is also related with lack of concern for future consequences. Therefore, when talking only a few days or less through the app, individuals may not take the time to consider the potential risk of contracting an STI/HIV before meeting a partner for casual sex.

On the other hand, individuals with a time before meeting of a few weeks or more are least impulsive, suggesting that these individuals are likely focused on forming long-term relationships rather than casual sex, are more risk aversive and are able to control impulses to engage in risk behaviors, should any arise. They may take longer talking through the apps because they are more interested in learning about the other person, including their sexual history, rather than a "no strings attached" hookup. However, because impulsivity accounted for less than half of the variance in group differences of sexual risk behavior, it is clear that other factors are contributing to GSN app users' engagement in sexual risk behavior. Therefore, future studies are necessary to identify these factors.

There are a few limitations to the present studies. There were a limited number of ethnic and racial minorities, who are especially vulnerable to HIV contraction. African American women are the highest risk group for contracting HIV other than MSM, and racial/ethnic minority MSM are also at increased risk compared to white MSM (CDC 2016a). Furthermore, MTurk use is limited to 18 years and older, so adolescents younger than 18 were not included in either study. Although Tinder now limits app use to individuals age 18 and older, it originally allowed users as young as age 13; therefore, future studies should examine GSN app use by adolescents, who are at especially high risk for STI/HIV acquisition. Next, recruitment of participants through MTurk does not allow for verification of current GSN app use status. While past studies have recruited directly through a GSN app (e.g., Holloway et al. 2014b), the recruitment method for the present study allowed for a more geographically diverse sample than would have been possible recruiting through the app—in which potential participants are limited within a specific geographic radius, usually of only a few miles. Similarly, online recruitment through MTurk may have over-sampled for GSN app users, as other individuals who use the Internet less frequently may also be less likely to use GSN apps. Similar to other online data collection methods, there are general limitations to using MTurk for behavioral research. For example, these findings cannot generalize to the population at large. There is also a potential for low-quality data (e.g., responses from automatic 'bot' programs) or random responses (Mason and Suri 2012); however, this was carefully monitored in the present studies. Still, overall, MTurk is well-studied as a source of high-quality data that allows for a diverse sample (Buhrmester et al. 2011; Shapiro et al. 2013).

Despite these limitations, there are several important findings to note. The use of GSN app technology does not appear to be a risk factor in and of itself for sexual risk behavior in general populations. However, examining within group differences of GSN app users reveals that individuals who talk a few days or less with partners through the app before meeting in person are more likely to engage in sexual risk behavior than those who talk longer before meeting. Furthermore, impulsivity was

closely related to time before meeting and subsequent engagement in sexual risk behavior; consistent with pervious findings linking impulsivity to sexual risk behavior. Future studies should continue to examine within-group differences of GSN app users in diverse populations, not just with men who have sex with men. There is a striking lack of literature on the use of GSN apps by heterosexuals, indicative of a potential to increase the spread of HIV/STIs if prevention strategies are not modified to target specific types of GSN app users who are likely to engage in sexual risk behavior. The present findings can be used to guide future research and intervention strategies, and provide a basis for generalization of findings from MSM GSN app users to other groups.

Compliance with Ethical Standards

All procedures in this study were approved by the Institutional Review Board at Texas A&M University in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflict of interest The authors declare that they have no conflict of interest.

Informed consent Informed consent was obtained from all individual participants included in the study.

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