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Assessing Causality in the Relationship Between Adolescents' Risky Sexual Online Behavior and Their Perceptions of this Behavior

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Abstract The main aim of this study was to investigate the causal nature of the relationship between adolescents' risky sexual behavior on the internet and their perceptions of this behavior. Engagement in the following online behaviors was assessed: searching online for someone to talk about sex, searching online for someone to have sex, sending intimate photos or videos to someone online, and sending one's telephone number and address to someone exclusively known online. The relationship between these behaviors and adolescents' perceptions of peer involvement, personal invulnerability, and risks and benefits was investigated. A two-wave longitudinal study among a representative sample of 1,445 Dutch adolescents aged 12–17 was conducted (49% females). Autoregressive cross-lagged structural equation models revealed that perceived peer involvement, perceived vulnerability, and perceived risks were all significant predictors of risky sexual online behavior 6 months later. No reverse causal paths were found. When the relationships between perceptions and risky sexual online behavior were modeled simultaneously, only perceived peer involvement was a determinant of risky sexual online behavior. Findings highlight the importance of addressing peer involvement in future interventions to reduce adolescents' risky sexual online behavior.

Keywords Adolescence · Internet · Risk behavior · Media · Teenagers · Risk perceptions

Introduction

Engagement in risk behaviors peaks during adolescence. Adolescents are over-represented in nearly every category of risk behavior, such as drug use, alcohol consumption, smoking, skipping school, and unsafe sexual activities (Bentlin et al. 1993; Boyer 2006; Dahl 2004; Furby and Beyth-Marom 1992; Parsons et al. 1997; Steinberg 2008). The rise of the internet may provide adolescents with many new outlets to engage in risk behaviors (Liau et al. 2005; Livingstone and Haddon 2008; Livingstone and Helsper 2007). Of these potential new risks, sexual online behaviors have been considered particularly alarming (Liau et al. 2005; Ybarra et al. 2007).

During adolescence the importance of sexuality strongly increases (Buzwell and Rosenthal 1996) and sexual curiosity peaks. To satisfy this sexual curiosity, adolescents may use the internet in unsafe ways. For example, they may send intimate information to strangers or search for sexual partners online. Previous research has indicated that these behaviors could lead to negative consequences, such as receiving unwanted requests for sexual pictures (Mitchell et al. 2007a; Ybarra et al. 2007), or making unsafe sexual contacts, which increase the risk of contracting sexually transmitted diseases (McFarlane et al. 2002). In sum, using the internet for sexual exploration may be potentially harmful for adolescents.

Despite public concerns (Ponte et al. 2009), little empirical research has investigated adolescents' risky sexual online behaviors. The few existing studies exploring this issue have focused mainly on the *prevalence* of these behaviors among youth. *Why* adolescents engage in risky sexual activities has rarely been investigated (Livingstone and Haddon 2008). Past research has examined more general predictors such as sociodemographic variables,

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parental monitoring, and the use of chat rooms (Lenhart 2005; Liao et al. 2005; Livingstone and Helsper 2007). More theoretically derived predictors have not been investigated to date. To advance our understanding of adolescents' risky sexual online behavior, the present study investigates theoretically derived cognitive predictors of risk behavior.

Theories concerning the predictors of adolescents' offline risk behavior can typically be divided into three groups: biological, psychological/cognitive, and environmental/social (Igra and Irwin 1996). Our study focuses on cognitive predictors, as adolescents' cognitions about risk behavior play a fundamental role in understanding their engagement in such behavior. Three types of relevant cognitions have been discussed in the literature. First, adolescents' perceptions of the involvement of their peers in risk behavior has been shown to predict subsequent risk engagement (Iannotti and Bush 1992). Second, adolescents' perceptions of the risks and benefits of this behavior are related to the engagement in risk behavior (Parsons et al. 1997). Third, adolescents' perceptions of invulnerability, that is, their presumed tendency to underestimate the chance that they will experience negative consequences when engaging in risk behavior, may influence their risk behavior (Greene et al. 2000). All of these three cognitive approaches received strong empirical support in offline risk research among adolescents.

Despite the importance of these cognitions in explaining offline risk behavior, no study has yet investigated whether perceived peer involvement, perceptions of risks and benefits, and perceived invulnerability influence risky sexual behavior on the internet. Studying these predictors is crucial in understanding why adolescents engage in online sexual behaviors. Moreover, no study has compared the relative predictive power of these distinct cognitive approaches by testing them against one another. Although each cognitive approach has found strong empirical support in offline risk research, they have yet to be studied together. Finally, the majority of studies on perceptions and risk behavior are cross-sectional. Hence, the causal direction of the relationships between perceptions and risk behavior have never been demonstrated (Goldberg et al. 2002). While it is often assumed that perceptions cause risk behavior, it may also be possible that perceptions are consequences of risk behavior (Festinger 1957) or that the relationship between perceptions and risk behavior is reciprocal (Gerrard et al. 1996). In light of the above research, this study had two goals. First, it investigates the causal nature of the relationships between perceptions of peer involvement, risks, benefits, and invulnerability and adolescents' engagement in risky sexual online behavior. Second, the study aims to single out which of these perceptions are the most important determinants (or

consequences) of risky sexual online behavior. As a result, this study deepens our understanding of adolescents' engagement in risky sexual online behavior.

Defining Risky Sexual Online Behavior

In a broad sense, risk behaviors can be defined as all behaviors involving potentially negative consequences (Beyth-Marom et al. 1993; Boyer 2006; Gullone and Moore 2000). In accordance with this definition, many online behaviors can be classified as risky. Previous research has identified online risk behaviors as hacking, downloading illegal content (Livingstone and Bober 2004), providing personal information online (Youn 2005), meeting someone face-to-face who was first met online (Liao et al. 2005), and risky sexual behaviors (Ybarra et al. 2007). Risky sexual online behavior can be specified as the exchange of intimate, sexually insinuating information or material with someone exclusively known online.

We limit our definition of risky sexual online behavior to communication with unknown people for two reasons. First, communicating with strangers is one of the main concerns parents raise about their children's online behavior (Eurobarometer 2008). This concern is based on the idea that true identities can be easily hidden online and adolescents may therefore become victims of sexual predators online. This parental fear may be fuelled by media coverage, which predominantly depicts young people as the targets of online perpetrators (Ponte et al. 2009). Second, previous research has shown that communicating with strangers online increases the chance of receiving unwanted sexual solicitation (Mitchell et al. 2001; Wolak et al. 2008). Thus, communicating with unknown persons online may be more problematic for adolescents than communicating with known persons.

The following behaviors may be categorized as risky sexual online behaviors: (a) searching online for someone to talk about sex, (b) searching online for someone to have sex (c) sending intimate photos or videos to someone online and, (d) disclosing personal information like telephone numbers and addresses to someone online. Engaging in these behaviors has been shown to increase the likelihood of negative experiences, such as unwanted aggressive sexual solicitation online (Cooper et al. 2002; Mitchell et al. 2007b). Other potentially negative consequences include the misuse of intimate information by others (Moreno et al. 2009) and feelings of shame, guilt and embarrassment. In addition, searching for sexual partners online may increase the risk of getting sexually transmitted diseases (McFarlane et al. 2002). While few adolescents may engage in these behaviors, as with many other risk behaviors, it is necessary to investigate them as their negative consequences may be serious. Moreover,

examining the predictors of risky sexual online behaviors may aid our understanding of *why* adolescents engage in these online behaviors.

Perceived Peer Involvement

During adolescence, individuals' social orientation shifts markedly from parents to peers (Guyer et al. 2009; Michael and Ben-Zur 2007). Peer behavior becomes directive for adolescents. Offline risk research has consistently shown that adolescents who perceive their friends to engage in a certain risk behavior are more likely to also engage in this behavior (Andrews et al. 2002; Gardner and Steinberg 2005; Jaccard et al. 2005). This holds for sexual risk behaviors, such as not using contraceptives or having various sexual partners (DiIorio et al. 2001; Millstein and Moscicki 1995; Prinstein et al. 2003; Rai et al. 2003).

Research on peer influence suggests that the *perceived* behavior of peers is more important than *actual* peer behavior in explaining adolescent risk behavior (Arnett 2007; Iannotti and Bush 1992; Unger and Rohrbach 2002). This is in line with cognitive developmental theories suggesting that it is not the actual environment that influences behavior but the subjective interpretation of the environment (Iannotti and Bush 1992; Inhelder and Piaget 1958). Adolescents who perceive more friends to engage in a specific risk behavior may appraise this behavior as socially acceptable and become more willing to engage in this behavior in the future (Gibbons et al. 1995; Sofronoff et al. 2005). This reasoning reflects social norms theory, which states that behavior is influenced strongly by perceptions of behavior and social group norms, even if this perception is incorrect (Scholly et al. 2005).

However, perceived peer involvement may also be a consequence of risk behavior. Adolescents who engage in a specific behavior consistently overestimate the number of peers who do the same (Heilbron and Prinstein 2008; Sofronoff et al. 2005). This phenomenon is known as the false-consensus effect. Adolescents who engage in risky activities project their own behavior onto their friends, thereby normalizing their behavior (Bauman and Ennett 1996; Gerrard et al. 1996). In a longitudinal study, Gerrard et al. (1996) demonstrated a reciprocal relationship between estimations of peer participation and risk behavior. This suggests that the relationship between perceived peer involvement and risk behavior may be complex and perceptions of peer behavior may cause, as well as reflect, adolescent risk behavior.

Given the importance of perceived peer behavior in offline risk behavior, we assume that perceived peer involvement will have a substantial influence on adolescents' online risk behavior. Similar to offline risk behavior, adolescents may talk about their online behavior and share

their online experiences. If adolescents perceive their friends to engage in risky sexual online behavior, they may believe that this is the acceptable norm among their friends. To conform to this peer norm, they may subsequently also engage in risky sexual online behaviors even if their perceptions of their peers' behavior were incorrect. Moreover, adolescents who engage in risky sexual online behavior may project this behavior onto their peers in order to normalize their own behavior. Therefore, we expect a reciprocal relationship between perceived peer influence and risky sexual online behavior.

Perceived Risks and Benefits

Decision-making theories posit that adolescents' estimations of risks and benefits influence their participation in risky behaviors (Furby and Beyth-Marom 1992). In general, adolescents who take risks perceive fewer risks associated with the behavior than adolescents who refrain from risk taking (Goldberg et al. 2002; Parsons et al. 1997). Similarly, adolescents who take risks perceive greater benefits than adolescents who do not take risks. For example, smokers (Halpern-Felsher et al. 2004), drinkers (Goldberg et al. 2002) and adolescents who have unprotected sex (Johnson et al. 2002), perceive these specific behaviors as less risky and more beneficial than adolescents who do not smoke, do not drink, and do not have unsafe sex (Benthin et al. 1993; Gerrard et al. 1996).

The causality of this relationship, however, is not clear. Instead of merely predicting risk behaviors, perceptions of risks and benefits may also be a consequence. This assumption is in line with cognitive dissonance theory (Festinger 1957) in that adolescents who engage in risky behaviors may deny potentially negative consequences and emphasize the benefits of this behavior to justify their behavior. Finally, the relationship may be reciprocal (Gerrard et al. 1996), which implies that risk and benefit perceptions influence risk behaviors and engagement in risks also leads to subsequent changes in perceptions of risks and benefits.

The predictive power of perceived risks and benefits depends on the risk behavior studied (Johnson et al. 2002). Parsons et al. (1997), for instance, showed that perceived risks predicted illegal drug consumption 3 months later, but failed to do so for other risk taking behaviors, such as drinking and driving and sexual risks. In contrast, perceived benefits predicted all risk-taking behaviors. To date, no study has investigated the longitudinal relationship between perceived risks and benefits and risky sexual behaviors on the internet. Some studies have indicated that adolescents perceive the risks of online risk behaviors as high (e.g., Liau et al. 2005). However, we do not know how these perceptions influence engagement in risky sexual

online behaviors and whether these perceptions are predictive or reflective of risk behavior. Based on the findings from offline risk research, we expect a reciprocal relationship.

Perceived Invulnerability

It is often assumed that due to cognitive development during this period, adolescents are particularly susceptible to a personal fable (Boyer 2006; Vartanian 2000), that is, the erroneous belief that one is unique and invulnerable (Elkind 1967, 1985; Ryan and Kuczowski 1994; Vartanian 2000). This perceived invulnerability has long been regarded as the main reason why adolescents engage in risks (Greene et al. 2000). Perceived invulnerability is closely related to low perceptions of risks. However, personal fable research assumes that even if adolescents have high risk perceptions, they may still fail to feel personally vulnerable (Johnson et al. 2002). For example, adolescent smokers may understand that smoking is dangerous generally but fail to acknowledge that smoking cigarettes may have negative consequences for them personally.

Several studies have supported this assumption by indicating that individuals who participate in risk behaviors perceive themselves as being less vulnerable (Greene et al. 2000; Morrongiello and Rennie 1998). Goldberg et al. (2002), for instance, demonstrated that perceived invulnerability predicted smoking 6 months later. Similar to the perceptions of risks and benefits, the relationship between perceived invulnerability and risk behavior may also be reciprocal. Specifically, perceived invulnerability may lead to more risk behavior, and engagement in risks may subsequently lead to perceptions of invulnerability in an attempt to justify this behavior. To date, perceptions of invulnerability relating to online sexual risk behaviors have not been assessed. Although some studies have indicated that, in general, adolescents are very risk-aware when online (Youn 2005), we do not know whether adolescents feel *personally* vulnerable to the negative consequences of online risk behaviors. Moreover, we do not know the causal direction of the relationship between perceptions of invulnerability and risk behavior. Based on offline risk research we anticipate a reciprocal relationship.

The Present Study

The present study aims to deepen our understanding of adolescents' risky sexual behavior on the internet by focusing on cognitive explanations for such behavior. Based on offline risk theories, we hypothesize that risky sexual online behavior is reciprocally related to perceptions of peer involvement, perceptions of risks and benefits of this

behavior, and to perceived vulnerability to potentially negative consequences of risky sexual online behavior. More specifically, we hypothesize, first, that adolescents who perceive more friends to engage in this behavior are more likely to subsequently engage in risky sexual online behavior (H1a). In addition, engagement in risky sexual online behavior will lead to perceptions of increased peer involvement, in an attempt to normalize own behaviors (H1b). Second, adolescents who perceive more risks relating to risky sexual online behavior are less likely to subsequently engage in this behavior (H2a). In addition, adolescents who engage in risky sexual online behavior will perceive fewer risks associated with this behavior (H2b). Third, adolescents who perceive more benefits associated with risky sexual online behavior are more likely to subsequently engage in this behavior (H3a). Moreover, adolescents who engage in risky sexual online behavior will perceive more benefits of this behavior (H3b). Fourth, adolescents who perceive themselves as being vulnerable to potentially negative consequences of risky sexual online behavior are less likely to subsequently engage in risky sexual online behavior (H4a). Finally, adolescents who engage in risky sexual online behavior will perceive themselves as less vulnerable to negative consequences to justify their engagement in this behavior (H4a).

In addition to identifying the causal structure of perceptions and risky sexual online behavior, this study also aims to compare the relative strength of these perceptions. More specifically, we investigate which perception is related most strongly to risky sexual online behavior. Most studies of offline risk perceptions have focused on one kind of cognition and have not tested the predictive ability of several indicators against one another. Such an approach may help our understanding of which of these perceptions has the strongest predictive ability for risky sexual online behavior and may thus be important to help prevent such behavior. Finally, to strengthen the internal validity of our causal model, we include a range of control variables. Previous research has shown that gender, age, and frequency of internet communication may influence risky sexual online behavior (Lenhart 2005; Liao et al. 2005; Livingstone and Helsper 2007). Moreover, we include sexual experience and relationship status as two additional control variables due to their immediate plausibility as alternative explanations of adolescents' risky sexual online behavior.

Method

Sample and Procedure

A two-wave online panel study among a nationally representative sample of Dutch adolescents between the ages

of 12 and 17 ($M = 14.5$, $SD = 1.68$) was conducted. The first wave was fielded in May 2008, the second wave 6 months later, in November 2008. Sampling and fieldwork were done by Veldkamp, a Dutch research institute. Respondents were selected from an existing nationally representative online panel of 10,990 Dutch adolescents. In contrast to online convenience samples, with their danger of self-selection biases, the pool of potential respondents was originally sampled randomly from the Dutch population and is continuously updated. In the first wave, 2,092 adolescents were randomly contacted. The response rate was 84% ($N = 1,765$). Of these 1,765 adolescents, 1,445 also completed the questionnaire in the second wave, resulting in an attrition rate of 18%. Of the final sample, 49% of the participants were female and 98.5% were of Dutch nationality. The majority (80.8%) of the adolescents lived with two parents (in line with official Dutch statistics). Participants came from urban as well as rural regions all over the Netherlands. Educational levels were equally distributed between primary education, and lower and higher secondary education.

To ensure that panel attrition did not reduce the generalizability of our sample, we checked for systematic differences between adolescents who completed the second survey and those who did not. The age of the participants who dropped out ($M = 14.66$, $SD = 1.71$) did not differ significantly from the age of participants who did not drop out ($M = 14.49$, $SD = 1.68$), $t(1763) = 1.7$, $p = .09$. They also did not differ in their educational levels, $t(1763) = 1.56$, $p = .12$ or levels of risky sexual online behavior $t(1763) = 0.63$, $p = .53$. Thus, panel attrition did not reduce the generalizability of the findings.

Official statistics from the Netherlands reveal that nearly all (98%) Dutch youth younger than 25 years of age have access to the internet at home (Duimel and De Haan 2007). This high percentage of home internet access may prevent the typical pitfalls of online surveys, such as a systematic sampling bias. Previous research has acknowledged that online surveys are especially useful when sensitive issues like sexuality are investigated (Mustanski 2001; Peter and Valkenburg 2006). Institutional approval and parental consent for adolescents' participation was obtained. At the beginning of the questionnaire, participants were informed that the survey would be about sexuality and the internet. We asked participants to fill in the questionnaire in private and emphasized that the answers would be analyzed only by the principal investigators. Participants were also informed that they could stop at any time they wished. Completing the questionnaire took about 20 min and respondents received a 5 € coupon for each completed survey.

Measures

Risky Sexual Online Behavior

Since risky sexual online behavior is a rather new research field, no validated measures exist. We based our items of risky sexual online behaviors on previous research that has shown that engagement in these specific risk behaviors are related to negative experiences, such as unwanted sexual solicitation (Wolak et al. 2008; Ybarra et al. 2007). Moreover, searching for sexual partners online has been shown to be related to an increased risk of sexually transmitted diseases (McFarlane et al. 2002). We used four items. Participants were asked how often, in the last 6 months, they participated in each of the following activities: (1) Searched for someone on the internet to talk about sex; (2) searched for someone on the internet to have sex; (3) sent on the internet a photo or video on which they were partly naked to someone they knew only online, and (4) sent an address or telephone number online to someone they knew only online.

Response categories to all questions were 0 (*never*), 1 (*once*), 2 (*two times*), 3 (*three to five times*) and 4 (*six times or more*). These four items formed a one-dimensional scale with a Cronbach's alpha of .71 at Time 1 and .70 at Time 2. Mean scores (with standard deviations in parentheses) of the scale were 0.13 (0.41) at Time 1 and 0.11 (0.37) at Time 2. The prevalence of all behaviors is displayed in Table 1. Since the prevalence of these behaviors was very low, we computed each variable into a binary variable 0 (*never*), 1 (*engaged in specific risk*). The four resulting binary risky sexual online behavior variables were added into a count variable of risky sexual online behavior. This new variable could take values from 0 to 4 ($M = 0.25$, $SD = 0.65$ for Wave 1; $M = 0.22$, $SD = 0.60$ for Wave 2), and was used in all further analyses.

Perceived Peer Involvement in Risky Sexual Online Behavior

Based on research on perceived peer involvement in an offline context (Iannotti and Bush 1992; Rai et al. 2003), respondents in our study judged the online risk involvement of their peers by estimating how many of their friends engaged in each of the four risky sexual online behaviors. The wording of the four items was as follows: (1) "How many of your friends search on the internet for someone to talk about sex?" (2) "How many of your friends search on the internet for someone to have sex?" (3) "How many of your friends send on the internet photos or videos on which they are partly naked to someone they know only online?" (4) "How many of your friends send an address or telephone number online to someone they know only online?"

Response categories ranged from 0 (*no one*) to 4 (*nearly all of my friends*). The four items resulted in a one-dimensional scale with a Cronbach’s alpha of .71 at Time 1 and .73 at Time 2. Mean scores of the scale were $M = 0.41$ ($SD = 0.53$) at Time 1 and $M = 0.38$ ($SD = 0.50$) at Time 2. Table 1 depicts the mean scores of perceived peer involvement for each behavior.

Perceived Risks of Risky Sexual Online Behavior

Respondents were asked to indicate how dangerous they judged each of the previously mentioned risk behaviors. This is a typical procedure used in offline risk research to assess perceptions of risks (Parsons et al. 1997; Siegel et al. 1994). Specifically, we asked participants: (1) “How dangerous is it to search on the internet for someone to talk about sex?” (2) “How dangerous is it to search on the internet for someone to have sex?” (3) “How dangerous is it to send on the internet photos or videos on which you are partly naked to someone you know only online?” (4) “How dangerous is it to send your address or telephone number online to someone you know only online?”

Response categories ranged from 0 (*not at all dangerous*) to 4 (*very dangerous*). The emerging four-item online-risk-perception scale resulted in a Cronbach’s alpha of .79 for both time points. Mean scores (with standard deviations in parentheses) of the scale were 3.32 (0.69) at Time 1 and 3.33 (0.68) at Time 2. As can be seen in Table 1, adolescents judged each of the four risky sexual online behaviors as very dangerous.

Perceived Benefits of Risky Sexual Online Behavior

Analogous to the risk perception scale, respondents indicated how beneficial they judged each of the four risk behaviors (Parsons et al. 1997; Siegel et al. 1994). For example, participants were asked, “How beneficial is it to search on the internet for someone to talk about sex?” Respondents could rate the benefits of each behavior from 0 (*not at all beneficial*) to 4 (*very beneficial*). The four items were added to a scale resulting in a Cronbach’s alpha of .84 and .85 at Time 1 and Time 2, respectively. Mean scores of the scale were $M = 0.68$ ($SD = 0.82$) at Time 1 and $M = 0.66$ ($SD = 0.80$) at Time 2 (see Table 1 for the mean scores for each behavior).

Perceived Vulnerability to Negative Consequences of Risky Sexual Online Behavior

Likewise to perceived risks and benefits, perceived vulnerability was assessed with one question for each risk behavior (Morrongiello and Rennie 1998). For example, “How likely is it that *you* get into trouble if you search for

Table 1 Prevalence of all risky sexual online behaviors and mean scores (standard deviations) of perceptions

Risky online behaviors	Prevalence risky sexual online behavior		Perc. peer involvement		Perceived risk		Perceived benefits		Perceived vulnerability	
	Time 1 % (N)	Time 2 % (N)	Time 1 M (SD)	Time 2 M (SD)	Time 1 M (SD)	Time 2 M (SD)	Time 1 M (SD)	Time 2 M (SD)	Time 1 M (SD)	Time 2 M (SD)
Search to talk about sex	7.1 (103)	6.2 (90)	0.45 (0.74)	0.43 (0.73)	3.03 (1.08)	3.03 (1.03)	0.79 (1.02)	0.86 (1.03)	2.97 (1.11)	2.95 (1.08)
Search to have sex	4.4 (64)	3.5 (50)	0.21 (0.55)	0.21 (0.56)	3.52 (0.86)	3.47 (0.85)	0.56 (0.98)	0.62 (0.99)	3.40 (0.94)	3.35 (0.94)
Send nude photo/video	2.3 (33)	2.5 (36)	0.24 (0.62)	0.22 (0.55)	3.47 (0.80)	3.52 (0.74)	0.50 (0.95)	0.45 (0.90)	3.28 (0.98)	3.31 (0.93)
Disclose information	11.6 (167)	9.9 (143)	0.73 (0.82)	0.66 (0.81)	3.32 (0.85)	3.32 (0.84)	0.71 (0.94)	0.71 (0.94)	3.03 (1.01)	3.07 (0.97)

N = 1,445; percentages are based on the number of respondents who had engaged in risky sexual online behaviors at least once in the past 6 months

someone on the internet to talk about sex?” Response categories ranged from 0 (*not at all likely*) to 4 (*very likely*). The four-item additive scale resulted in a Cronbach’s alpha of .82 and .84 at Time 1 and Time 2, respectively. Mean scores of the scale were $M = 3.16$ ($SD = 0.82$) at Time 1 and $M = 3.17$ ($SD = 0.81$) at Time 2.

Control Variables

We included a set of control variables in our model: gender, age, frequency of internet communication, sexual experience, and relationship status. These control variables were based on either previous research (Lenhart 2005; Liao et al. 2005; Livingstone and Helsper 2007) or on theoretical assumptions. Although not previously examined, we assumed that sexual experience and relationship status may be two plausible confounds of engagement in risky sexual online behavior. For our analyses we needed the control variables only at Time 1 (see Fig. 1). Thus, only Time 1 mean scores are reported.

Age and gender. Measures of age and gender were straightforward. Females were coded as 0, males as 1. Frequencies, means and standard deviations are reported in the description of the sample above.

Frequency of internet communication. Participants indicated how often they use instant messaging, internet chats, and social networking sites. Response categories ranged from 0 (*never*) to 10 (*every day*). The three variables built an additive scale ($M = 4.53$; $SD = 2.20$).

Sexual experience. Sexual experience was measured by asking respondents how many partners they had had sexual intercourse with so far ($M = 0.28$; $SD = 0.95$).

Relationship status. Whether adolescents were currently in a relationship was measured with one item: “Are you currently in a romantic relationship?” Adolescents who were single were coded 0 (83.9%), and adolescents who were in a relationship were coded 1 (16.1%).

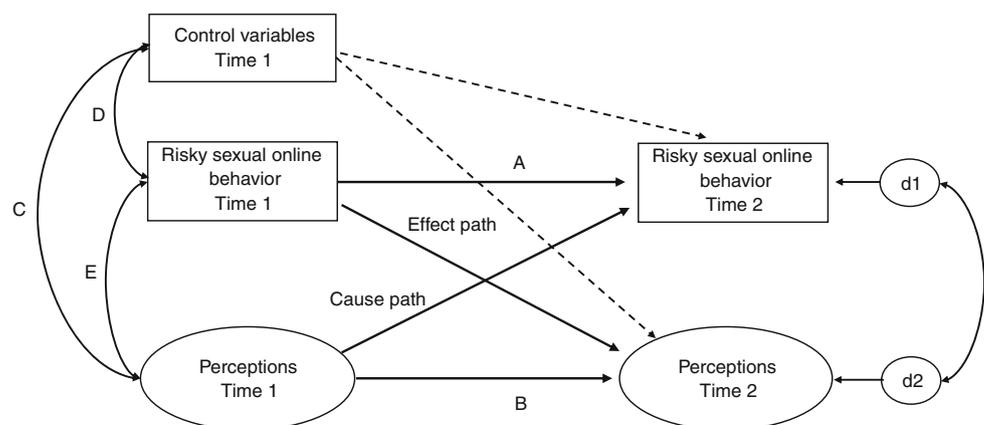
Data Analysis

Autoregressive Cross-Lagged Models

The first aim of this study was to investigate the causal relationship between risky sexual online behaviors and the perceptions of peer involvement, risks, benefits, and vulnerability. To do so, we analyzed four autoregressive cross-lagged panel models. Our hypothesized model is presented in Fig. 1. The model includes stability coefficients for both variables (path A and B). These autoregressive effects eliminate a considerable proportion of potentially confounding variance and increase the validity of the influence of a specific construct at Time 1 on the construct at Time 2 (Schlüter et al. 2006). The two cross-lagged paths represent the causal longitudinal relationship between perceptions and risky sexual online behavior. We named the path from perceptions at Time 1 to risky sexual online behavior at Time 2 “cause path”, and the reverse path “effect path”. The two-way arrows C, D, and E reflect the covariance between risk behavior, perceptions at Time 1 and the control variables. To control for potentially confounding variables, we included the five control variables in the model. The dashed lines represent the influence of the covariates at Time 1 on perceptions and risky sexual online behavior at Time 2.

Our hypothesized model (Fig. 1) was tested with structural equation modeling for each of the four perceptions separately. The variable for risky sexual online behavior was a manifest count variable of participation in risky behavior. All perception variables in our models represented latent variables. For all of these variables, two 2-item parcels were used as indicators of the latent construct. These item parcels were built according to the factorial algorithm procedure (Matsunaga 2008). First, a factor analysis was performed with the four items intended to measure each variable. The factor analyses resulted in one-factorial solutions for all variables, a requirement for item-parceling

Fig. 1 Hypothesized model of the causal relationship between risky sexual online behavior and perceptions at time 1 and time 2



(Little et al. 2002). In a second step, the item parcels are composed according to the factor loadings of each item. The first parcel contains the items with the first and fourth factor loading and the second parcel contains the items ranked two and three on the factor. This procedure emphasizes the equal distribution of item-specific components across parcels (Matsunaga 2008). In our models, we allowed error terms of the same indicators to correlate over time. Moreover, we correlated the disturbance terms between perceptions at Time 2 and risky sexual online behavior at Time 2. For all control variables, manifest variables were used.

As can be seen in Table 1, our variables were not normally distributed. Thus, the assumption of multivariate normality of the variables was not met. To check whether the skewness may have affected the analyses, we ran bootstrap analyses for the structural equation models. This method is used to alleviate problems resulting from violations of normality assumptions (Efron and Tibshirani 1993). The most desirable characteristic of bootstrapping is that it constitutes a nonparametric approach that estimates values of interest without making assumptions about the distribution type of the variables. We estimated a bootstrap bias-corrected 95% confidence interval for all values of interest (500 bootstrap samples, $N = 1,445$ each). If this interval includes zero, a given estimate is not significant.

Results

Descriptive Statistics and Zero-Order Correlations

In the first wave, 248 adolescents (17.2%) reported having engaged, at least once, in one of the four risk behaviors. In the second wave, 224 adolescents (15.5%) reported having engaged in risky sexual online behaviors in the last 6 months. Table 2 provides the zero-order correlation matrix for the four-item risky sexual online behavior scale and the perceptions of peer involvement, risks, benefits, and vulnerability for the two waves. As Table 2 shows, all variables were significantly correlated with each other. Engagement in risky sexual online behavior had moderate stability over time ($r = .38$, $p < .01$). These online behaviors were moderately and positively related to perceived peer involvement at both waves ($r = .43$, $p < .01$ and $r = .45$, $p < .01$, respectively). As expected, risky sexual online behavior was negatively related to perceived risks at both waves ($r = -.28$, $p < .01$ and $r = -.24$, $p < .01$), and positively related to perceived benefits ($r = .31$, $p < .01$ and $r = .26$, $p < .01$). As expected, there was also a negative relationship between risky sexual online behavior and perceived vulnerability for Wave 1 and Wave 2 ($r = -.25$, $p < .01$ and $r = -.22$, $p < .01$, respectively).

Causal Relationships Between Risky Sexual Online Behavior and Perceptions

The correlations in Table 2 already demonstrate significant relationships between perceptions and risky sexual online behavior. To analyze the causality of these relationships, we tested the hypothesized model as shown in Fig. 1 for all perceptions. The coefficients of the cause and effect paths, and the indicators of model fit are presented in Table 3. The model fits for the four hypothesized models were good. The CFI's of the four models were all above .95, and the RMSEA values were below .05.

Our first hypothesis (H1a) stated that adolescents who perceive more friends to engage in risks are more likely to engage in risky sexual online behavior 6 months later. H1a was supported as the relationship between perceived peer involvement at Time 1 and risky sexual online behavior at Time 2 (= cause path) was significant, $\beta = .13$, $B = .16$, $SE = .04$, $p < .05$ (bootstrap bias-corrected 95% confidence interval [bc 95% CI]: .04/.33).

Hypothesis 1b predicted that the reverse relationship would also be significant. As the effect path was not significant, $\beta = .07$, $B = .06$, $SE = .03$, *ns* (bc 95% CI: $-.02/.14$) this hypothesis was not supported. Therefore, perceptions of peer involvement and engagement in risky sexual online behavior were not reciprocally related. Instead, perceptions of peer involvement at Time 1 influenced subsequent online risk behavior. Engagement in risky sexual online behavior, however, did not influence subsequent perceptions of peer behavior.

Hypothesis 2a, which predicted that perceived risks negatively influence engagement in risky sexual online behaviors, received support. As expected, the relationship between perceived risks at Time 1 and risky sexual online behavior at Time 2 was significant, $\beta = -.06$, $B = -.07$, $SE = .03$, $p = .05$ (bc 95% CI: $-.15/.00$). The reverse relationship, as stated in Hypothesis 2b, was not significant, $\beta = .03$, $B = .06$, $SE = .03$, *ns* (bc 95% CI: $-.02/.14$). Therefore, this hypothesis also failed to find support.

The model for perceived benefits was not supported as neither the effect, $\beta = -.01$, $B = .04$, $SE = .03$, *ns* (bc 95% CI: $-.02/.09$), nor the cause path were significant, $\beta = -.01$, $B = .02$, $SE = .05$, *ns* (bc 95% CI: $-.05/.11$). Thus, adolescents' perceptions of the benefits of risky sexual behavior were not significantly related to risky sexual online behavior (H3a and H3b).

The influence of perceived vulnerability at Time 1 on risky sexual online behavior at Time 2 was significant, $\beta = -.06$, $B = -.06$, $SE = .02$, $p < .05$ (bc 95% CI: $-.12/-.01$), as stated in Hypotheses 4a. The reverse relationship was not significant. Therefore, H4b failed to find support, $\beta = -.01$, $B = -.01$, $SE = .03$, *ns* (bc 95% CI: $-.08/.06$).

Table 2 Zero-order correlations between risky sexual online behavior and risk-related perceptions

	Risky sex. onl. behav.		Peer involvement		Risks		Benefits		Vulnerability	
	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2	Time 1	Time 2
Risky sex. onl. Behav										
Time 1	–									
Time 2	.38**	–								
Peer involvement										
Time 1	.43**	.26**	–							
Time 2	.28**	.45**	.46**	–						
Risks										
Time 1	–.28**	–.17**	–.33**	–.26**	–					
Time 2	–.15**	–.24**	–.19**	–.37**	.52**	–				
Benefits										
Time 1	.31**	.16**	.43**	.24**	–.47**	–.33**	–			
Time 2	.19**	.26**	.22**	.41**	–.35**	–.50**	.47**	–		
Vulnerability										
Time 1	–.25**	–.15**	–.27**	–.24**	.72**	.46**	–.40**	–.30**	–	
Time 2	–.14**	–.22**	–.16**	–.32**	.41**	.75**	–.27**	–.40**	.45**	–

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 3 Indicators of the four autoregressive cross-lagged models

Perceptions	Standardized betas		Model fit		
	Cause path	Effect path	Chi-square ($df = 13, N = 1445$)	CFI	RMSEA (90% CI)
Peer involvement	.13*	.07	35.28**	.99	.03 [.02; .05]
Risks	–.06*	.03	26.83*	1.00	.03 [.01; .04]
Benefits	.04	.02	20.03	1.00	.02 [.00; .04]
Vulnerability	–.06*	–.01	17.01	1.00	.02 [.00; .03]

The cause path goes from perceptions at Time 1 to risky sexual online behavior at Time 2. The effect path goes from risky sexual online behavior at Time 1 to perceptions at Time 2

* $p < .05$; ** $p < .01$; *** $p < .001$

In sum, three causal paths—those of perceived peer involvement, perceived risks, and perceived vulnerability at Time 1 to risky sexual online behavior at Time 2—were significant. However, none of the effect paths from risky sexual online behavior at Time 1 to perceptions of these behaviors at Time 2 were significant.

Relative Influences of Perceptions on Risky Sexual Online Behavior

The results of the structural equation models showed that peer involvement at Time 1 had the strongest influence on online sexual risk taking at Time 2 (see Table 3). To investigate whether the other predictors provided additional explanatory value over and above the effect of peer involvement, we conducted a linear OLS regression analysis predicting the engagement in risky sexual online

behavior at Time 2. Because our variables are not normally distributed, homoscedasticity in the errors cannot be assumed. We, therefore, analyzed our regression model with heteroscedasticity-consistent standard errors (Long and Ervin 2000). Time 1 online sexual risk behavior, all control variables, and perceptions of peer involvement, risks, benefits, and vulnerability were entered into the regression. Overall the model accounted for 17% of the variance. Of the perception variables, only perceived peer involvement at Time 1 was a significant predictor of risky sexual online behavior at Time 2, $\beta = .12$, $SE = .05$, $t(1444) = 2.28$, $p < .05$. No additional variance was explained by perceived risks ($\beta = -.02$, ns), benefits ($\beta = -.01$, ns), and vulnerability ($\beta = -.02$, ns). Of the control variables, only frequency of internet communication was a significant predictor of risky sexual online behavior, $\beta = .02$, $t(1444) = 2.97$, $p < .01$.

Discussion

In identifying the emerging challenges and issues in the field of online risks, Livingstone and Haddon (2008) call for the investigation of adolescents' perceptions of online risk behavior to understand why youth engage in such online risks. Our study responded to this call by focusing on four theoretically based perceptions (i.e., perceived peer involvement, risks, benefits, and personal vulnerability), that may influence adolescents' risky sexual online behaviors. Moreover, we responded to the call for longitudinal research to understand the causal relationship between perceptions and risky sexual online behavior (Benthin et al. 1993; Goldberg et al. 2002; Ybarra et al. 2007). As a result, our study contributes substantially to our understanding of adolescents' engagement in risky sexual online behavior.

Our study yielded two important findings. First, in contrast to our expectations, we did not find a reciprocal relationship between the engagement in risky sexual online behavior and the perceptions of peer involvement, risks, benefits, and vulnerability. These perceptions were causes but not consequences of risky sexual online behavior. In separate structural equation models, perceived peer involvement, perceived risks, and perceived vulnerability predicted adolescents' engagement in risky sexual online behavior at Time 2. Perceived benefits had no impact on subsequent online sexual risk behaviors. Second, comparing the relative predictive ability of the perceptions of peer involvement, risks, benefits, and vulnerability in a regression analysis, perceived peer involvement remained the only predictor of the engagement in risky sexual online behavior. These findings emphasize the importance of perceptions, particularly of perceived peer involvement, in the explanation of adolescent risky sexual online behavior.

Our finding that perceptions of peer involvement, risks, benefits, and vulnerability are predictors but not consequences of risky sexual online behavior is not in line with previous offline risk behavior research, which notes a reciprocal relationship between perceptions and risk behavior (Gerrard et al. 1996). In our study, engagement in risky sexual online behavior had no influence on subsequent perceptions of peer involvement, personal vulnerability, and perceptions of risks and benefits of this behavior. This divergence from Gerrard et al. (1996) may be due to different statistical procedures (we used more conservative analyses) or, more likely, due to the different risk behaviors assessed (we assessed risky sexual online activities while Gerrard et al. (1996) focused on smoking, drinking, and reckless driving). The prevalence of risky sexual online behavior in our sample was very low. In contrast to more common risk behaviors such as drinking, most adolescents' may have less experience with this

behavior and may engage in this behavior far less often. Engagement in risky sexual online behavior seems to be a rather explorative behavior which is not pursued frequently by adolescents. Therefore, the perceptions about this behavior adolescents hold may be less stable and thus hard to assess in 6-month time lags.

While our results suggest that perceptions are causes but not consequences of risk behavior, we do not fully discard a reciprocal relationship. First, it may be that participants have had experience with risky sexual online behavior before the start of the study and also hold prior perceptions about this behavior. For example, it may be that adolescents' perceptions at Time 1 were based on past risk experiences which were not assessed in our study. Second, the causal relationship may be more volatile and may thus change during the 6 month time period between Wave 1 and Wave 2. For example, in an attempt to reduce dissonance, participants in online risk behavior may rationalize this by reducing their risk perception in the moment they engage in the behavior. This would reflect an online judgment of consequences rather than stable perceptions that could be assessed 6 months later.

Predictors of Risky Sexual Online Behavior

Cross-sectionally, our study showed that the engagement in risky sexual online behavior was related to perceptions of peer involvement, risks, benefits, and vulnerability of this behavior. More specifically, adolescents who engaged in these sexual online behaviors perceived more friends to engage in these behaviors, perceived fewer risks and more benefits, and felt personally less vulnerable to negative consequences than adolescents who did not engage in risky sexual online behaviors. This is in line with several other cross-sectional studies on offline risk behavior (Halpern-Felsher et al. 2004; Parsons et al. 1997).

Longitudinally, however, only perceived peer involvement, perceived risks, and perceived vulnerability predicted risky sexual online behavior. Moreover, the strength of these associations was rather weak. In contrast to earlier cross-sectional studies of offline risk behavior (Goldberg et al. 2002; Moore and Parsons 2000; Siegel et al. 1994), the perceived benefits related to the engagement in risky sexual online behavior had no impact on subsequent engagement in risky sexual online behavior. One reason why perceived benefits did not influence risky sexual online behavior may be that the potential benefits of online sexual risk behavior are not as clear to adolescents as benefits associated with traditional risk behaviors, such as drinking and smoking. In comparison to traditional risk behaviors, online sexual risk activities are not as common and are still new for adolescents. For example, the prevalence of drinking and smoking among adolescents often

exceeds 50% (Goldberg et al. 2002; Pomery et al. 2009). In contrast, only around 15–17% of Dutch adolescents engaged in risky sexual online behavior. With little previous experience in risky sexual online behavior, it may be difficult for adolescents to see the benefits of such behavior.

In terms of perceived risks and vulnerability, we also found only small effects on subsequent online sexual behavior. These effects had no predictive ability above the effect of perceived peer involvement. This is in line with most recent theories of adolescent risk behavior, such as fuzzy-trace theory or the prototype willingness model (Gerrard et al. 2008; Rivers et al. 2008). These theories suggest that engagement in risk behavior is based on heuristics and affect (Gerrard et al. 2008), rather than on reason and systematic processing. The prototype willingness model (Gerrard et al. 2008), for example, assumes that risk behavior often reflects reactions to specific situations rather than planned, intended behavior. For risky sexual online behavior, this suggests that adolescents may perceive many risks and only few benefits when they *reason* about online risk behaviors. In a specific situation, however, decisions may be based on contextual factors such as peer behavior. Therefore, future studies should investigate more elaborately the role of situational factors in adolescent online behaviors.

The Role of Perceived Peer Involvement in Risky Sexual Online Behavior

Perceived peer involvement was the only predictor of risky sexual online behavior after controlling for other perception variables. That perceived peer involvement is an important predictor of adolescent risk behavior is consistent with previous research on offline risk behavior (Bauman and Ennett 1996; Boyer 2006; Iannotti and Bush 1992; Jessor 1992; Michael and Ben-Zur 2007; Rai et al. 2003). Our finding that peer influence is also important for online sexual risk activities suggests that adolescents' online behavior does not differ much from their offline behavior. The perceived behavior of peers is also directive for online risk behaviors. What adolescents do online, even if pursued solitarily in front of their computer, is still directly or indirectly influenced by their friends' behavior.

Although we do not know whether adolescents' perceptions of peer behavior are based on actual behavior of peers or incorrect estimations of peer involvement, the findings suggest that adolescents' future risk behavior can be partly predicted by their perceptions of their friends' behavior. This fact may be important for prevention. If based on incorrect estimations of peer behavior, raising awareness of potential misperceptions may be an influential tool in preventing such behavior (Scholly et al. 2005;

Schroeder and Prentice 1998). If perceived peer influence reflects actual peer behavior, it may be beneficial to help adolescents find strategies to resist peer influence. Moreover, it has been shown that parental monitoring may moderate the influence of detrimental peer influence (Rai et al. 2003). To find the most effective strategies for prevention of risky sexual online behavior, future research should disentangle the underlying mechanisms in the relationship of perceived peer involvement and adolescent engagement in risky sexual online behavior.

Contributions, Limitations and Suggestions for Future Research

Our study has several limitations that need to be addressed in future research. First, to assess risky sexual online behavior, we used only four items. Since online risk behavior constitutes a rather new research field, no validated scales exist. Although our items were based on previous research and theoretical considerations, they do not present established measurements. The interpretation of our results should, thus, be limited to the four online behaviors we measured. To advance this promising research field, future studies should develop validated scales.

Second, we did not assess whether adolescents experienced any negative consequences from their engagement in risky sexual online behavior. Therefore, we cannot draw any conclusions about the dangers of engaging in these behaviors. However, the behaviors were judged as very dangerous by the adolescents themselves. This may be an indicator of their riskiness. Future research is needed to assess the negative (or positive) consequences of online risk engagement.

Third, while our findings suggest that adolescents' behavior is caused by their perceptions of peer behavior, an alternative explanation for this causal relationship cannot be fully ruled out. It may be that adolescents associate selectively with similar friends. Selective association means that adolescents become friends with similar peers. So, even if our longitudinal results show that peer behavior came before risk behavior it may be that the adolescents were already similar in their tendency to engage in risk behavior. Thus, the initiation of risk behavior may result from similar tendencies rather than from peer influence (Arnett 2007).

Fourth, the statistical associations between perceptions and risky sexual online behavior were not very strong. This may be because the prevalence of risky sexual online behavior was low. Most of the adolescents did not engage in any of the risky sexual online behaviors. Therefore, the rather weak associations between perceptions of peer involvement, risks, and vulnerability with subsequent risk

behavior may be partly the result of lacking variance in the distribution of our data.

Fifth, although the present study provides some support for a causal relation, causation cannot be decisively determined with longitudinal designs. Although perceptions occurred before engagement in risky sexual online behavior, this relationship may have also been based on third variables that were not investigated in this study, such as personality characteristics. While this possibility may not be ruled out with our design, we, nevertheless, believe that our results are at least an indication of causality. Further research is desirable to definitely establish causality between perceptions and risk behavior.

Despite these limitations, our study offers important insights into the rather new research field of adolescents' online risk behavior. By conducting a longitudinal study with a representative sample of Dutch adolescents, this study is the first to empirically test the relationship between adolescents' engagement in risky sexual online behavior and their perceptions of this behavior. Even while controlling for a range of potentially confounding variables, our findings indicate that perceptions of peer involvement, risks, and vulnerability influence subsequent online risk engagement. Testing the relative influence of several cognitive predictors, previously only investigated separately, perceived peer involvement remained the only predictor of risky sexual online behavior.

Online risk research may constitute an important new field in adolescent risk research. Adolescents are the defining users of the internet. Spending considerable leisure time online, they may transfer previous offline activities into their online "life". Thus, potentially risky online activities may substantially contribute to adolescent development and should be researched further.

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