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Bridget Christine McHugh, Pamela Wisniewski, Mary Beth Rosson, John M. Carroll,

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Bridget Christine McHugh
Department of Psychology, University of Central Florida, Orlando, Florida, USA
Pamela Wisniewski
Department of Computer Science, University of Central Florida, Orlando, Florida, USA, and
Mary Beth Rosson and John M. Carroll
College of Information Sciences and Technology, Pennsylvania State University, University Park, Pennsylvania, USA

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Abstract

Purpose – The purpose of this paper is to examine the extent to which negative online risk experiences (information breaches, explicit content exposure, cyberbullying and sexual solicitations) cause post-traumatic stress disorder (PTSD) symptoms in adolescents. The study also explores whether teens' short-term coping responses serve to mitigate PTSD or, instead, act as a response to stress from online events.

Design/methodology/approach – The study utilized a web-based diary design over the course of two months. Data were analyzed using hierarchical linear modeling with repeated measures.

Findings – The study confirmed that explicit content exposure, cyberbullying and sexual solicitations (but not information breaches) evoke symptoms of PTSD. Analyses also indicated that teens engage in active and communicative coping after they experience post-traumatic stress, regardless of risk type or frequency.

Practical implications – The authors found that teens took active measures to cope with online risks soon after they felt threatened (within a week). Actively coping with stressful situations has been shown to enhance adolescent resilience and reduce long-term negative effects of risk exposure. If these early coping behaviors can be detected, social media platforms may be able to embed effective interventions to support healthy coping processes that can further protect teens against long-term harm from exposure to online risks.

Originality/value – This is the first study to examine situational PTSD symptoms related to four types of adolescent online risk exposure within the week exposure occurred. By applying two competing theoretical frameworks (the adolescent resilience framework and transactional theory of stress), the authors show empirical evidence that suggests short-term coping responses are likely a stress reaction to PTSD, not a protective factor against it.

Keywords Coping, Post-traumatic stress disorder, Cyberbullying, Online privacy, Online safety, Online sexual solicitation

Paper type Research paper

1. Introduction

Most adolescents use social media daily (Lenhart *et al.*, 2010), which necessitates an examination of the potential "dark side" of social media use for teens. Adolescent internet use has been associated with decreased well-being (Kraut *et al.*, 1998), and excessive use has been tied to depression (Young and Rogers, 1998), anxiety (Dalbudak *et al.*, 2013), aggression (Lim *et al.*, 2015), and social isolation (Kraut *et al.*, 1998). Teens who use social media and similar platforms excessively may also develop addictive behaviors (Balakrishnan and

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Shamim, 2013), especially when they have fewer offline social ties (Yang *et al.*, 2016) and suffer from social anxiety (Elhai *et al.*, 2018). These addictive behaviors often lead to poorer mental health (Xue *et al.*, 2018) and an increased risk of identity theft via malicious profiles (Rose, 2011). Teens may also use social media to fulfill adverse gratifications such as voyeurism and exhibitionism (Mäntymäki and Islam, 2016). Negative effects of social media on mood have been related to the nature of teens' online interactions and viewing behavior (Lee *et al.*, 2015), suggesting that exposure to certain online risks may be detrimental to teens' developmental growth (Burk *et al.*, 2014). This has led to concern over the emotional and psychological effects of risks teens encounter online, including sexual solicitations (Rice *et al.*, 2015), privacy breaches (Berriman and Thomson, 2015; Berry, 2004), cyberbullying (O'Keeffe and Clarke-Pearson, 2011), and explicit content exposure (van Oosten, 2015). Although parents may restrict access to certain websites, this may still not shield them from online risks (Peters, 2006), as many risks teens encounter online occur on social networking sites (Mitchell *et al.*, 2014). Given the pervasiveness of social media use among teens (Forsyth *et al.*, 2013), it is unrealistic to completely prevent online risk exposure. Thus, some researchers have shifted away from restricting teens' internet behaviors to addressing the risks that teens may inevitably encounter online, so that they can be resilient against them (Wisniewski *et al.*, 2015).

Our study builds on this resilience-based perspective by conducting an "in-situ" two-month long diary study, which asked 75 teens to report their online risk experiences the week they occurred. This paper makes novel contributions to the adolescent online safety and risk literature in the following ways. First, we measure teens' episodic online risk experiences over a two-month period, as opposed to traditionally used cross-sectional approaches. Second, our diary prompts differentiated between four distinct types of online risks: information breaches, explicit content exposure, cyberbullying and sexual solicitations. Broadening our definition of online risks allowed us to compare across the four risk types and identify distinct differences regarding their effects. Third, when a teen reported experiencing an online risk event, we asked follow-up questions regarding how teens coped with each experience. Previous research has examined risk factors that lead to online risk exposure (Dredge *et al.*, 2014), but our study examines teens' coping behaviors in direct response to a particular risk event. Thus, the present study focuses on how teens' own actions rather than their circumstances shape their experience of online risk exposure. We are also the first to utilize a pre-validated psychological measure (the Child's Revised Impact of Event Scale or CRIES; Perrin *et al.*, 2005) for measuring clinical post-traumatic stress disorder (PTSD) symptoms across all four online risk categories of episodic online risk occurrences.

Combined with the methodological rigor used in our study design, we also make significant contributions to theory by applying two competing theoretical models to our empirical data set, the resilience framework (Fergus and Zimmerman, 2005) and the transactional theory of stress (Lazarus, 1966), to show how coping responses exhibited soon after an online risk event are likely reactions induced by PTSD, not protective factors against PTSD. Finally, we discuss practical implications for information online safety policies and laws, as well as design implications for social media developers to help teens more effectively cope with the risks.

2. Background: the dark-side of social media for teens

Our research examines the potential dark side of social media and online engagement for teens. Recent research has begun to illuminate the potential psychological effects of social media use, such as a detrimental impact on adolescent self-esteem (Kross *et al.*, 2013), and increased risk for depression (O'Keeffe and Clarke-Pearson, 2011). Social media sites encourage users to present the most positive aspects of their lives (Krämer and Winter, 2008), leading to dissatisfaction via social comparisons (Coyne *et al.*, 2017) and "Facebook

depression" (O'Keeffe and Clarke-Pearson, 2011). Adolescents may even develop social media addiction after excessive use (Balakrishnan and Shamim, 2013). While such psychological effects of social media use may be fairly insidious, social media can also directly expose teens to a myriad of risky online situations. In the next section, we provide a review of the adolescent online safety and risk literature to delineate these online risks.

2.1 A labyrinth of online risks

Drawing from the seminal work of Livingstone and Smith (2014), who differentiated between harmful content (e.g. explicit content exposure), contact (e.g. sexual solicitation and cyberbullying), and conduct (e.g. information breaches), we identified four primary categories of online risk from the literature: information privacy breaches, explicit content exposure, cyberbullying and sexual solicitations.

Though teens express concern about their privacy, they engage in behaviors that put them at risk for information privacy breaches (Barnes, 2006). Privacy concerns have little to no impact on adoption (Tan *et al.*, 2012) and self-disclosure (Cheung *et al.*, 2015) on social media sites. Privacy breaches often occur because of features included in social media sites, such as tagging other users without prior consent (Birnholtz *et al.*, 2017), automated geotagging (Albrecht and McIntyre, 2015) or other location-based features that may cause privacy concerns (Zhou, 2017). Social media also relies on users to self-report explicit content exposure and often has delayed and inconsistent enforcement of content policies (Crawford and Gillespie, 2016). Thus, teens may be exposed to images or videos that are overly violent (e.g. wars; De Choudhury *et al.*, 2014), or content that contain self-harm and other immoral and illicit behaviors (Wisniewski *et al.*, 2016) that may be disturbing to young viewers (Boyd and Swanson, 2016). Meanwhile, the anonymity of social media may also put teens at risk for cyberbullying, while protecting bullies (Barlett *et al.*, 2016), and increasing the sense of fear and powerlessness of victims (Dooley *et al.*, 2009). There is also concern about sexual solicitations teens may receive from other social media users, such as peers asking for nude photos. Indeed, 7 percent of teens indicate they have sent a nude photo to someone (Ybarra and Mitchell, 2014). As many social media users are much older (Bogdanova *et al.*, 2012), these sites also put teens at higher risk of sexual predation (Cano *et al.*, 2014).

2.2 Gaps in the literature

Past studies examining adolescent online risks have often taken case-based (McCarty *et al.*, 2011) or cross-sectional approaches that try to understand risk prevalence at a population level (Mitchell *et al.*, 2011). Large-scale studies often ignore the context of risks, only collecting dichotomous "yes" and "no" responses as to whether or not teens experienced online risks "ever" (Gross, 2004). Further, with cross-sectional designs, data about risks are collected long after the incident occurred (the best case is usually "within the past year"; Jones *et al.*, 2013; Smith *et al.*, 2014). A common theme among the literature is that the research typically focuses on risk exposure, or one type of risk (typically cyberbullying) in isolation from all others, as opposed to what occurs after exposure (Pinter *et al.*, 2017).

Some recent research has focused on how teens cope after experiencing stressful events online (e.g. blocking cyberbullies; Orel *et al.*, 2015), especially on why teens select specific coping strategies for certain online risks, and how employing these coping strategies may increase resilience (Raskauskas and Huynh, 2015). Yet, studies on risk-coping tend to use more qualitative approaches, such as asking teens to self-report their emotional reactions (e.g. Nie and Erbring, 2000). To our knowledge, no other empirical studies have been conducted over time to measure all four types of episodic online risk experiences teens have on a weekly basis, nor have they systematically examined coping behaviors or PTSD in relation to these risks. Therefore, the novelty of our approach sets our research apart from what has been done in the past.

3. Application of theory and research framework

3.1 Risk and adolescent resilience

Our work was initially motivated by Fergus and Zimmerman's (2005) framework for adolescent resilience. Resiliency is the ability to recover from an emotional trauma (Lazarus, 1966). Teens who are more resilient experience less severe and fewer emotions after an event (Kobasa, 1979). Resilience can be strengthened over time (McAllister and McKinnon, 2009). Depending on these risk and protective factors, teens may be less resilient, and therefore more likely to suffer negative outcomes of risk exposure including depression (Erdem and Slesnick, 2010) and delinquency (Glowacz and Born, 2015). Most previous research has focused on exposure itself and risk factors, not on the extent to which these risks actually cause emotional harm (Slavtcheva-Petkova *et al.*, 2015; Livingstone and Smith, 2014) and tends to assume all risk exposure is harmful (Pinter *et al.*, 2017). In contrast, our work specifically examines the relationship between online risk exposure and post-exposure symptoms of PTSD. Further, we apply two competing but relevant theories to better understand the role coping plays in this process. Our research framework is illustrated in Figure 1, and the constructs of our model are described below.

3.2 Post-traumatic stress disorder

To differentiate between online risk exposure and harm, our work supplements resilience theory with research on PTSD. PTSD is a clinically diagnosable condition that arises from exposure to negative events. Unlike traumatization symptoms that are general and somatic (Briere and Elliott, 2003), PTSD is event-specific (Green *et al.*, 1985). Risk type and individual factors influence the likelihood that PTSD will occur (Ozer *et al.*, 2008). Symptoms include avoidance of reminders of a specific event, hyper-arousal in similar situations and intrusive thoughts about the traumatic event (Perrin *et al.*, 2005). PTSD has been associated with unwanted sexual solicitations (Fitzgerald *et al.*, 1997), bullying (Spence Laschinger and Nosko, 2015), and explicit content exposure (Clohessy and Ehlers, 1999) in offline contexts.

While some research has examined post-traumatic stress in online contexts, this research examined severe trauma related to cyberbullying (Ranney *et al.*, 2016) and online sexual exploitations (Wells and Mitchell, 2007) in specific high-risk contexts. For instance, Ranney *et al.* (2016) surveyed youth who sought out emergency medical services, while Wells and Mitchell (2007) surveyed mental health professionals who reported on patients who were being treated for problematic internet experiences. Other research examined PTSD

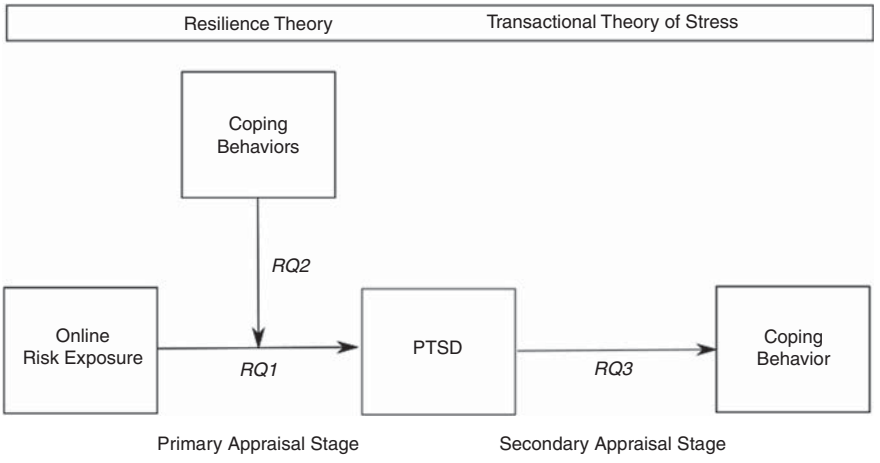

Figure 1.
Research framework

symptoms resulting from cyberbullying in high-risk youth populations, such as within the LGBT community (Beckerman and Auerbach, 2014) and teens at high risk of psychosis (Magaud *et al.*, 2013). Similarly, others who have studied online risks more generally tend to focus on risk prevalence (Mitchell *et al.*, 2011), or on severe online risks (e.g. cyber-sexual assault; Holladay, 2016), not risks typical teens encounter on a weekly basis. Since the association between PTSD and the frequency and type of risks teens encounter online is unclear, we must first examine whether these events are traumatic enough to warrant the need for resilience. Therefore, our first research question is:

RQ1. Is teen exposure to online risks associated with symptoms of PTSD?

3.3 Adolescent risk-coping

The resilience framework also suggests that the negative outcomes of traumatic events may be mitigated by various protective factors. For instance, teens who have supportive mentoring relationships (Hurd and Zimmerman, 2010) experience significantly less stress and a quicker recovery period than other teens exposed to the same situation (Fergus and Zimmerman, 2005). Thus, teens with protective resources have better outcomes following a negative event (Cline *et al.*, 2014), as well as lower anxiety and depression (Anyan and Hjemdal, 2016) than other teens who have been exposed to the same risks. Protective factors are usually framed as external to the individual (e.g. social support; Fergus and Zimmerman, 2005). However, resilience theory also posits that teens's own internal *assets*, or personal traits, can promote resiliency and may also protect against the negative effects of risk exposure. While the effect of teens' external resources on outcomes of risk exposure have been studied in the past (Hinduja and Patchin, 2008), research on teens' assets have rarely been applied to online risk exposure, and only to certain online risks (Orel *et al.*, 2015; Raskauskas and Huynh, 2015).

Coping is one of the most commonly studied assets exhibited by teens (Wills *et al.*, 1996). Coping behaviors can be active (i.e. actions to remove a stressor; Carver *et al.*, 1989), passive (i.e. avoiding a stressor; Connor-Smith and Flachsbart, 2007), or communicative (i.e. talking about the stressor; Saunders *et al.*, 2016). Coping has a strong protective effect against PTSD symptoms (Clohessy and Ehlers, 1999). While the protective effects of coping are well established (Wills *et al.*, 1996), there is little research on the protective effects of adolescent risk-coping behaviors within online contexts. Since the relationship between resilience and online risk-coping is under-studied, we ask the following research question:

RQ2. (Resilience theory): Do coping behaviors moderate the relationship between online risk exposure and PTSD symptoms?

Note that in our case, *RQ1* is a prerequisite for answering *RQ2* because a moderating relationship implies that there is a significant, direct relationship between online risk exposure and PTSD that requires mitigation from online coping.

3.4 Transactional theory of stress as an alternative

There is a lack of clarity in the literature as to whether coping is primarily a protective asset that insulates teens from harm resulting from risk exposure (Wills *et al.*, 1996) or if coping is primarily a response to stress from a situation (Lazarus, 1966). To empirically test these competing theories, we also frame coping using the transactional theory of stress (Lazarus, 1966), which takes a broader view of the antecedents and outcomes of negative life events. While the resilience framework views risk in terms of antecedents (assets and resources), moderation effects (protective factors), and negative outcomes (e.g. PTSD), the transactional theory of stress (Lazarus, 1966) suggests multiple stages of risk assessment marked by appraisals of the event. In the primary appraisal stage, when the victim is experiencing a

stressful event, the individual determines the potential for harm, while experiencing their initial emotional and behavioral reaction. In the latter stage, individuals form a secondary appraisal, evaluating their stress levels and responding with coping behaviors (Folkman *et al.*, 1986). Thus, the transactional theory of stress (Lazarus, 1966) proposes that coping may occur in response to negative emotional outcomes. As such, coping may be a response to PTSD, as documented in offline contexts (Coyne and Lazarus, 1980). Since the cross-sectional nature of previous online risk literature has not allowed for a systematic examination of coping behaviors in direct response to a specific risk event, an alternative research question examines the role of coping as a reaction to PTSD:

RQ3. (Transactional theory of stress): Are coping behaviors exhibited soon after online risk exposure a direct response to (outcome of) symptoms of PTSD?

4. Methods

4.1 Diary study overview

We conducted a two-month web-based diary study of 75 teens (ages 13–17) who reported their online risk experiences each week. We used event contingent diary methods because this method yields more accurate information than retrospective self-report data in cross-sectional studies. Cross-sectional studies are susceptible to recall error that leads to inaccurate reports when collected long after an event has occurred, mainly because individuals are more likely to recall only the most salient (or traumatic) experiences that happened to them over the course of a year instead of more frequent but less memorable experiences (Gorin and Stone, 2001).

Teens were given a unique login to an online "Diary Dashboard" where they could view their past diary entries, as well as complete new diary entries over a rolling, eight-week period. Teens were reminded to complete or finish weekly diary entries via e-mail. Parental consent was required but parents were not given access to their child's diary portal to protect the teen's privacy. To account for whether communication with parents affected study outcomes, the measures for communicative coping (described below) included a question asking if teens spoke with their parents or a trusted adult. In general, communication between teens and parents during the study was low (Table I).

4.2 Measures

Table I provides the psychometric properties and descriptive statistics for each construct in our model, along with each construct's definitions.

4.2.1 Teen online risk exposure. Each weekly diary entry included questions related to four online risk categories: information breaches; cyberbullying; sexual solicitations and explicit content exposure. The frequency of online risk exposure was reported using a five-point Likert scale (1 = never in that week, 5 = six or more times that week). Participants could report no risks, a single risk type, or multiple risk types each week. It is important to note that risk experiences were measured across all online platforms, not tied to a specific social media site (e.g. Facebook). This design choice makes our results more generalizable to the true social ecologies' perspective of teen multi-platform use (Zhao *et al.*, 2016) than if we had tied our study to one social media platform.

4.2.2 Teen coping behaviors. Participants indicated whether or not (e.g. yes or no) they engaged in various coping behaviors after reporting an online risk experience (Table I). The behaviors were based on items from previous surveys (Jia *et al.*, 2015; Livingstone *et al.*, 2010; Wisniewski *et al.*, 2016). These studies unfortunately did not establish construct validity for the scales. To determine the structure of our coping checklist, exploratory factor analysis was used. Three factors aligned with risk-coping theories of active coping

Post-traumatic stress disorder (PTSD) symptoms	α	*M*	SD
Intrusion – unwanted thoughts, images, and feelings related to the event (Horowitz *et al.*, 1979)	0.75	1.82	0.89
Avoidance – active efforts to avoid thoughts or reminders of the event (Horowitz *et al.*, 1979)	0.76	1.86	0.91
Arousal – heightened physiological arousal (Horowitz *et al.*, 1979)	0.71	1.59	0.72
Online risk exposure	α	*M*	SD
Information breaches – unwanted sharing of information or photos (Wisniewski *et al.*, 2016)	0.70	1.24	0.30
Someone else shared your information or a photo of you that you didn't want them to post			
You shared personal information or a photo of yourself that you later regretted sharing			
You have been the victim of what you felt was an improper invasion of privacy or misuse of your information in some other way			
Cyberbullying – deliberate, threatening or embarrassing online interactions (Wisniewski *et al.*, 2016)	0.97	1.29	0.49
You were treated in a hurtful or nasty way online			
Someone made rude or mean comments about you or threatened you in some way online			
Someone tried to spread a mean rumor about you online			
There are other types of negative and unwanted interactions that hurt your feelings, and made you feel embarrassed, or unsafe			
Sexual Solicitations – sexual interactions or requests (Wisniewski *et al.*, 2016)	0.72	1.25	0.48
Someone you know sent you a sexual message ("Sexting")			
Someone you know asked you to send them a sexual message, or a revealing or naked photo of yourself			
A stranger asked you to meet them offline			
There are other types of sexually suggestive interactions that made you feel even a little uncomfortable			
Explicit content exposure – voluntary or accidental viewing of pornographic, extremely violent, or deviant online content (Wisniewski *et al.*, 2016)	0.69	1.24	0.30
You saw online stories, images or videos that were pornographic (naked or sexual in nature)			
You saw online stories, images or videos that contained excessive violence			
You saw online stories, images or videos of illegal or deviant (morally questionable) behavior			
You saw online content that promoted self-harm (such as eating disorders, cutting, suicide, etc.)			
You saw other online content that made you feel uncomfortable some way			
Coping behaviors	KR-20	*M*	SD
Passive coping – behaviors that deny or ignore the stressor (Carver *et al.*, 1989)	0.63	0.55	0.40
I just ignored it and moved on			
I hoped the problem would go away by itself			
Active coping – behaviors that attempt to remove the stressor (Connor-Smith and Flachsbart, 2007)	0.73	0.30	0.33
I tried to fix the problem			
I blocked the person or message			
I changed filter or privacy settings			
I stopped using the internet for a while			
Communicative coping – communicating about the stressor (Saunders *et al.*, 2016)	0.65	0.26	0.32
I talked to a friend			
I talked to a parent or trusted adult			
I reported the problem to the proper authorities (school, police, website like Facebook, etc.)			

Notes: $N = 222$. Information breaches, cyberbullying, sexual solicitations and exposure to explicit content items were measured on a five-point Likert Scale ranging from 1 = not at all that week, 2 = once that week, 3 = 2–3 times that week, 4 = 4–5 times that week, 5 = 6 or more times in that week. Coping items were measured using a yes/no response option with 0 = no and 1 = yes. A value of 1 on the online risk exposure scale indicates no risk events occurred. KR-20 = Kuder-Richardson 20; α = Cronbach's α

Table I. Psychometric properties and descriptive statistics for model constructs

(e.g. adjusting privacy settings); communicative coping (e.g. talking about the problem) and passive coping (e.g. ignoring the problem) emerged (Cohen and Lazarus, 1973; Lerner and Shanan, 1972). Reliability estimates using Kuder-Richardson 20 for active (0.73) and communicative coping were acceptable (0.65). Passive coping had lower reliability (0.63), but was still within the typical range for weekly diary data (e.g. Schmitz and Wiese, 2006). However, these reliability estimates may have been lower because the reliability of measures can often fluctuate during diary studies (Cranford *et al.*, 2006). This appears to be the case with our study, as the reliability of measures in the pre-survey, which examined frequency

over the last year, was much higher for passive coping (0.85), active coping (0.83), and communicative coping (0.91).

4.2.3 Post-traumatic stress disorder symptoms. Each time a teen reported that they had been exposed to an online risk, PTSD symptoms were measured using the CRIES-13 (Perrin *et al.*, 2005). The CRIES-13 is a pre-validated measure of three types of clinical PTSD symptoms: arousal (e.g. hypervigilance), intrusion (e.g. persistent, unwanted thoughts about events), and avoidance (e.g. avoiding reminders of events) in relation to a particular adverse event (Giannopoulou *et al.*, 2006).

4.3 Data analysis approach

Analysis of repeated measures data must account for between-person's variance (i.e. portion of variations in PTSD due to differences between teens) and within-person's variance (i.e. portion of variations in PTSD for the same teen across weeks). Most of the variance in each dependent variable originated from within-person differences, as suggested by case one of the intraclass correlation coefficients (ICC (1)) calculated from the variance components (intrusion ICC (1) = 0.49, avoidance ICC (1) = 0.06, arousal ICC (1) = 0.01). As random coefficients modeling controls for within-person differences (Longford, 1994), we utilized this statistical technique to explore each research question through a series of models (Gräsbeck and Fellman, 1968). Following recommendations for random coefficients models, independent variables without a meaningful zero were grand mean centered (Hofmann and Gavin, 1998). We utilized SAS Enterprise 64's mixed procedure to calculate beta weights (β) and determined their significance using p values for two-tailed tests of significance, with a cutoff of 0.05 significance and 0.10 for marginal significance.

To answer *RQ1*, the effects of weekly online risk exposure on arousal, avoidance, and intrusion symptoms were examined in separate models. The week was included as a covariate to control for teens who reported fewer risks over time. *RQ2* was examined by modeling the moderating effects of each coping type onto each PTSD dimension. Moderation was calculated by creating an interaction term. These interaction variables were generated by creating a new variable that consisted of the product of the two primary variables (i.e., frequency of online risk exposure and frequency of coping behaviors; see Table II) as recommended by the literature (Dalal and Zickar, 2012). For *RQ3*, we modeled each PTSD symptom as an independent variable with each type of coping behavior as a dependent variable.

4.4 Recruitment and sample profile

Teens were recruited through over 700 organizations that served youth and through a contact list maintained by the university. Both teens and their parents consented to participate in the study. Participants were told they would receive a $25 gift card for completing the pre-survey and up to $50 on a gift card for completing all weekly diary entries and the post-survey. 98 teens registered and 75 completed the study. Since data collection was virtual, participants were not in a single location. Though most participants (74 percent) were from Pennsylvania, they were from different regions of Pennsylvania. The remaining participants were spread across twelve other states. Ages ranged between 13 and 17 ($M = 14.79$, SD = 1.30). The majority were 14 (31 percent), followed by 15 (21 percent), 13 (17 percent), 16 (17 percent), and 17 (13 percent). Participants were predominately female (63 percent) and Caucasian (73 percent; 13 percent African-American, 5 percent Hispanic, 3 percent Asian, and 5 percent Other). Only 1 percent of participants indicated that they did not go online every day or almost every day. Most teens (60 percent) were from two-parent households and many (56 percent) were from households with an income of $60,000 or more.

Table II.
Main effects and interaction effects of risk frequency and coping behaviors on PTSD

	Intrusion				Arousal				Avoidance			
	ΔD	β	SE	t	ΔD	β	SE	t	ΔD	β	SE	t
Main effects of online risk exposure												
Explicit content exposure	14.10[a]	0.11	0.10	1.20	11.20[a]	0.03	0.07	1.90**	12.40[a]	0.32	0.19	1.89*
Sexual solicitation	14.10[a]	0.35	0.14	2.52***	11.20[a]	−0.02	0.11	−0.67	12.40[a]	0.20	0.14	1.43
Cyberbullying	14.10[a]	0.20	0.19	1.20	11.20[a]	0.33	0.14	2.37**	12.40[a]	0.33	0.14	2.37**
Information breach	14.10[a]	−0.24	0.32	−0.92	11.20[a]	−0.01	0.24	−0.24	12.40[a]	−0.19	0.31	−0.71
Main effects of coping behaviors												
Active coping	16.40[a]	0.74	0.23	3.24***	26.30[a]	0.10	0.04	2.30***	20.80[a]	1.03	0.21	4.83***
Passive coping	16.40[a]	0.01	0.16	0.06	26.30[a]	−0.02	0.03	−0.70	20.80[a]	0.01	0.15	0.10
Communicative coping	16.40[a]	0.28	0.23	1.20***	26.30[a]	0.12	0.04	2.72***	20.80[a]	0.29	0.22	1.31
Interaction effects												
Active coping interactions												
Explicit content exposure	9.0[a]	0.37	0.20	1.89	9.5[a]	0.32	0.15	2.17**	35.7[a]	0.37	0.19	1.99**
Sexual solicitation	29.5[a]	0.91	0.31	2.92**	9.5[a]	0.60	0.25	2.40**	35.4[a]	0.83	0.32	2.61**
Cyberbullying	15.2[a]	0.18	0.40	0.46	11.1[a]	0.56	0.30	1.87	28.4[a]	0.47	0.38	1.23
Information breach	17.7[a]	0.16	0.62	0.25	3.8[a]	0.05	0.50	0.10	32.9[a]	0.21	0.60	0.35
Passive coping interactions												
Explicit content exposure	3.1	−0.04	0.18	−0.24	10.1[a]	−0.11	0.14	−0.83	9.70[a]	−0.19	0.18	−1.06
Sexual solicitation	12.5[a]	−0.33	0.26	−1.28	8.0[a]	−0.46	0.20	−2.28**	9.70[a]	−0.57	0.27	−2.17**
Cyberbullying	4.0	−0.51	0.33	−1.54	12.3[a]	−0.32	0.25	−1.30	4.0	−0.27	0.33	−0.82
Information breach	9.0[a]	−0.77	0.52	−1.49	4.5	−0.16	0.40	−0.39	11.1[a]	0.56	0.53	−1.07
Communicative coping interactions												
Explicit content exposure	10.9[a]	0.31	0.23	1.35	23.1[a]	0.22	0.17	1.31	18.4[a]	0.25	0.22	1.15
Sexual solicitation	25.8[a]	1.24	0.38	3.29**	18.4[a]	0.72	0.30	2.38**	21.5[a]	1.19	0.40	3.03**
Cyberbullying	10.6[a]	0.45	0.41	1.09	16.9[a]	0.46	0.30	1.52	11.2[a]	0.27	0.41	0.65
Information breach	12.0[a]	1.38	0.71	1.95	21.1[a]	1.03	0.53	1.94	16.8[a]	0.72	0.72	1.01

Notes: Main effects of each coping type were tested together in one model for each PTSD type. Interactions were tested in separate models, which included main effects for each risk type and each coping type. ΔD = change in deviance. [a]Adequate model fit. *$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

5. Results

5.1 RQ1: effects of online risk exposure on PTSD

Teens reported 222 online risk events (there were weeks when a teen would report experiencing no online risk events, and therefore did not fill out the *CRIES* that week). Explicit content exposure was the most common risk type (62 percent; information sharing = 15 percent, cyberbullying = 11 percent, sexual solicitation = 11 percent). While PTSD scores tended to be low (Table I), there were still teens that reported having symptoms, as the maximum score was also high across symptoms (4.75 for intrusion, 4.80 for arousal, and 5.00 for avoidance on a scale of 1 to 5). Indeed, 36.40 percent of online risk incidents resulted in clinically diagnosable PTSD (based on the cutoff score of 17 for the CRIES-13; Yule, 1998). The number of coping techniques reported on the coping behaviors checklist varied across events (active coping $M = 0.30$, $SD = 0.33$; passive coping $M = 0.55$, $SD = 0.40$; and communicative coping $M = 0.26$, $SD = 0.32$).

Fit statistics, beta weights, and significance for models testing *RQ1* are provided in Table II, Part A. Please note that, based on recommendations for assessing fit for hierarchical linear modeling (Snijders and Bosker, 1994), we used change in deviance to determine if each model had adequate fit. To do this, we calculated the change in the deviance statistic when comparing the time-only model (e.g. the null model) to the final model, then used a chi-squared distribution to determine if the change in deviance was significant.

Changes in deviance from the time-only model indicated good fit, further suggesting that the frequency of online risk exposure explained variation in PTSD symptoms from week to week. Three online risk types were significantly associated with various PTSD symptoms. Explicit content exposure and cyberbullying led to significantly higher arousal symptoms, as well as marginally significantly higher avoidance symptoms. Sexual solicitation also led to significantly higher intrusion symptoms in teens. In fact, only information breaches had no significant effect on any dimension of PTSD.

5.2 RQ2: coping behaviors as a protective factor (resilience theory)

For *RQ2*, we did not find evidence that coping behaviors served as a protective factor against PTSD symptoms (Table II, Part B.). There were significant effects, but these effects were contrary to resiliency theory and more consistent with the transactional theory of stress. Rather than reducing PTSD symptoms, main effects of coping behaviors on PTSD indicated that teens who engaged in higher than average coping behaviors experienced *more* PTSD symptoms, not *fewer* PTSD symptoms. Teens who engaged in more active coping reported more intrusion, avoidance, and arousal symptoms, while communicative coping also appeared to predict more intrusion and arousal symptoms. Thus, coping did not act as a protective mechanism to reduce PTSD, as suggested by *RQ2*.

5.3 RQ3: coping behaviors as a stress response

RQ3 examined whether PTSD symptoms acted as antecedents to coping behaviors (Table III). Our models indicated PTSD did predict certain coping behaviors. Active coping behaviors significantly increased as all types of PTSD symptoms increased. Teens who experienced arousal symptoms also were more likely to engage in communicative coping. Passive coping was not significantly related to PTSD symptoms (Table III), though this could be due to the low internal consistency of the measure (Kuder-Richardson 20 = 0.63).

We also tested the interaction effects between coping behaviors and online risk exposure frequency to examine whether the association between coping and PTSD symptoms depended on the frequency of risks (Table II, Part C). These effects were also contrary to resilience theory, as coping behaviors were associated with more PTSD symptoms. Teens who engaged in a higher than average number of active coping behaviors tended to

	β	SE	t
Active coping[a]			
Intercept	0.32	0.06	5.81**
Intrusion symptoms	0.32	0.07	4.40**
Intercept	0.33	0.06	5.95*
Arousal symptoms	0.32	0.08	4.24*
Intercept	0.31	0.05	5.81**
Avoidance symptoms	0.31	0.07	4.24**
Passive coping			
Intercept	0.73	0.07	10.44*
Intrusion symptoms	−0.14	0.12	−1.22
Intercept	0.72	0.07	10.14*
Arousal symptoms	−0.12	0.12	−1.04
Intercept	0.73	0.07	10.40*
Avoidance symptoms	−0.14	0.12	−1.18
Communicative coping[a]			
Intercept	0.19	0.06	3.28*
Intrusion symptoms	−0.06	0.05	−1.22
Intercept	0.20	0.06	3.39*
Arousal symptoms	0.05	0.05	−1.04*
Intercept	0.19	0.06	3.28*
Avoidance symptoms	−0.06	0.05	−1.18

Notes: Other coping behaviors and time points were included as covariates. [a]Adequate model fit based on Δ deviance from a time only model. Active coping Δ deviance = 20.70; communicative coping Δ deviance = 17.00; passive coping Δ deviance = 3.00. *$p < 0.05$; **$p < 0.01$

Table III. PTSD and coping behaviors

experience more symptoms from explicit content exposure and sexual solicitation. Teens who engaged in communicative coping following sexual solicitation were more likely to report PTSD symptoms, though this relationship was stronger when risk occurrence was low. On the other hand, teens who engage in high levels of non-coping behaviors (i.e., passive coping) had lower levels of arousal and avoidance symptoms when risk factors occurred frequently. These results (see Table II, Part C.) are not consistent with resiliency theory, which suggests that teens who engage in coping behaviors experience less post-traumatic symptoms as adolescent risk increases. Instead, coping behaviors were actually associated with worse outcomes, especially when risk exposure was more frequent. This also suggests that coping is used as a response to stress, rather than a protective factor, as suggested by the transactional theory of stress.

6. Discussion

Our results brought many novel insights. When examining our first research question (whether online risk exposure could lead to PTSD symptoms), we found that most online risks can lead to PTSD symptoms. Second, we found that these symptoms are not necessarily reduced by coping behaviors. Instead, as suggested by our third research question, teens tend to engage in behavior as a response to PTSD symptoms, rather than as a response to risk exposure. These results are consistent with the transactional theory of stress, which suggests that coping often occurs in response to stress, and not to the event itself. This suggests that teens tend to engage in online coping behaviors when they feel traumatized by risk exposure.

Our research was also novel in several other ways. All previous research has relied on asking teens to recall whether they had experienced an event long after it has occurred.

This method has been shown to reduce prevalence estimates in other contexts (Gorin and Stone, 2001). Thus, we found that online risk exposure was reported more often when teens were asked to recall events after a shorter period of time. The majority of teens (73 percent) who participated in the study experienced at least one risk event, which is higher than most studies of online risk exposure. In past research, between 24–57 percent of teens reported experiencing a risk event (Livingstone *et al.*, 2010; Livingstone and Smith, 2014; Temple *et al.*, 2012). In addition, the study took a more comprehensive approach to examining risk exposure. Previous research usually only examined one risk type in isolation (e.g. sexual solicitation or cyberbullying; Hinduja and Patchin, 2008; Temple *et al.*, 2012) and rarely examined information sharing (Livingstone *et al.*, 2010; Livingstone and Smith, 2014), which accounted for over a sixth of the risks teens reported.

The present study was also novel because it was the first to examine event-specific post-traumatic stress symptoms in a mainstream population (i.e. one without specific risk factors) following online risk exposure. Overall, we found that certain online risks cause more distress in teens than others, and the relationship between risk exposure and PTSD symptoms depends on what symptoms are being assessed. Cyberbullying, sexual solicitations, and explicit content exposure all had a significant effect on some type of PTSD symptoms. Information breaches (i.e. violations of privacy) had no effect on PTSD symptoms. This is consistent with previous research on teens' online privacy; though teens may indicate that they value privacy on surveys (Lenhart *et al.*, 2010), they tend to be less concerned with privacy than adults (Walrave and Heirman, 2011). They are more likely to share personal feelings and information online (White, 2004; Viégas, 2005). Teens are also more accustomed to having their personal contact information given to third parties without their consent (Galkin, 1996; Walrave and Heirman, 2011), and less likely to take precautions to protect their privacy (Walrave and Heirman, 2011).

Our results do suggest that other typical, weekly experiences that teens encounter online (i.e. cyberbullying, sexual solicitation, explicit content exposure) are associated with clinically diagnosable symptoms of PTSD. This is a noteworthy contribution of our work, showing the potential dark side of online engagement and social media use on adolescents. While explicit content exposure had a lesser effect on PTSD symptoms, the effect may have been weakened by our inclusion of common types of explicit content in our measures. For example, despite concern over teens' exposure to online pornography (Kanuga and Rosenfeld, 2004), many open-ended responses in our data suggested that many teens enjoyed pornography. In addition, teens frequently exposed to explicit content may be desensitized to its traumatic effects (Cline *et al.*, 2014), which could be another potential dark side of teen social media use. In contrast, we found no significant relationship between information breaches and PTSD, even though prior research suggests that privacy breaches make teens more vulnerable to other, more severe risks (Gross and Acquisti, 2005).

6.1 Implications for theory, policy, and design

We found that the transactional theory of stress more closely fit our data than framing coping behaviors as a protective factor as suggested by the adolescent resilience framework, as coping behaviors tended to be used in reaction to stress instead of a means to protect against it. There are several implications we can draw from these results. It is possible that in teens' primary appraisals of an initial online risk occurrence, they did not anticipate any imminent danger and waited to engage in active and communicative coping behaviors until the risk became particularly stressful or recurred. This delayed response is consistent with risks in offline contexts. Victims often wait to take more proactive measures, such as reporting the event (Mishna and Alaggia, 2005), because they fear retaliation from the perpetrator (Camodeca and Goossens, 2005). Second, teens do exhibit coping behaviors (e.g. blocking a bully) after the potential risky and stressful situation has already occurred.

If such coping behaviors could serve as an early warning system that triggers additional resources, this may help teens navigate online risks in the long-term. For example, when a teen takes a protective action to block a contact via social media (e.g, an active coping mechanism), the site could provide context-based assistance to help teens more effectively cope with a potential risk, such as urging them to talk to a trusted adult or teaching them how to repond to bullies (Common Sense Media, 2017). It may also be possible that, while teens' coping responses did not reduce PTSD in the short-term, they may help teens build resilience and decrease trauma symptoms over a longer period of time.

Our findings may also partially help explain why teens may not take protective measures to maintain online information privacy; privacy breaches do not prompt a strong stress response that triggers the need to cope. As such, raising teens' awareness of the potential risks posed by oversharing may be necessary for eliciting a stress response to encourage appropriate protective measures (Madden *et al.*, 2013). The difference in symptoms between different online risk types also has meaningful implications for legislation. While most laws focus on limiting youths' access to explicit content (Olagunju, 2009), our results suggest that cyberbullying and sexual solicitations are more harmful to teens. Thus, it may be more beneficial to teens if legislation focused more on contact-related risks by holding individuals accountable for perpetrating these types of crimes than trying to insulate teens from content (Livingstone and Smith, 2014).

In summary, rather than focusing our efforts on trying to prevent teens from being exposed to all online risks, it may be more beneficial to teach teens more effective ways of coping with the risks they do experience (Raskauskas and Huynh, 2015). For instance, it may be helpful to teach teens how to report perpetrators to the proper authorities instead of using abstinence-based approaches that attempt to disengage teens from all social media activities. Helping teens to engage in more proactive behaviors (e.g. changing privacy filters) may not only prevent future risk exposure, it may also reduce post-traumatic stress following the event (Van der Kolk, 1994). The end goal is to allow teens to reap the positive benefits of social media engagement but avoid long-term negative effects of risk exposure.

6.2 Limitations and areas for future research

There were several limitations to our study that can inform future research. First, we based coping behaviors on a previous survey that examined teens' behavioral responses to online risks, but later found that the passive coping measure had weak internal consistency. Future research should explore more stable techniques for measuring online coping behaviors. While measuring PTSD within a week of risk exposure was one of the strengths of our study design, we could not measure long-term PTSD symptoms that ranged beyond the duration of our study. For this reason, we encourage future research to examine longer-term effects (e.g. over a year or longer) of online risks and how teens cope with and are affected by these experiences. In addition, because many of the more severe online risks were relatively infrequent (e.g. cyberbullying), our sample size for those analyses was relatively small. We recommend that future research use a larger sample size over an extended timeframe to capture the long-term effects of online risk exposure.

The present study did not ask teens specifically what social media platform they were using when the risk occurred (though they often disclosed this in qualitative descriptions of the event). However, recent national polls of teens' social media use and mental health outcomes suggest that certain platforms, particularly Instagram (Royal Society for Public Health, 2017), may be more detrimental than others. Certain social media sites may also have features that can facilitate more risks. For example, Facebook allows geotagging (Albrecht and McIntyre, 2015) and unmoderated video streaming (Crawford and Gillespie, 2016) that may put teens at higher risk. While our study did not address how different features of specific social media platforms impact risk exposure, this should be explored in future research.

Our sample was slightly biased toward females (63 percent). While low demographic diversity in psychological research is common (Sears, 1986), theory and research on acceptance of technology suggest that this may constrain the generalizability of our findings (e.g. the unified theory of acceptance and use of technology; Venkatesh *et al.*, 2003). Indeed, females tend to use (Barker, 2009) and adopt (Borrero *et al.*, 2014) social media sites for different reasons than males. Participants were also only recruited from the USA. Culture can also influence the reasons individuals adopt certain technologies (Venkatesh *et al.*, 2003; Im *et al.*, 2011). Thus, we recommend that future research conduct follow-up studies with larger and more diverse populations.

6.3 Conclusion

Very little research has examined the behavioral processes and psychological outcomes that occur immediately after teens experienced exposure to online risks, or the effects of or relationships between multiple types on online risk exposure and different coping behaviors in relation to post-traumatic stress. To address these limitations, we conducted a two-month diary study that found that cyberbullying, sexual solicitations, and exposure to explicit content (but not information breaches) can cause symptoms of PTSD. We also established that the transactional theory of stress was a better fit for framing the underlying processes of risk-coping (as opposed to the resilience framework). Our findings inform research related to the dark side of social media use as it pertains to teens as they experience and cope with online risks.

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Corresponding author
Bridget Christine McHugh can be contacted at: mchugh.bridget@gmail.com