

POSTTRAUMATIC STRESS SYMPTOMS AFTER THE 2007 SHOOTINGS AT VIRGINIA TECH: FORM AND FUNCTION OF COMMUNICATION ABOUT THE EVENTS

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Abstract

Due to advances in technology, and the ever-changing ways in which people are communicating with one another, the role of electronic media and technology following traumatic events is a growing area of interest. The current study examined the form and function of communication following the 2007 shootings at Virginia Tech in a sample of 519 Virginia Tech students, alumni, and staff/faculty (65% female; 90.4% Caucasian). Results indicated that electronic forms of communication were used most frequently in the 24 hours following the shootings. The form of communication (i.e., cell phones, messaging, and face-to-face communication) was not related to posttraumatic stress (PSS) reactions; however, the function of communication (i.e., conveyance or convergence) did differentially relate to reports of subsequent PSS. Specifically, communication used for conveyance (i.e., sharing facts) functions was positively related to PSS, whereas convergence (i.e., sharing thoughts and feelings) was unrelated to PSS. The findings are discussed in the context of cognitive models of posttraumatic stress disorder and implications for the findings are offered.

Note: The authors would like to thank: Michael Hughes for his help in preparing this manuscript. We also thank the Virginia Tech community for participating in the study during this sad and tragic time. Out of respect for the VT Community and their desire not to have the VT identity equated with this tragedy, we will refer to the events as the 4-16 shootings.

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Introduction

On April 16, 2007, the Virginia Tech (VT) community experienced one of the deadliest school shootings in United States history when a lone gunman shot and killed 32 faculty and students and wounded 17 more before committing suicide. The shootings occurred in two separate acts of violence, separated by approximately two hours. In the first attack, the assailant fatally wounded two students in West Ambler Johnston, a residence hall. In the second attack, he entered Norris Hall, an academic building, and chained the three primary entrances shut before proceeding to multiple classrooms, where the shootings occurred. In the ensuing hours, the campus community experienced uncertainty about the safety of friends, loved ones, and other members of the community. Many were also overwhelmed by the multiple email and loudspeaker warnings, a campus lockdown, extensive media coverage, and various levels of exposure to rescue and recovery efforts, such as ambulance sirens, rescue squad activities and SWAT team activities. Immediate and long-term efforts were launched to address the mental health consequences of this trauma (Hughes, Brymer, Chiu, Fairbank, Jones, Pynoos, et al., 2011).

The current study aims to understand whether communication during and after these events promoted or buffered posttraumatic stress reactions in the VT community. It is possible that the use of communication technologies (e.g., email, instant messaging, text messages) and web-based virtual communities (e.g., Facebook or Myspace) during and after a crisis can impact individuals' grieving and healing processes common to tragic events, such as the 4-16 shootings.

Posttraumatic Stress Symptoms

As many as 10% of young adults who experience trauma will subsequently develop post-traumatic stress disorder (PTSD), which is considered one of the most common anxiety disorders experienced by this age group (Breslau, Davis, Andreski, & Peterson, 1991; Breslau, Wilcox, Storr, Lucia, & Anthony, 2004). The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR, American Psychiatric Association [APA], 2000) defines a traumatic event as "an extreme traumatic stressor involving direct personal experience of an event that involves actual or threatened death or serious injury, or other threat to one's physical integrity" that elicits "intense fear, helplessness, or horror" (pg. 463). Specific traumatic experiences can include natural or technological disasters, violent crimes, abusive relationships, and sexual assaults. Undoubtedly, the 4-16 shootings fall centrally within the realm of traumatic experiences.

It has been suggested that the 4-16 shootings can be considered a mass trauma because of its effects on the entire community (Littleton, Grills-Taquechel, & Axsom, 2009). Multiple studies have now investigated the posttraumatic effects of this mass shooting on psychological adjustment and quality of life of the students (e.g., Amatya, Jones, & Hughes, 2011; Grills-Taquechel, Littleton, & Axsom, 2011; Hawdon & Ryan, 2012; Hughes et al., 2011; Littleton et al, 2009; Littleton, Grills-Taquechel, Axsom, Bye, & Buck, 2011; Vicary & Fraley, 2010). These studies found that 15-30% of individuals experienced significant posttraumatic stress symptoms (PSS) about two months after the 4-16 shootings, although these numbers are somewhat higher than Breslau et al. (2004) and somewhat lower than prior studies of mass shootings (e.g., Norris & Stevens, 2007; North, Smith, & Spitznagel, 1994; Schwarz & Kowalski, 1991).

These studies clearly indicate that not all individuals who directly or indirectly experienced the 4-16 shootings developed significant clinical distress. Many individuals showed psychological resiliency in the face of tragedy. Conceptual models of PTSD explain its emergence in terms of interactions among factors related to the traumatic experiences (e.g., proximity to the event, degree of life threat), survivors' characteristics (e.g., gender, ethnicity, pre-existing psychopathology, prior trauma experiences), cognitive processing (e.g., positive or negative coping, emotional processing), the recovery environment (e.g., perceived social support; Green, Wilson, & Lindy, 1985; LaGreca, Silverman, Vernberg, & Prinstein, 1996), and loss of resources (Luszczynska, Benight, Cieslak, Kissinger, Reilly, & Clark, 2009). Several aspects of this model have been supported in relation to the 4-16 shootings. For example, in a study of female college students at VT, Littleton et al. (2011) found that exposure to sexual trauma prior to the shootings was associated with increased shooting-related PSS, and this relationship was mediated by specific cognitive schema (i.e., belief in the benevolence of others) and family support. Hughes et al. (2011) found support for the role of both direct and indirect exposure in increasing PSS in a large survey of 4,639 VT students approximately 3 months after the shootings. Specifically, the highest odds ratios for probable PSS were found for losses (i.e., injury or death of someone close) and the inability to confirm the safety of friends.

Electronic Communication

One facet of the coping process that is beginning to receive some attention in the literature involves the use of technology or electronic media for communication purposes. This is important because of the increased use of electronic forms of communication (e.g., email, text messaging, and social networking) in everyday life, particularly among teenagers and young adults (Hinchcliffe & Gavin, 2009). Several studies have specifically noted the massive use of Internet sites in the immediate aftermath of the 4-16 shootings. In a search of public sites that had entries for "Virginia Tech April 16," Fox and colleagues (2008) noted over 400,000 users on the social networking site Facebook. Vieweg, Palen, Liu, Hughes, and Sutton (2008) reported how Facebook, in particular, was used as a means of spontaneous collective problem-solving that determined the identities of the fatally shot victims, many hours before official announcements were made. These findings underscore the rising use of technology in our society, the use of technology to form virtual communities, and the impact of the actions of the collective. Online networking sites and forums may be particularly important because of the role of social solidarity in reducing depression and promoting well-being following mass traumas (Hawdon, Rasanen, Oksanen, & Ryan, 2012).

A central aim of the current study is to address how using technology during and after a crisis can serve to reduce anxiety and manage distress. A handful of studies on the effects of Internet use on psychological well-being have found inconsistent results. Some show that Internet use increases depression (e.g., Van den Eijnden, Meerkerk, Vermulst, Spijkerman, & Engels, 2008), others claim that it decreases depression (e.g., Bessièrè, Kiesler, Kraut, & Boneva, 2008), and still others show no relationship (e.g., Sanders, Field, Diego, & Kaplan, 2000). In one investigation of people who had recently lost a spouse, those who used the Internet reported lower levels of PSS (Vanderwerker & Prigerson, 2004).

Two particularly relevant studies examined psychological functioning following the 4-16 shootings. In a sample of 543 VT students following the 4-16 shootings, Hawdon and Ryan (2012) found that face-to-face social interactions were associated with the promotion of well-

being. Conversely, “virtual” interactions (e.g., email, text messaging) were unrelated to well-being following the 4-16 shootings. Vicarey and Fraley (2010) assessed Internet activities in students from VT and Northern Illinois University (NIU), where a similar event occurred less than a year following the 4-16 shootings. At NIU, a former student entered a large lecture hall and shot 23 students (five students were killed and 18 were injured). After these two campus shootings, 89% of the sample reported joining a Facebook group, 78% used instant messaging, and 74% used text messaging. Interestingly, while the majority of students reported that these online activities were beneficial to their well-being, results showed no relationship between communication technologies and depressive symptoms or PSS approximately 6 weeks post-shooting. Therefore, prior studies suggest that social interactions conducted through technology may not be beneficial in terms of promoting well-being or decreasing psychopathological symptoms. However, the findings are inconsistent and further research is needed.

The literature suggests that communication technology is widely used, but its effect on psychological adjustment is not clear. Furthermore, none of these studies investigated the nature of the communication or the type of information being shared. It is possible that the mixed findings are due, in part, to the fact that technologies were being used for different purposes or functions of communication, which in turn have different impacts on psychological adjustment. The current study aims to address this gap in the literature by assessing two fundamental functions of communication (i.e., conveyance, convergence).

Conveyance and Convergence Functions of Communication

A theoretical model in the field of media information systems, called Media Synchronicity Theory (MST), suggests that media can enhance communication when it helps individuals work together in a coordinated fashion to achieve a common goal (Dennis, Fuller, & Valacich, 2008). According to MST, communication involves two fundamental processes – conveyance and convergence. *Conveyance* consists of the transmission of new information to increase factual knowledge of another person. Conveyance processes involve the diversity of information that must be exchanged for an individual to build a mental model that enables sense-making in a situation. Facts and information about a situation are conveyed through a variety of media and information sources, which is then integrated through mental model-building activities. Conveyance processes can cause high levels of information processing as the communicators identify key concepts in the model and make connections among them. It requires cognitive resources to read, understand, and process the information. *Convergence* processes, however, are discussions among individuals about their interpretations (i.e., their mental models), with the goal of reaching a shared understanding of the meaning of the concepts in the situation. Because the factual aspects of the information have already been shared through conveyance, convergence demands fewer information-processing resources to verify that others’ understandings of the situation match our own or how they differ. In traumatic situations such as the 4-16 shootings, conveyance communications include the facts and information about the event (e.g., location, numbers of deaths and injuries, official announcements or instructions.), while convergence communication processes result in the exchange of thoughts and feelings about the facts, including the emergence of ranges of emotions (e.g., shock and fear for safety, happiness/relief for others’ safety, grief over losses, disgust toward perpetrators).

Psychologically speaking, conveyance and convergence may reflect different coping responses that are being communicated to others. Coping is a term used to refer to a wide range

of cognitions and behaviors that individuals use to regulate the internal and external demands associated with being exposed to stressors or threats (Folkman & Lazarus, 1980; Lazarus & Folkman, 1984). Traditionally, coping responses have been theorized to fall into two general categories: approach and avoidance. Approach responses help to integrate the traumatic information, while avoidance responses essentially shield the person from painful information (Holohan & Moos, 1987; Roth & Cohen, 1986). The former has been found to lead to better posttraumatic adjustment (Norris, Friedman, Watson, Byrne, Diaz, & Kaniasty, 2002.)

The cognitive processing model (Resick & Schnicke, 1993) maintains that greater levels of recovery are achieved when traumatized individuals engage realistic thoughts to modify or broaden prior mental models (i.e., accommodation) rather than minimizing the trauma or producing inaccurate and overgeneralized cognitive schema (i.e., assimilation or overaccommodation). Similarly, Ehlers and Clark (2000) maintain that the appropriate processing of the event provides new meaning and alteration of negative appraisals of the event, which often results in adaptive recovery. While the actual type of coping is beyond the scope of this present paper, it is clear that the processing of the event is an important predictor of outcome. These forms of accommodative cognitive processing that address the meaning of the event appear consistent with the convergence process of communication.

Since conveyance communication has the sole function of expressing facts for mental model-building, it necessarily excludes full cognitive processing that would also include meaning and emotions and allow for accommodation. On the other hand, convergence may reflect the ability to process and integrate the meaning of the trauma via the expression of emotions and perceptions. As such, we hypothesize that the use of communication for the function of conveyance of the 416 shootings will be positively related to PSS; while we hypothesize that the use of communication for convergence will have a buffering effect on PSS. Because prior studies have implicated the role of exposure and loss in increasing probable PSS, we will control for the effect of social and physical proximity to the shootings.

Method

Participants

Five hundred nineteen participants completed two online surveys approximately three months and six months after the April 16, 2007 shootings at VT. The final sample included 181 men and 337 women (1 failed to report sex; 90.4% Caucasian) between the ages of 18-54 years old ($M = 23.05$ years, $SD = 5.34$). A power analysis using G*Power software (Faul, Erdfelder, Lang, & Buchner, 2007) was conducted to determine the number of participants needed for the study. With a power of 0.8, alpha of .05 and 4 predictors, a total sample size of 85 was suggested. The current sample of 519 participants is more than adequate to detect a medium effect. In addition, 518 reported their marital status (83.6% single, 6.4% engaged, 8.9% married, 1.0% divorced) and their relationship to the university at the time of survey completion (17.7% sophomores, 18.9% juniors, 22.5% seniors, 21.4% graduate students, 1.0% faculty, 0.4% staff and 17.9% alumni-recently graduated in the semester of the shootings). VT's student body is approximately 70% Caucasian and 42% female. Therefore, the current study's sample is more homogenous (i.e., predominantly Caucasian, twice as many women as men) than the VT's student population and is not representative of the full VT community.

Measures

Social and physical proximity. Participants were asked questions concerning proximity to the events. Social proximity was defined as knowing someone who was killed or injured (0 = no one known, 1 = at least one person known). Physical proximity included being physically near (i.e., being in the building where the shootings occurred or being close enough to hear gunshots) the first event in West Ambler-Johnston Hall or the second event in Norris Hall (0 = not near; 1 = physically near).

Trauma Screening Questionnaire (TSQ; Brewin, Rose, Andrews, Green, Tata, McEvedy, et al., 2002). This 10-item instrument assesses for PSS based on the DSM-IV-TR re-experiencing, avoidance, and arousal criteria. The survey was adapted to be specific to the events on April 16, 2007 at VT. Participants were asked to indicate how often symptoms occurred during the previous two weeks on a scale of 1 (never) to 5 (just about every day), and were directly related to the 4-16 shootings. Scores were calculated by summing the ten items. Scores could range from 10 to 50, with higher scores indicating greater stress symptoms. Cronbach's alpha for the current study was .90.

Form of Communication Used. This 8-item questionnaire assessed whether different communication forms were used within the first 24-hours following the 4-16 shootings (i.e., cell voice, cell text, email, land line, face-to-face, online instant messaging, social networking, PDA). Respondents were asked to indicate the communication form he/she used with the first person he/she contacted (i.e., 1st sent), the communication form of the first person who contacted him/her (i.e., 1st received), and the communication form he/she used the most (i.e., overall). In all cases, 0 = communication form not used, and 1 = communication form used. For analyses, the forms of communication were collapsed into telephone/cell phone use, other electronic use (i.e., messaging, computer), and face-to-face.

Perceived Usefulness of Technology. This 8-item questionnaire assessed the degree to which each of the eight communication forms (e.g., cell voice, cell text, email) were perceived as being useful during the 4-16 shootings. Each form of communication was rated on a scale of 1 to 8, and summed to create a total score. Scores could range from 8 to 64, with higher scores indicating greater perceived utility. Cronbach's alpha for the current study was .79.

Satisfaction with Use of Technology. This 8-item questionnaire assessed the degree to which the eight forms of communication (e.g., cell voice, cell text, email) were satisfying when dealing with and recovering from the 4-16 shootings. In all cases, 0 = communication form not satisfying, and 1 = communication form was satisfying. A total score was created by summing the items, with higher scores indicating greater satisfaction. Cronbach's alpha for the current study was .45.

Conveyance and Convergence (Dennis & Valacich, 1999). This 16-item questionnaire assessed the degree to which each of the eight communication forms (e.g., cell voice, cell text, email) were important in (1) conveyance (i.e., describing factual information, 8 items) and (2) convergence (i.e., expressing thoughts and feelings, 8 items) about the 4-16 shootings. Each form of communication was rated on a scale of 1 (not at all important) to 7 (extremely important), and summed for conveyance and convergence items, respectively. Scores for each variable could range from 1 to 56, with higher scores indicating greater conveyance or greater convergence. Cronbach's alpha for the current study was .81 for conveyance and .82 for convergence.

Procedure

The current study was part of a larger study examining PSS in the VT community (Hughes et al., 2011). Participants completed an online survey three months after April 16, 2007, which included the TSQ and questions concerning their physical and social proximity. Participants were contacted six months after the events of April 16, 2007 to complete an additional 20-minute online survey, which included the conveyance and convergence measures, and questions about communication forms. They were asked to retrospectively report on conveyance and convergence in regards to their communication immediately following the 4-16 shootings. Institutional Review Board approval was obtained for both parts of the current study. Informed consent was also obtained from each participant for his or her online participation, by clicking on a button that said “I volunteer to participate.”

Data Analysis Plan

Descriptive statistics, correlations, and gender differences were examined for the predictors of interest: form of communication used, PSS (i.e., TSQ total), convergence, conveyance, satisfaction, utility, social proximity (i.e., knowing someone killed, knowing someone injured), and physical proximity (i.e., close proximity to the first event, and close proximity to the second event). Independent samples *t*-tests or one-way analyses of variance (ANOVAs) were conducted to determine whether levels of convergence, conveyance, and PSS differed depending on social or physical proximity or on the communication form used. A linear regression was conducted to determine if conveyance and convergence accounted for a significant amount of variance in PSS, after controlling for each other (i.e., both predictors were entered into the model simultaneously). Significant gender differences were found for PSS score; therefore, gender also was included in the model. Finally, the linear regression was repeated with proximity variables entered as covariates if they were found to be significantly related to conveyance, convergence, or PSS in order to examine if conveyance/convergence predicted PSS score beyond proximity or if proximity better accounted for the findings.

Results

Descriptive Statistics and Correlations

See Tables 1, 2, and 3 for complete descriptive statistics on all variables of interest and Pearson product moment correlations for all continuous variables.

Phones, especially cell phones, were most frequently used for the first communication sent (76.3%), the first communication received (73.8%), and the second most commonly used communication form overall following the shootings (42.0%). Messaging/computer forms (i.e., messaging, email, social networking) were used by 18.9% to first contact someone, 23.5% for first contact received from another, and 46.1% as the most used form overall. Face-to-face contact was used the least: 4.2% for first sent, 2.1% for first received, and 11.4% as the most used form overall.

Independent samples *t*-tests were used to examine gender differences on convergence, conveyance, and PSS. Women reported significantly more convergence ($M_{women} = 28.35$, M_{men}

= 26.13; $t = -2.51, p = .012$), conveyance ($M_{women} = 30.44, M_{men} = 27.99; t = -2.63, p = .009$), and PSS ($M_{women} = 20.51, M_{men} = 15.36; t = -6.56, p < .001$) than men.

Regarding social proximity, 11.4% ($n = 59$) of the respondents had someone close to them killed and 3.9% ($n = 20$) were close to someone who was injured. Additionally, 4.2% ($n = 22$) of respondents indicated they were in physical proximity to the first event and 15.2% ($n = 79$) reported they were in physical proximity to the second event. Therefore, approximately 15% of the sample reported having someone close to them injured or killed, and approximately 20% of the sample reported being physically in or near one of the buildings where the shootings took place.

Independent samples t -tests revealed that participants who reported knowing someone killed ($M = 33.52$) evidenced significantly higher conveyance scores, $t(480) = 3.11, p = .002$, than not knowing someone killed ($M = 29.13$). Conveyance scores did not significantly differ depending on whether the participants reported knowing someone injured ($M_{known} = 28.2, M_{not\ known} = 29.67, t(480) = .65, ns$), close proximity to the first event ($M_{close\ first} = 30.15, M_{not\ close\ first} = 29.38, t(480) = .80, ns$), or close proximity to the second event ($M_{close\ second} = 30.00, M_{not\ close\ second} = 29.27, t(480) = -.83, ns$). The levels of convergence did not significantly differ depending on whether or not the participants reported knowing someone killed ($M_{known} = 29.42, M_{not\ known} = 27.37, t(480) = -1.55, ns$), knowing someone injured ($M_{known} = 24.15, M_{not\ known} = 27.76, t(480) = 1.71, ns$), close proximity to the first event ($M_{close\ first} = 27.77, M_{not\ close\ first} = 27.54, t(480) = .80, ns$), or close proximity to the second event ($M_{close\ second} = 27.18, M_{not\ close\ second} = 27.98, t(480) = .96, ns$). Participants who reported knowing someone killed ($M = 25.67$) evidenced significantly higher PSS, $t(498) = -4.98, p < .001$, than not knowing someone killed ($M = 17.85$). The levels of PSS did not significantly differ depending on whether the participants reported knowing someone injured ($M_{known} = 22.32, M_{not\ known} = 18.60, t(498) = -1.83, ns$), close proximity to the first event ($M_{close\ first} = 22.23, M_{not\ close\ first} = 18.58, t(498) = -1.92, ns$), or close proximity to the second event ($M_{close\ second} = 19.60, M_{not\ close\ second} = 18.59, t(498) = -.95, ns$).

PSS total was significantly positively correlated with conveyance, but not significantly correlated with convergence. Perceived usefulness was significantly negatively correlated with both conveyance and convergence. Perceived satisfaction was significantly positively correlated with both conveyance and convergence. Convergence and conveyance were significantly positively inter-correlated (See Table 1).

ANOVA results indicated that the levels of convergence, conveyance, and PSS did not statistically differ among participants by the communication form they first sent or they first received (see Table 3). For the most commonly used form of communication overall following the shootings, PSS did not significantly differ; however, conveyance and convergence did significantly differ. Tukey's post-hoc testing indicated that participants who used messaging the most overall reported greater conveyance or convergence, respectively, than participants who used phone the most overall. Participants who used face-to-face contact did not differ in convergence or conveyance from those who used phone or messaging.

Table 1. Descriptive statistics: Means, standard deviations (SD), observed ranges, possible ranges, Cronbach's alphas, and inter-correlations for all variables of interest

Variable	Mean	SD	Observed Range	Possible Range	Alpha	Correlations (Sample Size)			
						1. PSS	2. Perceived Usefulness	3. Satisfaction Total	4. Conveyance
1. PSS	18.74	8.72	10-50	10-50	.903	-			
2. Perceived Usefulness	45.09	10.34	19-64	8-64		-.01 (500)	-		
3. Satisfaction Total	3.81	1.59	1-8	1-8	.447	.00 (492)	.03 (511)	-	
4. Conveyance Total	29.61	9.86	1-52	1-56	.805	.14** (475)	-.25** (492)	.20** (484)	-
5. Convergence Total	27.61	9.24	1-52	1-56	.821	.05 (465)	-.23** (482)	.19** (474)	.68** (481)

Note. ** Correlation is significant at the 0.01 level (2-tailed).

PSS = Posttraumatic stress total score

Table 2. Use of communication forms frequencies (percentages) (N =519)

	N (%)
Communication form first sent	
Phone	396 (76.3%)
Land line phone	22 (4.2%)
Cell phone	374 (72.1%)
Messaging/Computer	98 (18.9%)
Text messaging	38 (7.3%)
Online instant messaging	26 (5%)
Email	31 (6%)
Social networking	3 (0.6%)
Face-to-face	22 (4.2%)
Other	3 (0.6%)
Communication form first received	
Phone	383 (73.8%)
Land line phone	47 (9.1%)
Cell phone	336 (64.7%)
Messaging/Computer	122 (23.5%)
Text messaging	52 (10%)
Online instant messaging	36 (6.9%)
Email	28 (5.4%)
Social networking	6 (1.2%)
Face-to-face	11 (2.1%)
Other	3 (0.6%)
Communication form used the most overall	
Phone	218 (42%)
Land line phone	11 (2.1%)
Cell phone	207 (39.9%)
Messaging/Computer	239 (46.1%)
Text messaging	62 (11.9%)
Online instant messaging	93 (17.9%)
Email	40 (7.7%)
Social networking	44 (8.5%)
Face-to-face	59 (11.4%)
Other	3 (0.6%)

Table 3. Comparison of communication forms on Posttraumatic Stress Symptoms, Convergence, and Conveyance

	<i>M (SD)</i>	<i>F</i>
Communication form first sent		
Posttraumatic Stress Symptoms		.37 (<i>p</i> = .693)
Phone	18.93 (8.67)	
Messaging/Computer	18.42 (8.99)	
Face-to-face	17.45 (8.78)	
Convergence		.34 (<i>p</i> = .713)
Phone	27.77 (9.20)	
Messaging/Computer	27.31 (9.28)	
Face-to-face	26.11 (10.35)	
Conveyance		1.33 (<i>p</i> = .264)
Phone	29.73 (9.80)	
Messaging/Computer	29.86 (9.34)	
Face-to-face	26.00 (13.06)	
Communication form first received		
Posttraumatic Stress Symptoms		1.27 (<i>p</i> = .281)
Phone	18.43 (8.55)	
Messaging/Computer	19.81 (9.21)	
Face-to-face	17.36 (9.00)	
Convergence		.88 (<i>p</i> = .416)
Phone	27.41 (9.16)	
Messaging/Computer	28.50 (9.30)	
Face-to-face	25.50 (9.68)	
Conveyance		.60 (<i>p</i> = .551)
Phone	29.53 (9.80)	
Messaging/Computer	30.14 (9.90)	
Face-to-face	26.80 (8.15)	
Communication form used the most		
Posttraumatic Stress Symptoms		1.93 (<i>p</i> = .147)
Phone	17.93 (7.79)	
Messaging/Computer	19.56 (9.30)	

Face-to-face	18.54 (9.44)	
Convergence		3.46 ($p = .032$)
Phone	26.34 (9.04)	
Messaging/Computer	28.86 (9.25)	
Face-to-face	27.02 (9.61)	
Conveyance		4.07 ($p = .018$)
Phone	28.28 (10.32)	
Messaging/Computer	30.77 (9.28)	
Face-to-face	29.67 (10.19)	

Linear Regression

Linear regression analysis (See Table 4) revealed that the overall model including gender, conveyance and convergence, as predictors accounted for a significant amount of variance in PSS ($F(3, 454) = 15.51, p < .001, R^2 = .09$; see Table 4). Female gender ($B = 5.13, p < .001$) and conveyance ($B = .16, p = .006$) were significantly related to PSS. Specifically, the results indicate that being female resulted in a 5.13 unit increase in PSS and a one unit increase in conveyance was associated with a .16 unit increase in PSS. Convergence scores ($B = -.09, ns$) were unrelated to PSS symptoms.

Perceived satisfaction with and perceived usefulness of technology were both positively related to conveyance and convergence, and therefore were included in the model. Linear regression analysis revealed that the overall model including gender, conveyance, convergence, satisfaction and utility, continued to account for a significant amount of variance in PSS, $F(5, 449) = 9.34, p < .001, R^2 = .09$ (see Table 4). Female gender, $B = 5.11, p < .001$ and conveyance, $B = .16, p = .006$, continued to be significantly related to PSS. Convergence scores ($B = -.08, ns$), satisfaction with use of technology ($B = -.10, ns$) and perceived usefulness of technology ($B = .02, ns$) were unrelated to PSS.

Knowing someone killed was the only proximity variable related to conveyance and/or convergence, and therefore was included in the model. A linear regression analysis revealed that the overall model including gender, conveyance, convergence, satisfaction, utility, and knowing someone killed, continued to account for a significant amount of variance in PSS, $F(6, 448) = 14.30, p < .001, R^2 = .16$ (see Table 4). Female gender, $B = 4.98, p < .001$, and social proximity (i.e., knowing someone killed), $B = 7.28, p < .001$, were the strongest predictors in the model. Conveyance, $B = .12, p = .03$, continued to be significantly related to PSS beyond gender and proximity. Being female resulted in a 4.98 unit increase in PSS, knowing someone killed was associated with a 7.28 unit increase in PSS, and a one unit increase in conveyance was associated with a .12 unit increase in PSS. Convergence scores ($B = -.08, ns$), satisfaction with use of technology ($B = .02, ns$), and perceived usefulness of technology ($B = .03, ns$), were unrelated to PSS.

Table 4. Linear regression analyses testing the predictors of interest (N =455)

	<i>B</i>	<i>SE (B)</i>	β
Model 1 – Outcome: Posttraumatic Stress Symptoms			
Gender (0 = Male, 1 = Female)	5.13	.84	.27**
Conveyance Total	.16	.06	.16**
Convergence Total	-.09	.06	-.09
Model 2 – Outcome: Posttraumatic Stress Symptoms			
Gender (0 = Male, 1 = Female)	5.11	.85	.27**
Conveyance Total	.16	.06	.17*
Convergence Total	-.08	.06	-.08
Satisfaction Total	-.10	.26	-.02
Perceived Usefulness	.02	.05	.02
Model 3 – Outcome: Posttraumatic Stress Symptoms			
Gender (0 = Male, 1 = Female)	4.98	.82	.27**
Conveyance Total	.12	.06	.13*
Convergence Total	-.08	.06	-.08
Satisfaction Total	.02	.25	.00
Perceived Usefulness	.03	.04	.03
Close to someone killed	7.28	1.22	.26**

Note. $R^2 = .09$ for Models 1 and 2; $R^2 = .16$ for Model 3, * $p < .05$, ** $p < .01$.

Discussion

Two primary findings related to the form and function of post-trauma communicative behavior emerged from this study. First, the most frequently used form of communication after the 4-16 shootings was cell phones, followed by messaging. Face-to-face communication was used least often. Second, although the form of communication was not related to posttraumatic stress reactions, the function of communication (i.e., conveyance or convergence) did differentially relate to reports of subsequent PSS. As hypothesized, communication used for conveyance functions was positively related to PSS. Contrary to hypotheses, however, convergence was unrelated to PSS.

Vicary and Fraley (2010) found that about 89% and 75% of their sample joined Facebook or used messaging, respectively. Conversely, relatively fewer participants (46%) in our sample used messaging or other social networking sites. This was somewhat unexpected, in light of the rising use of the Internet among adolescents and young adults in our society reported by the U.S. Census Bureau's Current Population Survey (Day, Janus, & Davis, 2005). On the other hand, cell phones were most frequently used (76%) and face-to-face communication was rare (11%), suggesting that technology was a preferred medium for communication and perhaps more accessible and efficient than face-to-face communication by being able to reach greater numbers of people, talk to individuals in distant locations, and communicate in less time. Despite these

forms of communication being prominent and perceived as useful and satisfying, they did not relate to posttraumatic adjustment.

Not surprisingly, the two most powerful predictors of PSS in the current sample were female gender and close social proximity (i.e., knowing someone who was killed). These findings are consistent with prior conceptual models of PTSD that include survivor characteristics and elements of the trauma experience as important contributors to outcome (Green et al., 1985; La Greca et al., 1996). Beyond these strong predictors, conveyance communication emerged as having a small but significant association with increased stress reactions, but convergence communication was unrelated to PSS. These findings were not explained by the overall perceived utility of or satisfaction with the communication. Despite the fact that media can enhance communication when used to achieve a common goal, as described by MST (Dennis et al., 2008), it appears that the quality of the communication had less impact on reported PSS than the function of the communication (i.e., conveying information for the purpose of fact-finding versus emotional expression).

Consistent with prior findings on the effects of Internet use on psychological well-being, the current investigation found that technology use can both increase maladjustment (Van den Eijnden et al., 2008), as well as be unrelated to adjustment (Sanders et al., 2000). In particular, in the immediate aftermath of the 4-16 shootings, communication that was intended solely to convey facts was related to increased reports of PSS three months later. However, communication that was intended to express feelings or thoughts about the event was not significantly related to subsequent adjustment. We interpret this finding in relation to cognitive models of PTSD or fear/anxiety that incorporate emotional processing (e.g., Borkovec, Alcaine, & Behar, 2004; Ehlers & Clark, 2000; Foa & Kozak, 1986). These theories suggest that recovery is enhanced when traumas are processed at multiple levels, including the importance of eliciting emotional arousal and re-appraising its associated meaning, as opposed to either perseverating on event details and/or avoiding the emotion altogether. In the stress and coping literature, avoidance of emotional stimuli is often associated with poorer recovery from stress (Jones & Ollendick, 2005). Rumination, in particular, involves repetitive and perseverative thoughts fixated on symptoms of distress and the possible causes or consequences of those symptoms, which may functionally serve as a form of cognitive avoidance in terms of distancing the individual from directly experiencing the associated aversive emotion and taking action to correct the problem (Nolen-Hoeksema et al., 2008). Rumination has been positively related to a number of psychopathologies, including anxiety and PSS (Nolen-Hoeksema, 2000). Active or approach coping, on the other hand, permits the individual to experience the emotion while exploring possible solutions and alternative meanings, either through changing the situation or modifying thoughts/reactions to the situation (Roth & Cohen, 1986).

In the context of these cognitive models, conveyance communication may support avoidance functions by focusing on facts and details that keep the individual from fully experiencing the associated emotions and meanings, thereby increasing the likelihood of future psychological maladjustment. A focus on event facts and details may also increase cognitive re-experiencing of the event, a core feature of PTSD. By the same token, convergence communication should support emotional and cognitive processing and predict better outcome in terms of decreased PSS. In our sample, however, convergence communication was unrelated to later stress reactions. Therefore, we did not find evidence of a protective role of technology used for convergent communication. It is possible that our questionnaire was not sensitive enough to tap the emotional impact of convergence. Alternatively, whereas conveyance may interfere with

cognitive/emotional processing from the beginning of the coping process, the benefits of convergence may occur as part of a dynamic process of accommodation that unfolds over time. Therefore, benefits of convergence may not have been captured by the time-reference of our assessment, which provided a snapshot of communication within 24 hours after the 4-16 shootings. Finally, it is also possible that the communication of thoughts and feelings is not sufficient to protect individuals from PSS. In other words, expression of thoughts/feelings cannot be considered apart from how that communication actually affected the person's constructed meaning of the event, or apart from many other contributors to recovery from trauma (e.g., social support, prior traumas, pre-existing vulnerabilities, cognitive world-views, etc.; Littleton et al., 2011).

There are several limitations to be noted in this study. First, the magnitude of the effect for the relationship of conveyance to PSS was small. Nonetheless, the effect was significant and related to symptoms above and beyond the large effects of gender and proximity/loss. As such, we believe this finding is valid and reflects the small, but important, added contribution of cognitive and emotional processing on traumatic stress reactions. In addition, while factors such as gender and proximity cannot be changed after the trauma, coping strategies that interfere with adaptive cognitive/emotional processing can be targeted and modified with intervention. Second, the timing of measures in our study precludes our ability to make causal inference. In particular, while current levels of PSS were measured three months after the shootings, questions about communication that occurred within 24 hours post-shootings were not measured until six months after the event. As such, recall about communication forms and function may have been biased by current symptoms or simply not recalled accurately. Third, the internal consistency of the Satisfaction with Use of Technology measure was low and should be considered when examining results using this measure. Finally, the nature of the mass trauma under examination here and the characteristics of the VT community likely affect the external validity of the results. The mass trauma occurred in a relatively closed community and therefore, the observed communication patterns may not apply to other trauma populations. Additionally, the results may not apply to other forms of mass traumas, such as natural disasters or acts of terrorism. Further research is necessary before these findings can be generalized to other trauma types or populations.

Notwithstanding these limitations, the results make important contributions to the literature in understanding the effect of mass trauma on communication and posttraumatic stress reactions in a university community. This study highlights the rising use of communication technology after a crisis, in light of the fact that face-to-face communication occurred in only about 10% of our sample. Moreover, regardless of the form of communication and despite the perception of communication as being useful or satisfying, the purpose or function of post-trauma communication can have important effects on the healing process. Although pre-existing survivor characteristic and features of the trauma experience play a prominent role in adjustment, the use of communication that promotes perseveration on details and interferes with cognitive/emotional processing can potentially delay recovery and increase PSS. Since the use of technology to communicate in the aftermath of traumatic events is clearly growing, future research should explore the underlying mechanisms of such communication that may help or hinder posttraumatic psychological adjustment.

References

- Amatya, K., Jones, R.T., & Hughes, M. (2011). Parental reactions and posttraumatic symptoms in Asian survivors of the April 16th shooting at Virginia Tech. *Journal of Critical Incident Analysis*, 40-54.
- American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC: Author.
- Bessièrè, K., Kiesler, S., Kraut, R. & Boneva, B.S. (2008). Effects of Internet use and social resources on changes in depression. *Information, Communication and Society*, 11, 47-70. doi: 10.1080/13691180701858851
- Borkovec, T.D., Alcaine, O., & Behar, E. (2004). Avoidance theory of worry and generalized anxiety disorder. In R.G. Heimberg, C.L. Turk, & D.S. Mennin (Eds.), *Generalized Anxiety Disorder: Advances in research and practice* (pp. 77-108). New York: Guilford Press.
- Breslau, N., Davis, G., Andreski, P., & Peterson, E. (1991). Traumatic events and posttraumatic stress disorder in an urban population of young adults. *Archives of General Psychiatry*, 48, 216-222. doi:10.1001/archpsyc.1991.01810270028003
- Breslau, N., Wilcox, H.C., Storr, C.L., Lucia, V.C., & Anthony, J.C. (2004). Trauma exposure and posttraumatic stress disorder: A study of youths in urban America. *Journal of Urban Health*, 81, 530-544. doi:10.1093/jurban/jth138
- Brewin, C. R., Rose, S., Andrews, B., Green, J., Tata, P., McEvedy, C., Turner, S., & Foa, E. B. (2002). Brief screening instrument for post-traumatic stress disorder. *The British Journal of Psychiatry*, 181, 158-162.
- Day, J., Janus, A., & Davis, J. (2005). Computer and Internet use in the United States: 2003. Washington D.C.: U.S. Department of Commerce, U.S. Census Bureau.
- Dennis, A.R., Fuller, R.M., & Valacich, J.S. (2008). Media, tasks, and communication processes: A theory of media synchronicity. *MIS Quarterly*, 32, 575-600.
- Dennis, A. R., & Valacich, J. S. (1999). Rethinking media richness: Towards a theory of media synchronicity. *Proceedings of the 32nd Hawaii International Conference on System Sciences*, Los Alamitos, CA.
- Ehlers, A., & Clark, D.M. (2000). A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy*, 38, 319-345. doi: 10.1016/S0005-7967(99)00123-0
- Faul, F., Erdfelder, E., Lang, A.G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioural, and biomedical sciences. *Behaviour Research methods*, 39, 175-191. doi: 10.3758/BF03193146
- Foa, E.B., & Kozak, M.J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin*, 99, 20-35. doi: 10.1037/0033-2909.99.1.20
- Folkman, S., & Lazarus, R.S. (1980). An analysis of coping in a middle-aged community sample. *Journal of Health and Social Behavior*, 21, 219-239. doi: 10.2307/2136617
- Fox, E.A., Andrews, C., Fan, W., Jiao, J., Kassahun, A., Lu, S., . . . Boutwell, L. (2008). A digital library for recovery, research, and learning from April 16, 2007, at Virginia Tech. *Traumatology*, 14, 64-84. doi: 10.1177/1534765608315632
- Green, B.L., Wilson, J.P., & Lindy, J.D. (1985). Conceptualizing post-traumatic stress disorder: A psychosocial framework. In C. Figley (Ed.), *Trauma and its wake* (pp. 53-72) Bristol, PA: Brunner/Mazel.

- Grills-Taquechel, A.E., Littleton, H.L., & Axsom, D. (2011). Social support, world assumptions, and exposure as predictors of anxiety and quality of life following a mass trauma. *Journal of Anxiety Disorders, 25*, 498-506. doi: 10.1016/j.janxdis.2010.12.003
- Hawdon, J., Rasanen, P., Oksanen, A., & Ryan, J. (2012). Social solidarity and wellbeing after critical incidents: Three cases of mass shootings. *Journal of Critical Incident Analysis, 3*, 2-25.
- Hawdon, J., & Ryan, J. (2012). Well-being after the Virginia Tech mass murder: The relative effectiveness of face-to-face and virtual interactions in providing support to survivors. *Traumatology, 18*, 3-12. doi: 10.1177/1534765612441096
- Hinchcliffe, V., & Gavin, H. (2009). Social and virtual networks: Evaluating synchronous online interviewing using instant messenger. *Qualitative Report, 14*, 318-340.
- Holohan, C.J., & Moos, R.H. (1987). Risk, resistance, and psychological distress: A longitudinal analysis with adults and children. *Journal of Abnormal Psychology, 96*, 3-13. doi: 10.1037/0021-843X.96.1.3
- Hughes, M., Brymer, M., Chiu, W.T., Fairbank, J.A., Jones, R.T., Pynoos, R.S., Rothwell, V., Steinberg, A.M., & Kessler, R.C. (2011). Posttraumatic stress among students after the shootings at Virginia Tech. *Psychological Trauma: Theory, Research, Practice, and Policy, 3*, 403-411. doi: 10.1037/a0024565
- Jones, R.T., & Ollendick, T.H. (2005). Risk factors for psychological adjustment following residential fire: The role of avoidant coping. *Journal of Trauma & Dissociation, 6*, 85-99. doi: 10.1300-J229v06n02_08
- LaGreca, A.M., Silverman, W.K., Vernberg, E.M., & Prinstein, M. (1996). Symptoms of posttraumatic stress after Hurricane Andrew: A prospective study. *Journal of Consulting and Clinical Psychology, 64*, 712-723. doi: 10.1037/0022-006X.64.4.712
- Lazarus, R.S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer Publishing Company.
- Littleton, H., Grills-Taquechel, A., & Axsom, D. (2009). Resource loss as a predictor of posttraumatic symptoms among college women following the mass shootings at Virginia Tech. *Violence and Victims, 24*, 669-686. doi: 10.1891/0886-6708.24.5.669
- Littleton, H.L., Grills-Taquechel, A.E., Axsom, D., Bye, K., & Buck, K.S. (2011). Prior sexual trauma and adjustment following the Virginia Tech campus shootings: Examination of the mediating role of schemas and social support. *Psychological Trauma: Theory, Research, Practice, and Policy, 4*, 578-586. doi: 10.1037/a0025270
- Luszczynska, A., Benight, C.C., Cieslak, R., Kissinger, P., Reilly, D.H. & Clark, R.A. (2009). Self-efficacy mediates effects of exposure, loss of resources, and life stress on posttraumatic distress among trauma survivors. *Applied Psychology: Health and Well-Being, 1*, 73-90. doi: 10.1111/j.1758-0854.2008.01005.x.
- Nolen-Hoeksema, S. (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology, 109*, 504-511. doi: 10.1037/0021-843X.109.3.504
- Nolen-Hoeksema, S., Wisco, B., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science, 3*, 400-424. doi: 10.1111/j.1745-6924.2008.00088.x
- Norris, F.H., & Stevens, S.P. (2007). Community resilience and the principles of mass trauma intervention. *Psychiatry: Interpersonal and Biological Processes, 70*, 320-328. doi: 10.1521/psyc.2007.70.4.320

- Norris, F., Friedman, M., Watson, P., Byrne, C., Diaz, E., & Kaniasty, K. (2002). 60,000 disaster victims speak, Part I: An empirical review of the empirical literature, 1981 – 2001. *Psychiatry*, *65*, 207-239.
- North, C.S., Smith, E.M., & Spitznagel, E.L. (1994). Posttraumatic stress disorder in survivors of a mass shooting. *American Journal of Psychiatry*, *151*, 82-88.
- Resick, P.A., & Schnicke, M.K. (1993). Cognitive processing therapy for rape victims: A treatment manual. Newbury Park, CA: Sage.
- Roth, S.L., & Cohen, L.J. (1986). Approach, avoidance, and coping with stress. *American Psychologist*, *41*, 813-819. doi: 10.1037/003-066X.41.7.813
- Sanders, C.E., Field, T.M., Diego, M., & Kaplan, M. (2000). Moderate involvement in sports is related to lower depression levels among adolescents. *Adolescence*, *35*, 793-797.
- Schwarz, E.D., & Kowalski, J.M. (1991). Malignant memories: PTSD in children and adults after a school shooting. *Journal of the American Academy of Child & Adolescent Psychiatry*, *30*, 936-944. doi: 10.1097/00004583-199111000-00011
- Van den Eijnden, R. J. J. M., Meerkerk, G.-J., Vermulst, A. A., Spijkerman, R., & Engels, R. C. M. E. (2008). Online communication, compulsive Internet use, and psychosocial well-being among adolescents: A longitudinal study. *Developmental Psychology*, *44*, 655-665. doi: 10.1037/0012-1649.44.3.655
- Vanderwerker, L.C., & Prigerson, H.G. (2004). Social support and technological connectedness as protective factors in bereavement. *Journal of Loss and Trauma*, *9*, 45-57. doi: 10.1080/15325020490255304
- Vicary, A.M., & Farley, R.C. (2010). Student reactions to the shootings at Virginia Tech and Northern Illinois University: Does sharing grief and support over the Internet affect recovery? *Personality and Social Psychology Bulletin*, *36*, 1555-1563.
- Vieweg, S., Palen, L., Liu, S., Hughes, A., Sutton, J. (2008). Collective intelligence in disaster: An examination of the phenomenon in the aftermath of the 2007 Virginia Tech shooting. *Proceedings of the 5th International ISCRAM Conference*, Washington DC.