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Compulsive Cell Phone Use and History of Motor Vehicle Crash

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A B S T R A C T

Purpose: Few studies have examined the psychological factors underlying the association between cell phone use and motor vehicle crash. We sought to examine the factor structure and convergent validity of a measure of problematic cell phone use, and to explore whether compulsive cell phone use is associated with a history of motor vehicle crash.

Methods: We recruited a sample of 383 undergraduate college students to complete an online assessment that included cell phone use and driving history. We explored the dimensionality of the Cell Phone Overuse Scale (CPOS) using factor analytic methods. Ordinary least-squares regression models were used to examine associations between identified subscales and measures of impulsivity, alcohol use, and anxious relationship style, to establish convergent validity. We used negative binomial regression models to investigate associations between the CPOS and motor vehicle crash incidence.

Results: We found the CPOS to be composed of four subscales: anticipation, activity interfering, emotional reaction, and problem recognition. Each displayed significant associations with aspects of impulsivity, problematic alcohol use, and anxious relationship style characteristics. Only the anticipation subscale demonstrated statistically significant associations with reported motor vehicle crash incidence, controlling for clinical and demographic characteristics (relative ratio, 1.13; confidence interval, 1.01–1.26). For each 1-point increase on the 6-point anticipation subscale, risk for previous motor vehicle crash increased by 13%.

Conclusions: Crash risk is strongly associated with heightened anticipation about incoming phone calls or messages. The mean score on the CPOS is associated with increased risk of motor vehicle crash but does not reach statistical significance.

IMPLICATIONS AND CONTRIBUTION

This study examined aspects of compulsive cell phone use and found that anticipation of future cell phone use was significantly associated with reported motor vehicle crash incidence. The results offer insight into potential mechanisms underlying the association between cell phone use and risky driving practices, and may inform prevention efforts.

Motor vehicle crashes (MVCs) are the leading cause of death for adolescents and are the leading cause of nonfatal injury [1]. Crash rates are higher for adolescent drivers than for any other age group [2]. This elevated risk is attributed to inexperience

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with the complex task of driving [3], a tendency toward sensation seeking [4], and the continuing development of self-regulation capabilities [5]. This combination of factors may make adolescents particularly susceptible to distraction while driving [6].

Driver distraction is a risk factor for MVC injury and death [7], contributing up to 28% of crash risk [8]. Cell phones are a major cause of such distraction [7]. Most adolescents own a cell phone [9] and use it frequently. A recent study estimated that 63% of teens report exchanging daily text messages and 30% report sending and receiving $\geq$100 text messages each day [9]. Cell phone use during driving causes visual, manual, and cognitive distraction [10] and slows driver reaction time [11]. Despite perceiving that using a cell phone while driving is hazardous [12], both younger and older adolescents engage in this behavior [13]. An estimated 75% of college students report using a cell phone while driving [14].

Feelings of belongingness and social connection are listed by youth as reasons for cell phone use [15], which, with the strong influence of adolescent peers, may accentuate the importance of communication even in the face of risk. Among college students, stronger perceptions of the risk of text messaging only weakly predicted avoiding the behavior [16]. Even when students report that talking on a cell phone while driving is dangerous, the perceived importance of the call influenced them to talk on the phone while driving [17]. Similar results were found in a delayed discounting study of texting, with students demonstrating a greater willingness to forgo monetary gain when faced with a decision to respond to a close social contact compared with a distant social contact [18]. Therefore, it is plausible that adult attachment style with friends and romantic relationships may also contribute to the desire to respond to a text. We hypothesized that individuals with an anxious attachment style would view relationships as less stable and may experience a greater degree of urgency to respond to cell phone communication from a friend.

The delayed discounting research provides evidence that the mechanism underlying risky cell phone use is likely related to an overwhelming emotional urge to respond to a social contact [18,19]. Clinically, this is more consistent with compulsive behaviors that are performed to relieve emotional urgency caused by rigid cognitions than with a general addictive pattern of behavior marked by abuse and dependence. A small number of studies have begun to measure problematic cell phone use and its relationship with psychological characteristics [19,20]. Findings suggest that depression [21], impulsivity [22], extroversion [23], and low self-esteem [19] are associated with problematic or excessive cell phone use.

To date, there is no widely accepted, reliable, validated tool for the measurement of problematic cell phone use. Such a tool would be useful for scientists conducting research on cell phone use and may lead to more specific identification of psychological factors associated with increased risk of injury and impact on quality of life functioning. The Cell Phone Overuse Scale (CPOS) is a good candidate for further study [20]. It was developed from *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (DSM-IV) [24] criteria for pathological gambling. The CPOS demonstrated significant associations among elevated anxiety, depression, somatic reports, social dysfunction, and insomnia in individuals with greater compulsive cell phone use behaviors. Previous research also discriminated compulsive cell phone use from substance use and gambling disorders based on DSM-IV criteria [20]. These are initial steps needed to establish the construct validity of the CPOS, in which the goal is to demonstrate how well responses on the measure agree or disagree with similar constructs (i.e., convergent and discriminant validity). However, no previous psychometric research studies have investigated whether the CPOS items measure single or multiple dimension(s) of problematic cell phone use. We sought to build on previous CPOS research by first examining the underlying factor structure and convergent validity of the CPOS with trait impulsivity, alcohol use, and relationship style measures, followed by evaluating the association between cell phone overuse and history of crash in young drivers.

Methods

Study population and recruitment

We enrolled students registered for an undergraduate psychology course at the University of Washington in Seattle, Washington, between May and October 2011. The study was advertised through the University of Washington Psychology Subject Pool. Interested students were linked to a Web page describing the study. After providing written consent, participants anonymously completed an online assessment over approximately 45 minutes. Participants received extra credit for participation in the study. Non-drivers, individuals older than 22 years, and those for whom driving history information was missing were excluded from the analysis. The study was approved by the University of Washington Institutional Review Board.

Measures

The current study included questionnaires to measure the properties of the CPOS and its association with MVCs and other behaviors associated with driving risk, such as impulsivity and alcohol use. The survey included a measure of interpersonal relationships to examine whether adult attachment style affected cell phone use behavior.

Compulsive cell phone use

The CPOS is a 24-item questionnaire based on seven of 10 pathological gambling operational definitions in the DSM-IV [20,24]. The questions ask about the frequency of behaviors that may represent problematic cell phone use (e.g., "Do you think about your cell phone when it is turned off?") Response options ranged from 1 = "never" to 6 = "always," with 3 = "sometimes" and 4 = "often" as midpoint values. Previous research suggests that high scores on the CPOS were associated with female gender, elevated anxiety, and insomnia [20].

Impulsivity

The Urgency Premeditation Perseverance Sensation Seeking–Positive Urgency (UPPS-P) Impulsive Behavior Scale is a 59-item measure composed of five separate subscales associated with unique qualities of impulsivity [25,26]. These subscales include planning, negative urgency, sensation seeking, persistence, and positive urgency. The first four subscales correspond with aspects of the Neuroticism Extroversion Openness to New Experiences Personality Inventory–Revised [25], whereas the fifth was

included in the revised version used in the current study [26]. Negative urgency reflects an individual's tendency to engage in potentially damaging behavior when experiencing a negative mood, whereas positive urgency is the extent to which an individual may engage in risky or regrettable behavior when experiencing an elevated mood state. A mean score was computed for each UPPS-P subscale. Overall, the subscales of the UPPS-P had good internal consistency: planning ($\alpha = .90$), negative urgency ($\alpha = .88$), sensation seeking ($\alpha = .91$), persistence ($\alpha = .87$), and positive urgency ($\alpha = .95$).

Alcohol use

We employed the Alcohol Use Disorders Identification Test (AUDIT), a validated 10-item questionnaire, for identifying individuals with problematic drinking behaviors [27,28]. Scores on the AUDIT were dichotomized using the standard cutoff: participants with a total score of $\geq$8 were classified as having harmful or hazardous drinking behavior. The AUDIT demonstrated good reliability in the current study ($\alpha = .87$).

Relationship style

The Relationships Style Questionnaire (RSQ) is a 30-item measure of adult attachment style [29]. The questions are relevant to both romantic and non-romantic relationships. Two separate factor solutions have been established for the RSQ; we chose to use a two-factor solution given preferable reliability over an alternative four-factor solution [30]. For the present study, we used items from the anxiety subscale (e.g., "I worry about being abandoned") of the two-factor solution, which demonstrated acceptable internal reliability ($\alpha = .76$).

Driving history

To assess driving history, we asked, "How many years have you been driving?" "What is the most serious type of car accident in which you have been involved while driving?" and "How many accidents have you been involved in while driving, regardless of the severity of damage done to your car?" Participants were provided a possible range of responses for number of accidents that ranged from "0" to "$\geq$5." In addition, participants were asked to report basic demographic information regarding their age, gender, and race(s) as white, African American/black, Native American or Alaska Native, Asian, Native Hawaiian or Pacific Islander, or Other.

Statistical analysis

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted using MPlus statistical software [31], and predictive analyses were conducted using Stata [32]. Statistical analysis involved three specific steps. Because we had no a priori hypotheses about the number of factors, the data were analyzed in a stepwise EFA procedure, using the geomin rotation in MPlus to compare solutions with varying numbers of factors and identify the optimal solution. We compared solutions with one to six latent factors, and selected the final solution based on a balance of fit indices, eigenvalues, and examination of the factor loading matrix (to minimize cross-loading of items). For the EFA and CFA, we used the maximum likelihood estimator with robust standard errors, and utilized chi-square as an indicator of exact fit. Where exact fit was not achieved (because chi-square is sensitive to violations of normality and sample size [33]), we used relative fit indices, specifically the comparative fit index (CFI), root-mean square error of approximation (RMSEA), and standardized root mean squared residual (SRMR) [34]. Nested models were compared against a less restrictive model using the Satorra-Bentler scaled chi-square difference test for log-likelihoods [35]. The final outcomes of the factor analysis are presented in the Results section.

To measure convergent validity, we conducted a series of ordinary least-squares regressions to examine the relationship between the CPOS and the subscales of the UPPS, the anxiety subscale of the RSQ, and the AUDIT two-group categorization (e.g., alcohol abuse, yes/no). All convergent validity models were adjusted for gender and subject age. Separate subscales were created for the CPOS that corresponded with the item loadings from the factor analysis, and mean scores were created by dividing the total subscale score by the number of items included. This process was repeated to derive an overall CPOS mean score. The association between cell phone overuse and crash history was examined using a series of negative binomial regression models, controlling for other measured potential confounders. We included all UPPS subscales, the RSQ anxiety subscale, the AUDIT two-group categorization, as well as gender and number of years driving in each negative binomial regression model. Each item had complete data for at least 88% of the total sample. We imputed missing data using multiple imputation by chained equations [36] using 30 imputations.

Results

Sample characteristics

A total of 490 students completed the online assessment out of the approximately 4,150 who were eligible, based on enrollment in a psychology course at the University of Washington during the enrollment period. Non-drivers (n = 86) were excluded from the analyses, as were 10 participants >22 years of age. Eleven participants had no driving history information and

Table 1
Cell Phone Overuse Scale fit indices for exploratory factor analyses for one to six factors

Factors	χ^2	Degrees of freedom	*p* value	Comparative Fit Index	Root mean square error of approximation	Standardized root mean square residual	Bayesian information criterion
One	2,559.973	252	.000	.684	.139	.094	31.800.595
Two	1,562.464	229	.000	.817	.111	.058	30.844.793
Three	1,020.962	207	.000	.888	.091	.044	30.538.834
Four	618.483	186	.000	.941	.07	.027	30.265.745
Five	438.677	166	.000	.963	.059	.021	30.209.162
Six	350.816	147	.000	.972	.054	.019	30.238.365

were omitted from the analytic sample. Therefore, our analytic sample included 383 participants (mean, 18.9 years; standard deviation [SD], .05 years).

Participants were more likely to be female (62% vs. 38% male). Self-reported race was as follows: white (52%), Asian (42%), African American/black (4%), Native American (2%), and Pacific Islander (2%), representative of the undergraduate student population at the University of Washington. Average time driving a vehicle was 2.8 years (SD, .07 years) and average number of previous MVCs in which the participant was driving was .82 (SD, .05 crashes). A total of 48% of the sample reported no history of MVC, whereas 31.9% reported two MVCs, 13.1% reported two MVCs, 5% reported three MVCs, 1.3% reported four MVCs, and .8% reported five or more MVCs. The positively skewed distribution in count outcome data was a good fit for the negative binomial regression model to examine MVC outcomes [37].

Factor structure of Cell Phone Overuse Scale

The EFA comparing models with one to six latent factors indicated that the optimal model had four factors, based on the number of eigenvalues >1, a minimum number of items loading on multiple factors, and acceptable model fit: $\chi^2 = 618.48$; $p < .001$; CFI = .94; RMSEA = .07; SRMR = .03 (n = 474; degrees of freedom [df] = 149). Models with fewer factors had poor model fit. Models with more factors tended to have items that significantly loaded on more than one factor and the factors had generally poor loadings, which suggests they were modeling residual error (Table 1).

The four factors reflected (1) the subject anticipated incoming calls or messages; (2) the cell phone interfered with routine life activities; (3) the subject had a strong emotional reaction to the phone; and (4) the subject recognized a problem with phone use. Our initial four-factor model had the following number of items loading on each factor: anticipation (two items), activity interference (eight items), emotional reaction (five items), and problem recognition (six items). Model fit indicated that this factor structure did not fit the data well, $\chi^2 = 708.84$, $p < .001$, CFI = .91, RMSEA = .063, SRMR = .05 (n = 474; df = 245). We examined model residuals and modification indices to determine sources of model misfit. This suggested that three items (items 3 and 6 from the activity interference factor and item 18 from the emotion factor) did not contribute substantial amounts of unique information to the model. Substantially improved model fit was achieved after excluding these three items: $\chi^2 = 427.382$; $p < .001$; CFI = .94; RMSEA = .053; SRMR = .04 (n = 474; df = 182).

All standardized factor loadings in the CFA were >.67, the latent factors explained between 46% and 77% of the variance in the items, and the latent factors exhibited moderate to large correlations ($r = .40–.73$; $p < .001$). Table 2 provides the final factor loadings for each item and correlations between latent factors. We utilized this reduced scale for the remainder of analyses.

Table 2
Cell Phone Overuse Scale confirmatory factor analysis item loadings and correlations among latent factors[a]

Factor loadings	Estimate	Standard error
Factor 1: anticipation		
1. Often think about calls or messages you may receive	.750	.035
2. Think about your cell phone when it is turned off	.864	.028
Factor 2: activity interference		
4. Choose to spend time on your cell phone rather than other activities	.741	.039
5. Family or friends said you spend too much time on your cell phone	.729	.035
7. School grades have been negatively affected by use of cell phone	.744	.047
8. Lie to family and friends about amount of time spent on cell phone	.777	.046
9. Use cell phone to escape from problems	.792	.035
10. Replace bad thoughts with thoughts about how good using cell phone feels	.792	.057
11. Think about when you will use cell phone next	.679	.050
12. Think that life without your cell phone would be boring, empty, or sad	.739	.028
Factor 3: emotional reaction		
13. Get angry or shout when someone interrupts you while on cell phone	.684	.061
14. Have nightmares related to your cell phone	.683	.082
15. Feel irritated or worried if not using your cell phone	.836	.023
16. Feel the need to send more and more time on cell phone to feel satisfied	.876	.024
19. Feel grumpy, irritable, or sad if not using cell phone	.819	.046
Factor 4: Problem Recognition		
17. Try to cut back on time spent on your cell phone	.730	.051
20. Surprised by amount of time spent on your cell phone	.792	.028
21. Cut back on time spent on your cell phone	.823	.030
22. Feel that time flies when using your cell phone	.707	.034
23. Felt guilty for spending too much time on your cell phone	.838	.023
24. Tried not to use your cell phone and failed	.738	.044
Factor correlations		
Factor 1		
Factor 2	.648	.050
Factor 3	.402	.094
Factor 4	.428	.078
Factor 2		
Factor 3	.647	.100
Factor 4	.673	.082
Factor 3		
Factor 4	.726	.057

[a] All associations are significant at $p < .001$.

Convergent validity of Cell Phone Overuse Scale

To measure convergent validity, univariate associations were investigated between the overall CPOS score and four identified subscales with the UPPS-P subscales, the AUDIT, and the anxiety subscale of the RSQ. The overall CPOS score was significantly associated with greater negative urgency, positive urgency, positive AUDIT classification, and greater tendency to have anxious relationship qualities (Table 3). The anticipation subscale demonstrated significant positive associations with negative urgency, persistence, positive AUDIT classification, and an anxious relationships style. Activity interference was significantly positively associated with negative urgency, positive urgency, positive AUDIT classification, and an anxious relationship style. The emotional reaction subscale demonstrated similar significant associations with negative urgency, positive urgency, positive AUDIT classification, and anxious relationship style, whereas the problem recognition subscale was significantly associated with positive urgency, negative urgency, positive AUDIT classification, and anxious relationship style (Table 3).

Table 3
Ordinary least-squares regression models measuring associations between Cell Phone Overuse Scale overall score and subscales with variables of interest[a,b]

	Coefficient	Standard error	*t*	Lower confidence interval	Upper confidence interval	*p* value
Cell Phone Overuse Score (total)						
Planning	.08	.05	1.79	−.01	.17	.08
Negative urgency	.19	.05	4.06	.10	.28	<.001
Sensation seeking	−.01	.04	−.14	−.08	.07	.89
Persistence	−.02	.05	−.31	−.12	.09	.76
Positive urgency	.29	.05	6.40	.20	.38	<.001
AUDIT group	.25	.07	3.40	.10	.39	.001
Anxiety	.18	.04	4.44	.10	.26	<.001
Anticipation						
Planning	.09	.08	1.07	−.07	.25	.29
Negative urgency	.28	.08	3.40	.12	.45	.001
Sensation seeking	.13	.07	1.92	.00	.27	.06
Persistence	.18	.09	1.95	.00	.36	.05
Positive urgency	.19	.09	2.20	.02	.36	.03
AUDIT group	.70	.13	5.50	.45	.94	<.001
Anxiety	.18	.07	2.52	.04	.32	.01
Activity interference						
Planning	.08	.06	1.47	−.03	.19	.14
Negative urgency	.20	.06	3.44	.09	.32	.001
Sensation seeking	−.03	.05	−.67	−.13	.06	.50
Persistence	−.07	.06	−1.11	−.19	.06	.27
Positive urgency	.31	.06	5.62	.20	.42	<.001
AUDIT group	.20	.09	2.22	.02	.38	.03
Anxiety	.21	.05	4.14	.11	.30	<.001
Emotional reaction						
Planning	.07	.05	1.26	−.04	.17	.21
Negative urgency	.20	.05	3.81	.10	.31	<.001
Sensation seeking	−.02	.04	−.58	−.11	.06	.56
Persistence	−.08	.06	−1.39	−.19	.03	.17
Positive urgency	.34	.05	6.94	.25	.44	<.001
AUDIT group	.20	.08	2.44	.04	.36	.02
Anxiety	.15	.05	3.34	.06	.24	.001
Problem recognition						
Planning	.10	.07	1.48	−.03	.23	.14
Negative urgency	.17	.07	2.60	.04	.31	.01
Sensation seeking	.00	.06	.09	−.11	.12	.93
Persistence	.03	.08	.45	−.11	.18	.65
Positive urgency	.30	.07	4.48	.17	.43	<.001
AUDIT group	.25	.10	2.38	.05	.45	.02
Anxiety	.21	.06	3.57	.09	.33	<.001

AUDIT = Alcohol Use Disorders Identification Test.
[a] Analyses were run using multiple imputation by chained equations with 30 imputations.
[b] All analyses were adjusted for gender and age.

Cell Phone Overuse Scale association with motor vehicle crashes

The final analyses examined the extent to which the CPOS total score and subscales were associated with reported MVCs, while controlling for the UPPS-P, AUDIT categorization, and RSQ subscale. The CPOS anticipation subscale was significantly associated with crash history (relative ratio, 1.13; confidence interval, 1.01–1.26). The CPOS total score and the subscales for activity interference, emotional reaction, and problem recognition were not significantly associated with history of MVC (Table 4).

Discussion

Results from the current study suggested that the CPOS is composed of four correlated factors: anticipation, activity interference, emotional reaction, and problem recognition. Each factor demonstrated significant associations with aspects of impulsive behavior, the most consistent of which were constructs involving emotional urgency. In fact, there were no significant associations between aspects of compulsive cell phone use and the (lack of) planning or sensation-seeking subscales of the UPPS-P. This finding is consistent with previous research demonstrating that the opportunity to respond to a text appears to lose its perceived value most quickly when involving close social ties [18], which may lead to a heightened burst of emotional urgency that might in turn prompt impulsive behavior. The (lack of) planning and sensation seeking behaviors described on the UPPS-P may relate more to risk taking in a more general sense that is potentially less likely to be affected by cell phone communication.

The results also demonstrated a statistically significant positive association between the anticipation factor and persistence on the UPPS-P, which means that individuals who had a greater tendency to maintain intense focus on activities and tasks also experienced higher levels of thinking about incoming calls and messages on their cell phone. One interpretation of these data is that cell phones may function to prolong engagement in specific tasks, which then leads to anticipation about receiving calls related to those same tasks. Future studies may wish to examine this potential relationship between prolonged engagement and anticipation of context via cell phone.

Table 4
Negative binomial regression models measuring association between overall Cell Phone Overuse Score and subscales with motor vehicle crash history[a,b]

	Rate ratio	Standard error	*t*	Lower confidence interval	Upper confidence interval	*p* value
Cell Phone Overuse Score	1.17	.12	1.59	.96	1.42	.11
Planning	.86	.08	−1.59	.72	1.03	.11
Negative urgency	1.09	.12	.75	.88	1.35	.45
Sensation seeking	1.14	.10	1.54	.97	1.34	.13
Persistence	1.00	.11	.01	.81	1.23	.99
Positive urgency	1.04	.11	.34	.84	1.28	.74
AUDIT group	1.23	.16	1.58	.95	1.59	.11
Anxiety	.91	.08	−1.07	.76	1.08	.28
Years driving	1.25	.06	4.96	1.14	1.37	≤.001
Female	1.26	.17	1.71	.97	1.64	.09
Anticipation	1.13	.06	2.15	1.01	1.26	.03
Planning	.86	.08	−1.61	.72	1.03	.11
Negative urgency	1.06	.12	.51	.85	1.32	.61
Sensation seeking	1.12	.09	1.41	.95	1.32	.16
Persistence	.98	.11	−.16	.79	1.21	.87
Positive urgency	1.07	.11	.68	.88	1.31	.49
AUDIT group	1.19	.16	1.28	.91	1.54	.20
Anxiety	.91	.08	−1.07	.77	1.08	.28
Years driving	1.24	.06	4.77	1.14	1.36	≤.001
Female	1.23	.17	1.53	.94	1.61	.13
Activity interference	1.11	.09	1.34	.95	1.30	.18
Planning	.87	.08	−1.55	.72	1.04	.12
Negative urgency	1.09	.12	.78	.88	1.35	.43
Sensation seeking	1.14	.10	1.52	.96	1.34	.13
Persistence	1.01	.11	.09	.82	1.25	.93
Positive urgency	1.05	.11	.42	.85	1.29	.67
AUDIT group	1.25	.16	1.72	.97	1.61	.09
Anxiety	.91	.08	−1.04	.77	1.08	.30
Years driving	1.25	.06	4.97	1.15	1.37	≤.001
Female	1.26	.17	1.72	.97	1.65	.09
Emotional reaction	1.12	.10	1.26	.94	1.33	.21
Planning	.87	.08	−1.52	.73	1.04	.13
Negative urgency	1.09	.12	.76	.88	1.35	.45
Sensation seeking	1.13	.09	1.50	.96	1.34	.14
Persistence	1.01	.11	.08	.82	1.25	.94
Positive urgency	1.04	.11	.37	.84	1.28	.71
AUDIT group	1.25	.16	1.68	.96	1.61	.09
Anxiety	.92	.08	−.94	.78	1.09	.35
Years driving	1.25	.06	4.99	1.15	1.37	≤.001
Female	1.30	.17	1.97	1.00	1.69	.05
Problem recognition	1.05	.07	.71	.92	1.20	.48
Planning	.88	.08	−1.46	.73	1.05	.15
Negative urgency	1.08	.12	.73	.87	1.35	.46
Sensation seeking	1.13	.09	1.44	.96	1.33	.15
Persistence	1.00	.11	−.01	.81	1.24	1.00
Positive urgency	1.07	.11	.61	.87	1.31	.54
AUDIT group	1.26	.16	1.74	.97	1.62	.08
Anxiety	.92	.08	−.96	.77	1.09	.34
Years driving	1.25	.06	4.98	1.15	1.37	≤.001
Female	1.29	.17	1.88	.99	1.68	.06

AUDIT = Alcohol Use Disorders Identification Test.
[a] Analyses were run using multiple imputation by chained equations with 30 imputations.
[b] All regressions controlled for confounders listed.

In addition to impulsivity, the results showed that higher CPOS scores were associated with greater risk of reporting problematic drinking behavior on the AUDIT and greater anxiety about interpersonal relationships. Alcohol use is one of the most powerful predictors of both intentional and unintentional injury, which suggests that compulsive cell phone use may be associated with other risky behaviors associated with injury. With regard to our findings on adult attachment style, the capacity of cell phones to serve as a proxy for natural experiences and relationships is rapidly accelerating through technological improvements that heighten visual and auditory sensations. Thus, the decision to accept a phone call in a potentially risky situation may be influenced by an individual's interpersonal expectations (e.g., "If I don't answer my friend's call will she hate me?").

Finally, the anticipation subscale of the CPOS was significantly associated with history of MVC, when controlling for the main effects of gender, years driving, impulsivity, alcohol use, and relationship styles. For each 1-point increase on the 6-point anticipation subscale, risk for previous MVC increased by 13%. Heightened anticipation for incoming contact could lead to either increased cell phone checking behavior and averting one's gaze while driving, or potentially affecting cognitive load and decreasing processing speed. Several of the items included in the

activity interference subscale reflected what might be considered avoidant or escape behaviors through cell phone use. In this manner, the cell phone may provide a means for coping with stressors, but ultimately leads to difficulty completing daily tasks. One may posit that driving does not elicit the same need for avoidant or escape behavior that may occur in other environmental contexts.

Legislation to prohibit young drivers from using cell phones has been adopted by 37 states and the District of Columbia [38], but evidence indicates that in the absence of highly effective enforcement, cell phone bans have limited impact on the rate of in-vehicle cell phone use by adolescents [39]. If the results from this study are replicated elsewhere, it would suggest that focusing on norms and expectations of constant phone contact and efforts to designate the car as a space in which adolescents do not have to worry about or anticipate phone calls or messages may be beneficial to reducing distracted driving. Alternatively, it may be helpful to provide real-time feedback (either with technology or education inside and outside the driving environment) to help drivers better understand why using a cell phone under various situations would be considered dangerous [40].

Our study had several limitations. The anticipation subscale consisted of two items, which limited variability in statistical models. Increasing the number of items would not affect the possible range of the subscale (1–6), but would introduce increased overall variance in the model. Next steps in this line of research begin with exploring improvements to the CPOS. We have created a second version with fewer overall items to reduce participant burden, while also adding items to the anticipation subscale. We were not able to measure actual cell phone use behavior during driving, nor did we ask specifically about using a cell phone while driving. Our cross-sectional study examines associations between cell phone use and risk of crash, and causality cannot be inferred. Our study relied on self-report for history of MVCs without taking into consideration the severity of each of the reported crashes. Although this method of assessing number of previous accidents does not take into account severity of each accident and cannot be validated against police-reported crashes, we were interested in any previous vehicle crash, and self-reported crash history was the best measure available to us. We are currently employing real-time in-vehicle recording of crashes in a study of teenage drivers and will be able to investigate the reliability of self-report crash history in this trial. Finally, the study is limited to an undergraduate student population, which may not generalize to high school students and adults older than 22 years of age.

It appears that problematic cell phone behavior is a multifactorial construct, with dimensions related to aspects of anticipation, activity interference, emotional reaction, and problem recognition. Our study suggests that the anticipation of incoming calls and messages may have a role in crash risk. These findings add to the growing body of research into potential risks and benefits as technological advances are incorporated into daily experience.

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