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METHODS IN ADDICTION RESEARCH

The Self-perception of Text-message Dependency Scale (STDS): Psychometric update based on a United States sample

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ABSTRACT

Background: Some have suggested that text messaging is an addictive behavior. However, this characterization is uncertain, partly due to lack of well-validated measures of text messaging attitudes and behaviors. One standard instrument for measuring text messaging attitudes and behaviors is the Self-perception of Text-message Dependency Scale (STDS), though the psychometric properties of this scale have only been examined with a sample of Japanese youth. *Objectives*: The primary objective of this study was to evaluate the STDS in the United States to determine its utility as a measure of text messaging dependence. We were interested in examining the factor structure and determining the extent to which this scale would correlate with two important outcome measures: motor vehicle accidents (MVAs) and moving violations. *Methods*: We analyzed data from 468 adults (age 18–74; 274 women) recruited via Amazon's Mechanical Turk (mTurk) service. Participants completed the STDS and provided information about their driving-related incidents in the past year. *Results*: First we performed a confirmatory factor analysis, which supported the instrument's original factor structure. Then we tested the relationship between scores on the STDS and two important variables, MVAs and moving violations. We found that the STDS significantly correlated with both MVAs and moving violations. *Conclusion*: The present study confirms that the STDS is a potentially useful instrument for studying texting dependence in the United States and with adults of all ages. The instrument may be particularly useful in predicting motor vehicle outcomes.

Americans between 18 and 24 years old send and receive an average of 2,022 texts per month (1), more than twice the number sent and received by individuals 35 years of age and older (2,3). Across demographics, the number of texts sent per day has rapidly increased (3,4) and texting has surpassed voice calls and e-mails as the most common means of transmitting information, particularly for adolescents and young adults (5). Concurrent with the increasing popularity of texting, the number of automobile crashes in the United States has risen over the past decade while the number of fatalities and injuries from crashes has decreased (6,7). It appears that safety features of cars have reduced injuries and death from these incidents (7,8), yet fatalities from distracted driving have increased (9). There is evidence to suggest that the problem of motor vehicle collisions involving distracted drivers is underestimated and the actual rates are worse than previously presented (8).

Despite widespread awareness of the dangers of texting while driving (10,11), the practice of doing so continues. Engaging in behaviors despite associated hazards is among the symptoms of addiction (12),

and some have argued that texting while driving constitutes this symptom (13,14). However, there is controversy about behavioral addictions as diagnosable mental health problems (15–17) where some express concern that any behavior might become characterized as addictive (13,18). One component of addiction is *dependence*, or relying on a substance or behavior to attain reinforcement (e.g., euphoria) or avoid punishment (e.g., withdrawal) (14). In the case of texting, dependence may be driven by social norms and expectations to remain in contact with others (13,14,19,20). While the link between problematic texting and harmful outcomes (e.g., motor vehicle accidents (MVAs)) is well established, it is not yet known how dependence on texting may be involved in these outcomes.

Igarashi et al. (21) developed the Self-perception of Text-message Dependency Scale (STDS) to measure three factors related to texting: excessive use, emotional reaction, and relationship maintenance. The scale was initially administered to 1,581 high school students in Japan, and the resulting factors showed strong coherence as well as associations with personality and other

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psychological functioning. For example, self-perceived excessive use was associated with extroversion, while emotional reactions to receiving text messages were associated with neuroticism. Despite the scale's development in Japanese adolescents over a decade ago, it has been translated and used in a variety of populations, including children, college students and adults worldwide (19,22–28). While there are some examples of the instrument's properties being confirmed (20), to our knowledge, the psychometric properties of this scale have not yet been specifically assessed in the United States with adults.

The fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) introduced the term *behavioral addiction*, with gambling disorder as the sole category and Internet gaming proposed as needing further study (12). Some experts have argued that digital-based communication, such as texting and other messaging methods, should also be under consideration (29,30). Others argue that a major impediment to the adoption and acceptance of behavioral addictions is the expectation that they meet the same criteria as substance use disorders (18,31,32). It remains controversial whether behavioral addictions can, or should, be made to fit in the same framework as substance use disorders, and if it is appropriate to group all addictive behaviors into the same broader diagnostic category (16–18). Improving the nosology and clarifying the phenomenology of addictive behaviors are necessary steps to determine which diagnostic criteria should be included for these addictions, or if they should be included at all. The STDS may be helpful in this regard as it was developed to measure one aspect of addiction – *dependence* – that some suggest is what specifically distinguishes the addiction-like behavior of excessive texting from that of other addictions (19,21,22).

To achieve the goal of establishing diagnostic criteria for behavioral addictions, it is necessary to develop reliable and valid measures of these behaviors and regularly assess their psychometric properties, especially since technology and social trends related to these behaviors change rapidly. For example, the STDS (21) was published in 2008, when the now-obsolete (33) AOL Instant Messenger was a dominant method of communication (34). Less than 30% of Americans owned a "smartphone" and text messages could be costly (34–36). In contrast, by 2016 it was estimated that over 77% of Americans owned a smartphone with over 90% of plans including an unlimited number of text messages and other messaging services (4,35,36). Given the growth of texting and the increasing use of the STDS, it is important to revisit its psychometric properties in a contemporary adult sample in the United States.

The present study had several interrelated goals. The first was to confirm the factor structure of the STDS in a sample of adults in the United States. The second was to sample a wider range of ages. The third was to examine the relationship between the STDS and previously established criteria for substance-related addictions. Finally, we wanted to examine the relationship between texting dependence and driving outcomes (i.e., moving violations and MVAs. To achieve these goals, we recruited a large, diverse sample of adults in the United States via Amazon Mechanical Turk (mTurk) service. They completed the STDS and provided the number of (both major and minor) MVA and moving violations they committed in the past year. We hypothesized that the basic psychometric properties of the STDS would be confirmed in a diverse sample of adults in the United States, though we understood that the psychometrics might have changed since the initial publication of the scale. We further hypothesized that the STDS subscale scores would be positively associated with: (a) self-reported DSM-5-based criteria of behavioral addictions, (b) self-reported moving violations, and (c) major and minor MVAs.

Methods

Participants

We used the Amazon mTurk service for subject recruitment as it is likely to attain a more representative and adherent sample than undergraduate samples (37–39). A total of 500 US adults completed the present study. Recruitment took place in May of 2016. Non-drivers (*n* = 32) were excluded from analyses, resulting in a final sample size of 468 (45% women). Ages ranged from 18–74 years old (*M* = 35.11, *SD* = 12.24, Mdn = 31.0), with 53% of respondents (*n* = 265) reporting their age to be over 30 years old; 15% of respondents (*n* = 74) reported their age to be over 50 years old. The modal age was 25 years (*n* = 32). Details regarding demographics can be found in Table 1. The Institutional Review Board of the University of Kansas approved all methods and recruitment procedures in the present study and participants were presented with informed consent prior to completing the assessments described next.

Instruments

STDS

The STDS (21) contains 15 items, rated on a five-point Likert-type scale (*strongly disagree* to *strongly agree*). The 15 items correspond with three factors: (1) emotional reaction to receiving (or not receiving) a text; (2) relationship maintenance via text; and (3) excessive use of texting. The items of the scale can be found in Table 2.

Table 1. Descriptive statistics of the included sample (*n* = 468).

Characteristic	n (%)
Gender	
Male	212 (45)
Female	256 (55)
Ethnicity	
White/Caucasian	381 (81)
Black/African American	36 (8)
Asian	34 (8)
Native American	5 (3)
Other	12 (3)
Highest education	
High school	42 (9)
Some college	117 (25)
Two- or four-year college degree	232 (50)
Post-graduate degree or professional certification	77 (16)
Employed	371 (79)
Annual income	
<$25,000	131 (28)
$25,000 – $50,000	149 (32)
$50,000 – $75,000	109 (23)
$75,000 – $100,000	46 (10)
$100,000 – $125,000	22 (5)
>$125,000	11 (2)

Notes: Percentages are rounded; no respondent selected Pacific Islander/ Native Hawaiian as their ethnicity

DSM-5-based scale of texting addiction

Like other researchers (40), we constructed a scale based on the DSM-5 criteria for substance use disorders (12), modified to reflect parallel behaviors regarding texting. The 11 items were scored as "completely true," "somewhat true," "neither true nor false," "somewhat false," or "completely false." Items included "Sometimes it bothers me that I text so much," "When I have tried to cut down or stop texting I have become restless or irritable, like I am going through withdrawal," and "I text in dangerous or illegal circumstances (e.g., while driving)." We included this novel

inventory to assess the relationship between *dependence* measured by the STDS and *addiction* or *substance use disorder* as assessed by DSM-like criteria.

Motor vehicle incidents

Participants were asked to provide the number of minor (not causing injury and/or causing small damage) and major (causing injury and major damage) MVAs and moving violations in the past year.

Results

Psychometric properties of the STDS

Each item of the STDS significantly correlated with each of the other items (all *p*s < .01) with *r* values ranging from .14 to .68. We conducted a Confirmatory Factor Analysis (CFA) using STATA software (StataCorp, College Station, TX). The results of the CFA factor loadings are presented in Table 2, along with descriptive statistics and Cronbach's α for each scale (which ranged from good to excellent reliability). Note that items significantly maintained their classification within the established three factors. Model fit indices are presented in Table 3. Note that the full model indicates marginal, but adequate goodness of fit (41,42). Next, modification indices were examined to identify items that may explain model strain. Due to relatively few items, we removed single items with the greatest modification index values in each model until satisfactory fit indices emerged. Improvements in these indices are also presented in Table 3. Goodness of fit indices improved with each removal and reached generally accepted

Table 2. Factor loadings and descriptive statistics for each of the three original factors from Igarashi, et al. (2008).

Item		Standardized coefficient	SE	Z	95% CI Low	95% CI high	M (Mdn; SD)
Emotional reaction (α = .87)							8.82 (9; 4.62)
1	After sending a text message, I check my mailbox repeatedly to see if I had received a response.	0.736	0.03	28.76	0.69	0.79	2.70 (2; 1.15)
2†	I feel disappointed if I don't get a reply to my message.	0.749	0.02	30.36	0.70	0.80	3.21 (3; 1.10)
3	I feel anxious when people don't immediately reply to my text message.	0.779	0.02	34.03	0.73	0.82	2.64 (2; 1.12)
4	I often check my mailbox to see if I had a new text message.	0.756	0.02	30.72	0.71	0.80	2.73 (2; 1.19)
5	I feel disappointed if I don't receive any text messages.	0.767	0.02	32.88	0.72	0.81	2.55 (2; 1.13)
Excessive use (α = .82)							8.78 (9; 4.65)
6	I sometimes send text messages while engaging in a conversation with another person.	0.797	0.02	35.81	0.75	0.84	2.79 (3; 1.26)
7†	I sometimes spend many hours on text messages.	0.649	0.03	20.19	0.59	0.71	2.02 (2; 1.11)
8†	I often exchange many text messages in a short period of time.	0.661	0.03	21.52	0.60	0.72	2.97 (3; 1.24)
9	I use text messages even while I am talking with friends.	0.862	0.02	44.96	0.82	0.90	2.65 (2; 1.24)
10	I consider myself a quick typist on mobile phones.	0.514	0.04	13.71	0.44	0.59	3.35 (4; 1.20)
Relationship maintenance (α = .86)							5.62 (5; 4.24)
11	I cannot maintain new friendships without text messages.	0.770	0.02	33.4	0.72	0.82	2.13 (2; 1.07)
12	I can't form any new relationships without using text messages.	0.809	0.02	39.16	0.77	0.85	1.96 (2; 0.97)
13	I think my relationships would fall apart without text messages.	0.800	0.02	37.92	0.76	0.84	2.01 (2; 1.07)
14†	Without text messages, I would not be able to contact friends whom I cannot meet on a daily basis.	0.677	0.03	23.36	0.62	0.73	2.60 (2; 1.24)
15	Without using text messages, I can't say what is on my mind.	0.677	0.03	23.54	0.62	0.73	1.93 (2; 0.95)
Scale total (α = .90)							38.23 (38; 11.02)

Note: All factor loadings were significant (*p*s < .001); †removal of item improved model fit indices (See Table 3)

Table 3. Fit indices of each model in the confirmatory factor analysis resulting from each item removed.

Items removed	χ^2 (df)*	RMSEA*	RMSEA 90% CI	CFI	TLI	SRMR
None	411.86 (87)	0.089	.081–.098	0.907	0.888	0.067
7	266.09 (74)	0.074	.065–.084	0.939	0.925	0.055
7 and 14	214.44 (62)	0.072	.062–.083	0.947	0.934	0.050
7, 14, and 2	154.26 (51)	0.066	.054–.078	0.959	0.947	0.048
7, 14, 2, and 8	101.67 (41)	0.056	.043–.070	0.974	0.965	0.039

*all ps < .001
Note: Each item was removed stepwise based on the greatest modification index value, with the final model resulting in fit statistics that meet preferred criteria (41).

thresholds (41,42) with the omission of items 7, 14, 2, and 8 (in descending order of model improvement). In short, the structure of the full STDS was supported in the present sample, and model fit was improved with removal of several items (discussed further later). For ease of presentation and consistency with previous research, the remaining analyses were conducted with sum scores of each subscale with all original items included.

An ANCOVA with age as the covariate revealed a significant main effect of factor, with a small effect size [F (2, 932) = 13.00, p < .001, η_p^2 = .027]. Pairwise comparisons showed that the sample reported significantly lower scores for relationship maintenance (M = 5.62, SE = 0.19) than excessive use (M = 8.83, SE = 0.21) and emotional reaction (M = 8.78, SE = 0.20; ps < .001). The respondents reported statistically comparable levels of excessive use and emotional reaction (p = 1.0).

Relation of the STDS to age, gender, and ethnicity

The present sample is more diverse than in previous studies and therefore an assessment of demographic variables was warranted. The sum score of the instrument correlated negatively with age (r = −.39, p < .001). The largest subscale correlate with age was that of excessive use (r = −.42, p < .001), followed by relationship maintenance (r = −.34, p < .001), and emotional reaction (r = −.19, p < .001). Results of a 2 (Gender) × 5 (ethnicity) MANOVA showed a main effect of ethnicity on the relationship maintenance subscale of the STDS [F (4, 458) = 4.43, p = .002, η_p^2 = .04]. Pairwise comparisons showed that Caucasians reported lower scores (M = 5.30, SE = 0.22) on this subscale than did African Americans (M = 7.82, SE = 0.71; p = .01) and Asian Americans (M = 7.44, SE = 0.79; p = .08). No other pairwise comparison approached significance, and there were no other main effects or interactions of gender and ethnicity on the subscales of the STDS (ps > .14).

Relation of the STDS to the DSM-5 scale

The mean number of items endorsed as "somewhat true" or "very true" on the scale was 1.42 (SD = 1.81,

range: 0–9). The median and modal number of symptoms was zero, with nearly half of the sample reporting no symptoms as true (47%, n = 218). An additional 18% (n = 82) reported one symptom, while 12% (n = 55) reported two symptoms, which is the threshold for substance use disorders in the DSM-5. A minority of the sample (14%, n = 66) reported four or more responses as true, which is the current diagnostic threshold in the DSM-5 for gambling disorder. All three of the STDS subscales moderately correlated with the scale (rs .46 to .57, ps < .001).

Motor vehicle incidents

Of the 468 individuals in the present sample, 58 (12%) reported any minor MVAs, 16 (3%) reported any major MVAs, and 54 (12%) reported any moving violation. Thus, the median and mode for each of these was zero. Seventeen respondents (4%) reported both an MVA and a moving violation. Of those that did report an MVA or moving violation, the mean number of minor MVAs was 1.13 (SD = 0.34, Mdn = 1.0, range: 1–2), the mean number of major MVAs was 1.19 (SD = 0.54, Mdn = 1.0, range: 1–3), and the mean number of moving violations was 1.34 (SD = 0.78, Mdn = 1.0, range = 1–5). Due to the infrequency of MVAs and moving violations, we collapsed these categories into binary variables (any MVA and any violation, respectively) for the remaining analyses.

Sixteen percent of men reported a moving violation compared to 9% of women, a significant discrepancy [χ^2 (1) = 4.74, p = .029, ϕ = .10]. Nineteen percent of men reported an MVA compared to 6% women, which was also a significant discrepancy [χ^2 (1) = 5.23, p = .022, ϕ = .11]. Those who had a moving violation in the past year were significantly younger (M = 29.00, SD = 9.0) than those who did not have a moving violation (M = 35.98, SD = 12.40, t (90.64) = 5.24, p < .001), though the effect size of this difference was negligible (d = .06). Those who reported any MVA were significantly younger (M = 30.89, SD = 10.43) than those who did not (M = 35.87, SD = 12.39, t (466) = 3.19, p = .002), although, again, the effect size

of this difference was negligible ($d = .04$). Ethnicity was not significantly associated with MVAs or violations ($ps > .5$). Together, these results indicate that men and younger adults were slightly more likely to report motor vehicle incidents than others.

Relationships between STDS, DSM-5 scale, and motor vehicle incidents

To assess the relation of the STDS and DSM-5 scale to motor vehicle incidents, we conducted a 2 (MVA: yes or no) × 2 (moving violation: yes or no) MANCOVA with the subscales of the STDS and the DSM-5 scale as the dependent variable and age as the covariate. Descriptive statistics for the MANCOVA can be found in Table 4. Results showed that those who reported an MVA in the past year also reported higher emotional reaction scores than those who did not report an MVA, which was a trend-level difference [F (1, 463) = 3.73, $p = .054$, $\eta_p^2 = .008$]. Similarly, those who reported an MVA in the past year also reported significantly more symptoms in the DSM-5 scale than those who did not report and MVA [F (1, 463) = 4.10, $p = .044$, $\eta_p^2 = .009$]. There were no other significant main effects of MVAs on the scales. Those who reported a moving violation reported significantly higher scores on the Emotional Reaction [F (1, 463) = 5.50, $p = .019$, $\eta_p^2 = .012$], Excessive Use [F (1, 463) = 4.04, $p = .045$, $\eta_p^2 = .009$], and Relationship Maintenance [F (1, 463) = 4.95, $p = .027$, $\eta_p^2 = .011$] subscales, as well as the DSM-5 scale [F (1, 463) = 9.21, $p = .003$, $\eta_p^2 = .019$] compared to those who did not report a moving violation.

There was a significant interaction of moving violations and MVAs only on the DSM-5 scale [F (1, 463) = 15.13, $p = .022$, $\eta_p^2 = .011$]. Pairwise comparisons showed those who reported both moving violations and MVAs scored higher on the DSM-5 scale than those who reported a moving violation but no MVA or an MVA and no moving violation, respectively (both $ps = .001$). Interpreting the aforementioned results regarding moving violations and MVAs should be approached with caution due to their infrequent occurrence.

Discussion

The STDS was introduced and originally validated by Igarashi and colleagues (21) approximately one decade ago in a sample of Japanese adolescents. According to Google Scholar, it has been cited more than 170 times. Over a relatively brief period of time, texting has gone from being a behavior primarily practiced by affluent adolescents and young adults to being a staple of individuals across the lifespan and social strata. To our knowledge, this is the first study to examine whether the STDS is a reliable instrument for measuring texting dependence in United States adults. The present findings confirm the factor structure of the STDS. Further, the results show that scores on the STDS are positively associated with MVAs and moving violations.

The psychometric properties of the full STDS were tentatively acceptable in the present analyses, and improved with removal of several items. These results underscore the importance of carefully examining self-report instruments used in research, particularly those intended to assess a rapidly evolving behavior like mobile messaging. Given the increasing volume of research on texting, there are surprisingly few broadly adopted instruments for measuring this behavior. Therefore, this instrument and its subscales have the potential to be useful across age groups in the assessment of psychological dependence on text messaging, but the instrument itself is in need of updating, particularly the measurement of "excessive use." For example, the removal of item 7 ("I sometimes spend many hours on text messages") resulted in the single greatest improvement in model fit. In the past, this statement may have represented "excessive use," but the average United States adult in 2016 texted for over 3 h per day, or 23 h per week (43). As well, while it may have been unusual to text or check one's phone while talking face-to-face in 2008 (i.e., item 6), this behavior is presently common, though perhaps no more acceptable (44). In short, the STDS may continue to be a useful instrument, but its properties and item content should be reevaluated and updated as social norms change.

Table 4. Descriptive statistics [M (SD)] of STDS subscales and DSM-5 scale for each of the motor vehicle incident categories.

	Emotional reaction	Excessive use	Relationship maintenance	DSM-5 criteria
Neither MVA nor Violations	8.46 (4.57)	8.32 (4.57)	5.29 (4.21)	1.20 (1.68)
Violation only	9.85 (4.51)	10.71 (4.32)	6.90 (4.25)	1.85 (1.82)
MVA only	9.39 (4.72)	9.50 (4.92)	5.94 (4.2)	1.77 (1.94)
Both	12.12 (4.18)	11.47 (4.17)	8.41 (3.83)	3.53 (2.24)
Whole Sample	8.82 (4.62)	8.78 (4.65)	5.62 (4.24)	1.41 (1.81)

Note: All values are rounded; DSM-5 questionnaire column represents the number of items reported as either "somewhat true" or "completely true" out of a possible 11 items

The present results also highlight the importance of distinguishing dependence from addiction; the two are related, but are not the same. Dependence can be understood as the perception that one is unable to function without a particular person, object, substance, or behavior. The distinction between dependence and addiction is important as some argue that digital communications cannot meet the contemporary framework for addiction, which emphasizes substantial impairment and physiological reactivity (19,20). Igarashi and colleagues (21) developed their instrument with a focus on dependence rather than addiction, emphasizing that text messaging can become a compulsive behavior that facilitates contact and communication with close others. The present study reveals some important individual differences in compulsive texting.

Age negatively correlated with the STDS and its subscales. This is not surprising given that texting, despite increasing popularity with adults of all ages, remains most popular among younger adults and adolescents (2–5,36,45). While age was negatively associated with MVAs and moving violations, it did not better account for the association of the STDS with moving violations and, to a lesser degree, MVAs. Therefore, in this sample, adults of all ages with increased dependence engaged in increased hazardous driving.

Controlling for age, the emotional reaction subscale of the STDS was the only subscale to approach significance in predicting MVAs and was associated with the largest effect size comparing those who had a moving violation and those who did not. It is notable that Igarashi and colleagues (21) found that the emotional reaction subscale of the STDS was most associated with neuroticism scores on the Big Five personality scale. Concurrently, Sween et al. (46) found that Emotionality predicted increased reckless driving behaviors and recreational risk behaviors. Therefore, the emotional reaction subscale of the STDS may measure proneness for risky behaviors above and beyond hazardous texting. Future studies should consider additional personality and psychological assessments when using the STDS to examine driving behavior.

The present data compliment previous research on hazardous and inappropriate texting. For example, Schroeder and Sims (24) found that, using the Big Five model of personality, extraversion, neuroticism, and sensation-seeking were related to risky text messaging. Further, they found that conscientiousness positively correlated with harm-reduced texting (e.g., texting while stopped rather than in motion), and agreeableness was related to relationship maintenance behaviors. Brown et al. (47) found risky drivers were higher on sensation-seeking and extraversion, while lower on stress and risk management. Perhaps texting dependence, as measured by the STDS, is related to similar impulsive, sensation-seeking behaviors.

There were unexpected differences in the STDS based on ethnicity and on motor vehicle incidents based on gender. Namely, compared to women, men reported slightly higher, though significant, frequency of MVAs and moving violations. However, men and women did not significantly differ on any STDS scales. These gender differences are infrequently reported in the literature. Some (48–50) have found that women and men varied in their motives and methods of hazardous texting but did not differ in their rates of hazardous texting or the consequences of having done so. Schroeder and Sims (49) found that women sent shorter texts and were more dependent on their cell phone than men. Struckman-Johnson et al. (48) found that men reported a higher level of confidence in their driving skills and sent longer texts while driving. We did not assess these variables in the present study, though it may explain the higher incidence of MVAs and moving violations for men. In terms of ethnicity, African Americans and Asian Americans reported higher levels of texting for relationship maintenance than did Caucasians. The present results compliment previous studies that found Black and Hispanic individuals (51,52) as well as Asian individuals (14,19,21) view electronic communication to be particularly important in relationship maintenance.

It is important to continue examining individual differences in texting behavior in order to disentangle the role of culture and environment in risk-taking behaviors. In doing so, we may better understand the nuances of texting in order to tailor social policies and interventions. For example, outright bans on texting while driving show limited, temporary reductions in accidents and fatalities (53) and have the potential to be misused to discriminate against drivers' age, race, and gender (54–56). Interventions that show potential effectiveness at reducing hazardous texting include age-appropriate, culturally sensitive education and public health campaigns geared to youth, their parents, as well as the general adult population (57–59). Technological interventions are gaining popularity, including software that disables most smartphone functions and text messaging while driving and/or rewards drivers for refraining from using their phones (8,57).

Limitations and future directions

While this study provides an important replication and extension of previous work exploring texting dependence, it is not without limitations. For example, we did not achieve a representative sample of the

United States adult population, particularly in terms of ethnicity. We did not consider the cost of texting for the respondents in the present sample, which may have influenced some respondents' behavior. The present sample (n = 486) is considered large for the analyses we conducted, which may have inflated otherwise small differences. Thus, the present findings need further replication. We did not examine measurement equivalence in the present sample, and future work would do well to determine whether, and how, different demographic groups (e.g., age, ethnicity, nationality) respond on the STDS. Future research should monitor item appropriateness, as social norms regarding excessive, dependent, or otherwise atypical texting behavior are likely to change over time. New and updated self-report instruments should include language that captures emerging media and communication platforms, such as Snapchat and WhatsApp, as these are gaining popularity and modifying the role of texting (4,5,43,60). Additionally, we inquired about hazardous driving (i.e., MVAs and moving violations), but we did not ask whether hazardous drivers were texting at the time of their incidents.

In conclusion, this study provides evidence that the STDS remains a reliable instrument, and hazardous driving is linked to texting dependence. It is important for future research to continue examination of this link and monitoring the instruments used to establish it.

Acknowledgments

Disclosure of interest

The authors declare no conflicts of interest or financial conflicts.

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References

1. Experian. Young adults: texting is just as meaningful as a phone call; 2012. http://www.experian.com/blogs/marketing-forward/2012/12/03/young-adults-texting-is-just-as-meaningful-as-a-phone-call/.

2. Ling R, Bertel TF, Sundsøy PR. The socio-demographics of texting: an analysis of traffic data. New Media Soc. 2011;14(2):281–98. doi:10.1177/1461444811412711.

3. Smith A. Americans and text messaging. Pew; 2011 [accessed 2017 Sep 10]. http://www.pewinternet.org/2011/09/19/americans-and-text-messaging/.

4. Smith A, Page D. U.S. smartphone use in 2015; 2015 [accessed 2017 Sep 10]. http://www.pewinternet.org/2015/04/01/us-smartphone-use-in-2015/.

5. Newport F. The new era of communication among Americans. Gallup; 2014 [accessed 2017 Sep 10]. http://www.gallup.com/poll/179288/new-era-communication-americans.aspx.

6. NHTSA. Traffic safety facts 2015: a compilation of motor vehicle crash data from the fatality analysis reporting system and the general estimates system. Washington, DC: US Department of Transportation; 2015.

7. CDC. Motor vehicle crash deaths; 2016 [accessed 2016 Jul 18; 2017 Sep 13]. https://www.cdc.gov/vitalsigns/motor-vehicle-safety/index.html.

8. National Safety Council. Crashes involving cell phones: challenges of collecting and reporting reliable crash data. Itasca, IL; 2016. http://www.nsc.org/DistractedDrivingDocuments/NSC-Under-Reporting-White-Paper.pdf.

9. 2015 Motor Vehicle Crashes: Overview [Internet]. 2015 [accessed 2017 Sep 10]. https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812318.

10. Terry CP, Terry DL. Distracted driving among college students: perceived risk versus reality. Curr Psychol. 2015;35(1):115–20. doi:10.1007/s12144-015-9373-3.

11. Schroeder P, Meyers M, Kstyniuk L. National survey on distracted driving attitudes and behaviors, 2012. Department of transportation. Washington, DC: NHTSA; 2013.

12. American Psychiatric Association. Diagnostic and statistical manual of mental disorders: DSM-5. Washington, DC: American Psychiatric Association; 2013.

13. Billieux J, Maurage P, Lopez-Fernandez O, Kuss DJ, Griffiths MD. Can disordered mobile phone use be considered a behavioral addiction? An update on current evidence and a comprehensive model for future research. Curr Addict Rep. 2015;2(2):156–62. doi:10.1007/s40429-015-0054-y.

14. De-Sola Gutierrez J, Rodriguez De Fonseca F, Rubio G. Cell-phone addiction: a review. Front Psychiat. 2016;7:175. doi:10.3389/fpsyt.2016.00175.

15. Petry NM, Rehbein F, Gentile DA, Lemmens JS, Rumpf HJ, Mossle T, Bischof G, Tao R, Fung DSS, Borges G, et al. An international consensus for assessing internet gaming disorder using the new DSM-5 approach. Addiction. 2014;109(9):1399–406. doi:10.1111/add.12457.

16. Robbins TW, Clark L. Behavioral addictions. Curr Opin Neurobiol. 2015;30:66–72. doi:10.1016/j.conb.2014.09.005.

17. Robinson SM, Adinoff B. The classification of substance use disorders: historical, contextual, and conceptual considerations. Behav Sci. 2016;6(3):18. doi:10.3390/bs6030018.

18. Billieux J, Schimmenti A, Khazaal Y, Maurage P, Heeren A. Are we overpathologizing everyday life? A tenable blueprint for behavioral addiction

research. J Behav Addict. 2015;4(3):119–23. doi:10.1556/2006.4.2015.009.

19. Lu X, Katoh T, Chen Z, Nagata T, Kitamura T. Text messaging: are dependency and excessive use discretely different for Japanese university students? Psychiatry Res. 2014;216(2):255–62. doi:10.1016/j.psychres.2013.12.024.

20. Lu X, Watanabe J, Liu Q, Uji M, Shono M, Kitamura T. Internet and mobile phone text-messaging dependency: factor structure and correlation with dysphoric mood among Japanese adults. Comput Hum Behav. 2011;27 (5):1702–09. doi:10.1016/j.chb.2011.02.009.

21. Igarashi T, Motoyoshi T, Takai J, Yoshida T. No mobile, no life: self-perception and text-message dependency among Japanese high school students. Comput Hum Behav. 2008;24(5):2311–24. doi:10.1016/j.chb.2007.12.001.

22. Ferraro FR, Holfeld B, Frankl S, Frye N, Halvorson N. Texting/iPod dependence, executive function and sleep quality in college students. Comput Hum Behav. 2015;49:44–49. doi:10.1016/j.chb.2015.02.043.

23. Harrison MA, Gilmore AL. U txt WHEN? College students' social contexts of text messaging. Soc Sci J. 2012;49(4):513–18. doi:10.1016/j.soscij.2012.05.003.

24. Schroeder BL, Whitmer DE, Bailey SK, Sims VK, editors. Individual differences in middle school and college students' texting. Proc Hum Fact Soc An. Los Angeles, CA: SAGE Publications Sage CA; 2016. doi:10.1177/1541931213601284.

25. Lopez-Fernandez O, Honrubia-Serrano L, Freixa-Blanxart M, Gibson W. Prevalence of problematic mobile phone use in British adolescents. Cyberpsychol Behav Soc Netw. 2014;17(2):91–98. doi:10.1089/cyber.2012.0260.

26. Walsh SP, White KM, Cox S, Young RM. Keeping in constant touch: the predictors of young Australians' mobile phone involvement. Comput Hum Behav. 2011;27(1):333–42. doi:10.1016/j.chb.2010.08.011.

27. Reyes García V. Móvil-Izando. Significado del teléfono móvil. Revista CuidArte. 2017;6(12):30.

28. Dlodlo N. Salient indicators of mobile instant messaging addiction with selected socio-demographic attributes among tertiary students in South Africa. S Afr J Psychol. 2015;45(2):207–22. doi:10.1177/0081246314566022.

29. Liu -C-C, Chang I-C. Model of online game addiction: the role of computer-mediated communication motives. Telemat and Informat. 2016;33(4):904–15. doi:10.1016/j.tele.2016.02.002.

30. Sultan AJ. Addiction to mobile text messaging applications is nothing to "lol" about. Soc Sci J. 2014;51(1):57–69. doi:10.1016/j.soscij.2013.09.003.

31. Kardefelt-Winther D. A critical account of DSM-5 criteria for internet gaming disorder. Addict Res Theory. 2015;23 (2):93–98. doi:10.3109/16066359.2014.935350.

32. Kardefelt-Winther D. A conceptual and methodological critique of internet addiction research: towards a model of compensatory internet use. Comput Hum Behav. 2014;31:351–54. doi:10.1016/j.chb.2013.10.059.

33. AIM. All good things come to an end. On Dec 15, we'll bid farewell to AIM. Thank you to all our users. https://twitter.com/aim/status/916290747850264577 [Tweet]. [accessed 2017 Oct 8]. http://archive.is/a3WUh.

34. Geller JS. Mobile IM clients: sidekick, Helio Ocean, BlackBerry, iPhone, and more: BGR; 2007 [accessed 2017 October 1]. http://archive.is/qqiTj.

35. Technology Device Ownership: 2015 [Internet]. 2015 [accessed 2017 Sep 10]. http://www.pewinternet.org/2015/10/29/technology-device-ownership-2015/.

36. Smith A. Record shares of Americans now own smartphones, have home broadband. Washington, DC: Pew Research Center; 2017. http://www.pewresearch.org/fact-tank/2017/01/12/evolution-of-technology.

37. Casler K, Bickel L, Hackett E. Separate but equal? A comparison of participants and data gathered via Amazon's mTurk, social media, and face-to-face behavioral testing. Comput Hum Behav. 2013;29(6):2156–60. doi:10.1016/j.chb.2013.05.009.

38. Hauser DJ, Schwarz N. Attentive Turkers: mTurk participants perform better on online attention checks than do subject pool participants. Behav Res Methods. 2016;48(1):400–07. doi:10.3758/s13428-015-0578-z.

39. Huff C, Tingley D. Who are these people?" evaluating the demographic characteristics and political preferences of mTurk survey respondents. Res Pol. 2015;2 (3):1–2. doi:10.1177/2053168015604648.

40. Chóliz M. Mobile-phone addiction in adolescence: the test of mobile phone dependence (TMD). Prog Health Sci. 2012;2(1):33–44. doi:10.3389/fpsyg.2016.00650.

41. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct Equ Modeling. 1999;6(1):1–55. doi:10.1080/10705519909540118.

42. MacCallum RC, Browne MW, Sugawara HM. Power analysis and determination of sample size for covariance structure modeling. Psych Meth. 1996;1(2):130. doi:10.1037/1082-989X.1.2.130.

43. Khalaf S, Kesiraju L U.S.consumers time-spent on mobile crosses 5 hours a day: flurry analytics; 2017. http://archive.is/f5NtW.

44. Chotpitayasunondh V, Douglas KM. How "phubbing" becomes the norm: the antecedents and consequences of snubbing via smartphone. Comput Hum Behav. 2016;63:9–18. doi:10.1016/j.chb.2016.05.018.

45. Ling R. Texting as a life phase medium. J Computer-Mediated Commun. 2010;15(2):277–92. doi:10.1111/j.1083-6101.2010.01520.x.

46. Sween M, Ceschi A, Tommasi F, Sartori R, Weller J. Who is a distracted driver? associations between mobile phone use while driving, domain-specific risk taking, and personality. Risk Anal. 2017. doi:10.1111/risa.12773.

47. Brown TG, Ouimet MC, Eldeb M, Tremblay J, Vingilis E, Nadeau L, Pruessner J, Bechara A, Yechiam E. Personality, executive control, and neurobiological characteristics associated with different forms of risky driving. PLoS One. 2016;11(2):e0150227. doi:10.1371/journal.pone.0150227.

48. Struckman-Johnson C, Gaster S, Struckman-Johnson D, Johnson M, May-Shinagle G. Gender differences in psychosocial predictors of texting while driving. Accid Anal Prev. 2015;74:218–28. doi:10.1016/j.aap.2014.10.001.

49. Schroeder BL, Sims VK. Texting as a multidimensional behavior: individual differences and measurement of texting behaviors. Psychol Pop Media Cult. 2017. doi:10.1037/ppm0000148.

50. Schroeder BL, Sims VK. Problematic texting behaviors. Proc Hum Fact Soc An. 2016;59(1):907–11. doi:10.1177/1541931215591267.

51. Bergdall AR, Kraft JM, Andes K, Carter M, Hatfield-Timajchy K, Hock-Long L. Love and hooking up in the new millennium: communication technology and relationships among urban African American and puerto rican young adults. J Sex Res. 2012;49(6):570–82. doi:10.1080/00224499.2011.604748.

52. Lee EB. Facebook use and texting among African American and hispanic teenagers. J Black Stud. 2014;45(2):83–101. doi:10.1177/0021934713519819.

53. Abouk R, Adams S. Texting bans and fatal accidents on roadways: do they work? Or do drivers just react to announcements of bans? Am Econ J-Appl Econ. 2013;5 (2):179–99. doi:10.1257/app.5.2.179.

54. Gershowitz AM. Texting while driving meets the fourth amendment: deterring both texting and warrantless cell phone searches. Ariz L Rev. 2012;54:577.

55. Lazerow A. Near Impossible to Enforce at Best, Unconstitutional at Worst: Maryland's Text-Messaging Ban on Drivers Has GTG. Richmond J Law and Technol. 2010;17(1):1–41.

56. Rudisill TM, Zhu M. Who actually receives cell phone use while driving citations and how much are these laws enforced among states? A descriptive, cross-sectional study. BMJ Open. 2016;6(6):e011381. doi:10.1136/bmjopen-2016-011381.

57. Delgado MK, Wanner KJ, McDonald C. Adolescent cellphone use while driving: an overview of the literature and promising future directions for prevention. Media Commun. 2016;4(3):79–89. doi:10.17645/mac.v4i3.536.

58. Engelberg JK, Hill LL, Rybar J, Styer T. Distracted driving behaviors related to cell phone use among middle-aged adults. J Transp Health. 2015;2(3):434–40. doi:10.1016/j.jth.2015.05.002.

59. Raymond Bingham C, Zakrajsek JS, Almani F, Shope JT, Sayer TB. Do as I say, not as I do: distracted driving behavior of teens and their parents. J Safety Res. 2015;55:21–29. doi:10.1016/j.jsr.2015.07.007.

60. Vaterlaus JM, Barnett K, Roche C, Young JA. Snapchat is more personal": an exploratory study on Snapchat behaviors and young adult interpersonal relationships. Comput Hum Behav. 2016;62:594–601. doi:10.1016/j.chb.2016.04.029.