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Psychometric Properties of the Internet Addiction Test in Chinese Adolescents

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Objective This study examined the psychometric properties of the Young's Internet Addiction Test (IAT) in 844 Hong Kong Chinese adolescents (37.7% boys) with mean age of 15.9 (standard deviation = 3.5) years. **Methods** Demographic items, Internet use habits, IAT, and the Revised Chen Internet Addiction Scale (CIAS-R) were administered. 3 percent of the participants were classified as addicted and 31.6% as occasional problematic Internet users. Confirmatory factor analysis results indicated that the 18-item second-order three-factor model has the best fit with our data (Satorra–Bentler scaled $\chi^2 = 160.56$, $df = 132$, $p < .05$, normed fit index = 0.95, non-normed fit index = 0.99, comparative fit index = 0.99, root mean square error of approximation = 0.02). **Results** IAT demonstrated strong internal consistency (Cronbach's $\alpha = .93$). Satisfactory concurrent and convergent validity of IAT were found moderately correlated with CIAS-R ($r = .46$) and the average online time per day ($r = .40$ for weekdays; $r = .37$ for weekends). **Conclusion** IAT has evidence of being a valid and reliable scale for screening Internet addiction in Chinese adolescents.

Key words adolescents; Internet Addiction Test; psychometric properties.

Internet addiction could be conceptualized as a maladaptive pattern of Internet use behavior which is associated with several psychological and social problems (Chou, Condron, & Belland, 2005). Such non-conventional addictive behaviors are still lacking a well-established nomenclature (Morahan-Martin, 2005) and definition (Chou et al., 2005). Although the term Internet addiction is widely used, synonyms such as Internet abuse, compulsive Internet use, and pathological Internet use are also commonly used (Fu, Chan, Wong, & Yip, 2010). These variations have increased the difficulties of defining the disorder, and thus correspondingly increased the difficulties of formulating appropriate clinical diagnoses (Beard & Wolf, 2001; Shapira et al., 2003; Yellowlees & Marks, 2007).

Emerging studies have reported Internet addiction as an alarming public health concern with the rapid growth of Internet users worldwide in the 2000s (Block, 2008). In Asia, the prevalence in adolescents was reported to be 13.8% in Taiwan (Yang & Tung, 2007), 10.7% in South Korea (Park, Kim, & Cho, 2008), 6.7% in Hong Kong (Fu et al., 2010), and 2.4% in China (Cao & Su, 2007). In Europe, a recent nationwide study in 11 countries reported a prevalence of pathological Internet users ranging from 11.8% in Israel to 1.2% in Italy (Durkee et al., 2012). To our knowledge, similar statistics have yet to be reported

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in the United States. The variability in prevalence rates reported by the above studies may be attributed to the variations of accessibility to the Internet in different societies, definitions of Internet addiction, as well as diagnostic instruments for assessments (Weinstein & Lejoyeux, 2010).

Assessment of Internet Addiction

Young (1996a) conducted an empirical study to explore the behavioral problems of misuse of the Internet using the term ''Internet addiction.'' Based on the DSM-IV-TR (American Psychiatric Association, 2000) criteria for pathological gambling, diagnostic criteria for Internet addiction were proposed as (1) preoccupation with the Internet; (2) need to spend increasing amounts of time online; (3) repeated but unsuccessful attempts to reduce Internet use; (4) suffering withdrawal symptoms from reduction of Internet use; (5) time management problems; (6) environmental distress from school, family, work, and friends; (7) deception of Internet time; and (8) mood modification through Internet use (Young, 1996a). Similar to pathological gambling, Internet addiction was conceptualized as an impulse-control problem that is not caused by mania, hypomania (Shapira, Goldsmith, Keck, Khosla, & McElroy, 2000; Shapira et al., 2003), or intoxication (Young, 1996a, 1998b). The eight criteria of Internet addiction disorder are the major components of the 8-item Young's Diagnostic Questionnaire for Internet addiction (YDQ). Respondents would be classified as ''Internet dependent'' if they agreed with five or more of the YDQ items. An additional 12 items were later included in YDQ and the instrument was renamed as the Internet Addiction Test (IAT). IAT may have a better discriminating ability than YDQ, as it can indicate the severity of the Internet addiction problems by providing Likert-scale responses, whereas only yes or no responses are available for the eight questions of YDQ. Respondents could be classified as an ''average online user'' (having complete control over one's use), ''frequent online user'' (having occasional or frequent problems), or ''Internet addict'' (having significant problems in one's life because of Internet usage). IAT has also avoided unclear terminologies, such as ''preoccupation'' and ''dysphoric mood'' that may have caused confusion in other instruments. Although there are still no standard instruments for assessing Internet addiction or problematic Internet use (Shaw & Black, 2008), the YDQ and IAT have been widely used instruments in both Western (e.g., Durkee et al., 2012; Johansson & Götestam, 2004) and Chinese populations (e.g., Cao & Su, 2007; Chou & Hsiao, 2000; Zhou et al., 2011).

Apart from Young's YDQ and IAT, the definition of problematic Internet use varies across instruments. For instance, the Pathological Internet Use scale (Morahan-Martin & Schumacher, 2000) was developed with a key focus on psychological and behavioral problems, and daily life routine disruption associated with Internet use, while the Generalized Problematic Internet Use Scale (Caplan, 2002) was developed from Davis's (2001) cognitive–behavioral model of pathological Internet use. In addition, the Revised Chen Internet Addiction Scale (CIAS-R) was developed as an indigenous Internet addiction instrument for Chinese, based on clinical observations and diagnostic interviews (Chen, Weng, Su, Wu, & Yang, 2003). CIAS-R is a popular scale for assessing Internet use problems in Chinese populations (e.g., Ko, Yen, Chen, Yeh, & Yen, 2009; Lin, Ko, & Wu, 2011; Tokunaga & Rains, 2010; Tsai et al., 2009; Yen et al., 2008). Previous studies in Taiwan and Mainland China have provided support that CIAS-R is a reliable instrument for revealing the core symptoms and related problems of Internet addiction (Bai & Fan, 2005; Chen et al., 2003). While IAT was developed as a screening assessment of Internet addiction on the basis of DSM-IV diagnostic criteria of pathological gambling, CIAS-R was developed to capture key conceptual dimensions of functional impairment due to Internet addiction construct (Chen et al., 2003). IAT has been used more frequently in other parts of the world, whereas CIAS-R has been used mainly in Chinese populations. From an epidemiological and assessment perspective, because of the relatively widespread use of both IAT and CIAS-R, it is instructive to examine the statistical overlap between the two measures in a Chinese population.

Psychometric Properties of IAT

The psychometric properties of the original IAT scale (1998a) have been evaluated in university students (Jelenchick, Becker, & Moreno, 2012; Widyanto, Griffiths, & Brunsden, 2011) and adults (Widyanto & McMurran, 2004). Although strong internal reliability estimates of IAT have been demonstrated, reports of its factor structures were inconsistently reported. Widyanto and McMurran (2004) revealed six factors (salience, excessive use, neglect of work, anticipation, lack of control, and neglect of social life) underlying the construct of Internet addiction assessed by IAT among adults in the U.K. using exploratory factor analysis (EFA). Their results indicated that these factors were positively correlated with each other, whereas the total IAT score was negatively correlated with history of Internet use, but positively with greater

amount of time spent online. Thereafter, Widyanto et al. reported a clear three-factor solution (psychological/emotional conflict, time management problems, and mood modification) of IAT among college students in the U.K. (Widyanto et al., 2011). They also suggested that the total IAT score was positively associated with daily Internet usage, but not history of Internet use. In another recent study, a two-factor structure (dependent use and excessive use) was reported among U.S. college students (Jelenchick et al., 2012).

IAT has been translated into different languages and used in French (Khazaal et al., 2008), Italian (Ferraro, Caci, D'Amico, & Blasi, 2007), Finnish (Korkeila, Kaarlas, Jääskeläinen, Vahlberg, & Taiminen, 2010), Korean (Kim, 2000), Malay (Ng, Isa, Hashim, Pillai, & Harbajan Singh, 2013), and Chinese (Chang & Man Law, 2008) among college students and adults. While a six-factor structure (compromised social quality of life, compromised individual quality of life, compensatory usage of the Internet, compromised academic/working careers, compromised time control, and excitatory use) was found with the Italian version (Ferraro et al., 2007), a one-factor structure was revealed in the French and Finnish versions (Khazaal et al., 2008; Korkeila et al., 2010). In the Malay version (Ng et al., 2013), five factors including lack of control, neglect of duty, problematic use, social relationship disruption, and email primacy, were extracted from a sample of 162 medical students according to the results of EFA. However, one problematic item ''check email before something else'' emerged as a single-item factor. These mixed findings have challenged the notion that IAT represents a unidimensional structure as it was originally designed.

In Chang and Man Law's (2008) study, they found two problematic items: the item ''check e-mail before something else'' emerged as a single-item factor, similar to Ng et al.'s (2013) study, and ''anticipate to go online again,'' which did not load on any of the factors. After deleting these two problematic items, they identified an 18-item three-factor structure in the split-half sample of 410 Hong Kong college students. The results suggested that ''withdrawal and social problems,'' ''time management and performance,'' and ''reality substitute'' were the three components underlying the construct of IAT. This EFA solution was then cross-validated by confirmatory factor analysis (CFA) in the second half of the sample. Given the high correlations between the three factors, Chang and Man Law concluded that the second-order three-factor model of IAT provided the best fit to the data. The above review suggested that across studies, the psychometric validation of IAT generated inconsistent results with respect to the dimensionality of Internet addiction. This observation is likely due to the differences of demographic factors and languages, as well as statistical methods being used.

Adolescence is a period of rapid psychological maturation and of susceptibility to Internet attraction (Kaltiala-Heino, Lintonen, & Rimpelä, 2004). With a high penetration rate of Internet worldwide (Cole et al., 2012), adolescents were found to be particularly vulnerable to the negative health impacts of Internet overuse (Ferraro et al., 2007; Griffiths, Davies, & Chappell, 2004; Widyanto & McMurran, 2004). To date, the psychometric properties of IAT have never been examined in adolescents. Given that IAT is the most common assessment tool in Internet addiction research (Frangos, Frangos, & Sotiropoulos, 2012), comparison of the IAT and CIAS-R scores within a Chinese population would provide a foundation of future cross-cultural validation of IAT. The present study aims to examine the psychometric properties of IAT in Hong Kong Chinese secondary school students. The goodness-of-fit of other plausible models of IAT will be examined in adolescents. Convergent and concurrent validity of IAT will also be examined with its correlations with CIAS-R and patterns of Internet use. The results of the current study will allow pediatric psychologists to have a better understanding about the dimensionality of the construct and applications of IAT among adolescents.

Methods

Administration

A total of 844 Hong Kong Chinese adolescent students (37.7% boys) from Grade 7 to Grade 13 [mean age = 15.9; standard deviation (*SD*) = 3.5 years] from local coeducation secondary schools completed a survey in 2012 (see Table I). Participants were asked to complete a structured questionnaire about their demographic backgrounds and Internet use patterns, including average number of hours spent online daily during school days and holidays, frequency of Internet use, as well as ownership of a personal computer. Participants were required to respond on a 6-point scale from 1 (once a week or less) to 6 (>3 times a day) for the question on frequency of Internet use, a 4-point scale (1 = no personal or shared computer; 2 = shared computer with one sibling; 3 = shared computer with more than one sibling; 4 = own a personal computer) for the question about computer ownership; and a 5-point scale (1 = become much better; 2 = become a bit better; 3 = not much difference; 4 = become a bit poorer; 5 = become much poorer) for the question about students' academic performance of this year in comparison with the past year. In addition, the

Table I. *Characteristics of the Participants by Level of Internet Use*

	Average users ($n = 552$)	Problematic users ($n = 267$)	Addicted users ($n = 25$)	Total ($N = 844$)	p
	n (%)	*n* (%)	*n* (%)	*n* (%)	
Age (year) (Mean, *SD*)	15.71 (2.02)	16.43 (5.41)	15.68 (2.08)	15.94 (3.48)	.006
Gender					
Male[a]	187 (33.9)	115 (43.1)	16 (64.0)	318 (37.7)	.001
Female	364 (66.1)	152 (56.9)	9 (36.0)	525 (62.3)	
Computer ownership					
No[a]	49 (8.9)	13.0 (5.0)	2.0 (8)	64.0 (7.7)	.017
Shared with one sibling	161 (29.3)	70.0 (26.8)	3.0 (12)	234.0 (28.07)	
Shared with more than one sibling	80 (14.6)	28.0 (10.7)	2.0 (8)	110.0 (13.2)	
Own one personally	259 (47.2)	150.0 (57.5)	18.0 (72)	427.0 (51.1)	
Age of first ownership (year) (Mean, *SD*)	10.23 (3.52)	9.72 (3.55)	8.75 (3.80)	10.01 (3.55)	.065
Daily Internet use (hr) (Mean, *SD*)					
During school days	2.3 (2.0)	3.6 (3.2)	8.0 (8.2)	2.8 (3.0)	<.001
During holidays	4.1 (3.1)	6.1 (4.4)	12.5 (7.8)	4.9 (4.0)	<.001
Frequency of Internet use					
Once a week or less[a]	41 (7.7)	17 (6.5)	1 (4.3)	59 (7.2)	<.001
2–3 times a week	69 (12.9)	14 (5.4)	0 (0)	83 (10.2)	
4–6 times a week	90 (16.9)	26 (10.0)	1 (4.3)	117 (14.32)	
Once a day	112 (21.0)	57 (21.9)	0 (0)	169 (20.7)	
2–3 times a day	47 (8.80)	21 (8.1)	2 (8.7)	70 (8.6)	
More than 3 times a day	175 (32.8)	125 (48.1)	19 (82.6)	319 (39.0)	
IAT (Mean, *SD*)					
Withdrawal and social problems	11.89 (2.47)	20.05 (4.89)	36.40 (5.98)	15.20 (6.36)	<.001
Time management and performance	9.780 (2.67)	16.87 (3.91)	26.24 (3.63)	12.51 (5.13)	<.001
Reality substitute	4.89 (1.72)	8.464 (2.31)	13.60 (1.76)	6.28 (2.84)	<.001
Total	29.40 (5.42)	49.80 (8.27)	84.28 (10.85)	37.48 (14.14)	<.001
CIAS-R (Mean, *SD*)					
Sym-C	7.18 (4.84)	11.59 (6.64)	15.72 (4.64)	8.83 (5.96)	<.001
Sym-W	6.64 (6.36)	10.62 (10.68)	12.48 (3.71)	8.08 (8.18)	<.001
Sym-T	7.87 (6.45)	12.05 (6.64)	15.44 (4.81)	9.41 (6.83)	<.001
RP-IH	10.67 (11.6)	14.97 (3.77)	25.4 (20.54)	12.46 (10.66)	<.001
RP-TM	7.93 (6.44)	12.66 (10.76)	16.2 (4.32)	9.67 (8.38)	<.001
Total	40.28 (22.04)	61.9 (23.2)	85.24 (29.95)	48.45 (25.57)	<.001

Note. p-value refers to chi-square of multinomial logistic regression with group membership of Internet user as the dependent variables (reference category is ''average user''). IAT = Internet Addiction Test; CIAS-R = Revised Chen Internet Addiction Scale; Sym-C = compulsive use; Sym-W = withdrawal; Sym-T = tolerance; RP-IH = interpersonal and health-related problems; RP-TM = time management problems.

[a]Denotes the reference level in multinomial logistic regression.

Chinese version IAT (Young, 1996a, 1996b) and CIAS-R (Chen et al., 2003) were included. To ensure the quality of the translated items, a forward and backward translation procedure was applied by two independent bilingual translators. The face validity of the translated questionnaire was then assessed for final approval. Participation was completely voluntary, and informed consent was granted. Ethics approval from the University Research Ethics Committee was also obtained.

Instruments

The IAT

IAT consists of 20 items rated on a Likert scale from 1 (*rarely*) to 5 (*always*) (Young, 1998a). These items were derived from the DSM-IV-TR (American Psychiatric Association, 2000) diagnostic criteria of pathological gambling, which examines the degree of preoccupation and compulsiveness to go online, and the impact on life related to Internet usage. In the Chinese version of IAT, items were translated with considerations of relevance to adolescents. For instance, ''household chores'' in Item 2 was translated into ''daily hassles,'' and ''intimacy with partner'' of Item 3 was translated into ''activities with companions.'' According to Young (1998a), respondents who scored $\geq$70 were classified as addictive Internet users who have encountered significant life problems due to excessive Internet use. Those with an IAT score between 40 and 69 were classified as problematic Internet users who

encounter general life problems due to excessive Internet use. Respondents with an IAT score of ≤39 were classified as average Internet users only having some problems of controlling Internet use. A high reliability estimate of IAT was consistently reported in adolescents with a Cronbach's $\alpha > .80$ in the previous studies (Bayraktar & Gün, 2007; Milani, Osualdella, & Di Blasio, 2009; Wang et al., 2011).

The CIAS-R

CIAS-R was developed for assessing the Internet use problems, specifically for Chinese populations (Chen et al., 2003). CIAS-R consists of 26 items on a 4-point scale ranging from 1 (*does not match my experience at all*) to 4 (*definitely match my experience*). The scale consists of five subscales: compulsive use (Sym-C), withdrawal (Sym-W), tolerance (Sym-T) symptoms of Internet addiction, and interpersonal and health-related problems (RP-IH) and time management problems (RP-TM), and the clusters of constructs rest on the axis of core symptoms and related problems of Internet addiction. A higher score indicates increased severity of addiction to Internet activities. The original study reported a Cronbach's α of .93 for the total CIAS-R, and a range of .79–.83 for the subscales (Chen et al., 2003). In the present study, the Cronbach's α of CIAS-R was .97 for the total score, .87 for Sym-C, .87 for Sym-W, .85 for Sym-T, .89 for RP-IH, and .85 for RP-TM.

Data Analysis

In addition to the one-factor model (Model 1), a series of plausible models identified in the previous studies were evaluated: (a) Model 3a: Widyanto et al.'s (2011) three-factor model; (b) Model 3b: Chang and Man Law's (2008) second-order three-factor mode; (c) Model 4: a four-factor model modified from Ng's five-factor model by discarding the single-item factor; (d) Model 6a: Widyanto McMurran's (2004) six-factor model; (e) Model 6b: Ferraro, Caci, D'Amico, and Di Blasi's (2007) six-factor model. In each model, every single item of IAT was modeled as a reflective indicator with no inter-related error variances. Variances and covariance were freely estimated, except that the variance of first indicator of each factor was fixed to one. The pattern of factor loadings within each model are summarized in Table II.

A total of 82 cases with missing answers in any of the IAT items were excluded from the CFA. Because the assumption of multivariate normality was not fulfilled, the robust maximum likelihood method of estimation with the Satorra–Bentler scaled χ^2 (SB χ^2) correction (Satorra & Bentler, 2001) was used to indicate the overall goodness of fit of the tested models. Given that the SB χ^2-difference test is sensitive to sample size, particularly in models with a large number of estimated paratmeters, other fit indexes, including the comparative fit index (CFI; Bentler, 1990), the normed fit index (NFI), the non-normed fit index (NNFI; Bentler & Bonett, 1980), and the root mean square error of approximation (RMSEA; Steiger, 1990) were reported to complement the SB χ^2-difference test in assessing the model fit. A proposed construct is regarded to be acceptable if its value of CFI, NFI, and NNFI exceeds 0.90, and its value of RMSEA is less than 0.08 (Bentler, 1992). For the non-nested models, model comparisons were conducted according to the Akaike's Information Criterion (AIC), in addition to other fit indexes. Model with lower value of AIC indicate a better fit. For the nested models, a corrected SB χ^2-difference (SDCS) test was conducted to determine any significant differences in the goodness-of-fit for a further restricted model (Satorra &

Table II. *Composition of Factor Structure of the Internet Addiction Test Reported in the Past Studies*

	Model				
Item[a]	3a	3b[b]	4	6a	6b
Q1	2	2	1	2	5
Q2	2	2	1	1	2
Q3	1	1	2	6	6
Q4	3	1	3	6	1
Q5	1	1	4	5	1
Q6	3	2	2	3	4
Q7	1	–	–	4	3
Q8	1	2	2	2	4
Q9	1	1	2	2	1
Q10	3	3	1	1	6
Q11	3	–	1	4	3
Q12	3	3	1	1	2
Q13	3	1	4	1	1
Q14	2	3	1	2	2
Q15	1	1	4	1	4
Q16	1	2	1	5	1
Q17	1	2	1	5	5
Q18	3	1	2	2	1
Q19	2	1	2	1	2
Q20	2	1	2	1	2

Note. Items in each model with the same number were loaded onto the same factor in model specification. The minus mark denotes the discarded items. The maximum numeric value in each model indicates the number of factors of the model. Model 3a was reported in Widyanto, Griffiths, & Brunsden (2011); Model 3b was reported in Chang and Man Law (2008); Model 4 was derived from Ng et al. (in press); Model 6a was reported in Widyanto and McMurran (2004); Model 6b was reported in Ferraro, Caci, D'Amico, and Di Blasi (2007).

[a]Content of the items refer to Young (1998a).

[b]Factors of Model 3b were regressed on a second-order factor. Except Model 3b, all models were specified on a first-order structure in which factors were allowed to correlate freely.

Bentler, 2001). A significant decrease in the SDCS test indicates that the unrestricted model is preferred.

To examine the internal consistency of the construct of Internet addiction, Cronbach's α, item-total correlations, and inter-item correlations were computed. A benchmark value of .70 for Cronbach's α, and .30 for item-total correlations indicated an acceptable level of internal consistency (Nunnally, 1978). Concurrent and convergent validity of IAT were examined using the correlation of IAT with CIAS-R, amount of time spent online per day, and academic results. To investigate the risk factors of problematic Internet use and Internet addiction, a series of multinomial logistic regressions were conducted with types of Internet users (average user, problematic use, and addicted user) as the criterion; age, gender, ownership of personal computer, daily use, and frequency of Internet use as the predictors. The average user was identified as the reference category with nominal and ordinal variables entered into the model in an ascending order. The response of ''male'' in gender, ''no personal or shared computer'' in ownership of personal computer, and ''once a week or less'' in frequency of Internet use was selected as the reference groups. SPSS 19.0 was used for the item analysis and multinomial regression analyses, and EQS 6.1 (Bentler, 2005) for CFA.

Results

Internet Use and Risks of Internet Addiction

Based on the total IAT score, 25 (3.0%) and 267 (31.6%) of the participants were classified as ''addicted'' and ''problematic Internet user'' respectively. As seen from Table I, addicted Internet users spent more time online than problematic or average users. On average, addicted, problematic, and normal users spent 8.0 ($SD = 8.2$), 3.6 ($SD = 3.2$), and 2.3 ($SD = 2.0$) hr per day online during schooldays, and 12.5 ($SD = 7.8$), 6.1 ($SD = 4.4$), and 4.1 ($SD = 3.1$) during holidays, respectively. Independent-samples *t*-test revealed that boys spent significantly longer time online during both weekdays than girls with mean (SD) = 3.27 (3.74) hr/day for boys, and mean (SD) = 2.60 (2.33) for girls ($t = 2.81$, $p = .005$); and weekends with mean (SD) = 5.59 (4.49) hr/day for boys and mean (SD) = 4.54 (3.45) hr/day for girls ($t = 3.34$, $p = .001$). Results of multinomial regression reported that the log odds of risks of Internet addiction was significantly associated with age, gender, ownership of personal computer, daily use, and frequency of Internet use. Boys had a higher risk than girls to be problematic, *OR* (95% *CI*) = 1.47(1.09–1.99), $p = .011$, and to be addicted Internet users, *OR* (95% *CI*) = 3.46 (1.50–7.98), $p = .004$. Consistent gender difference was found that boys scored significantly higher on the score of withdrawal and social problems, boys: mean (SD) = 16.65 (7.49); girls: mean (SD) = 14.33 (5.40), $t = 4.83$, $p < .001$, reality substitute, boys: mean (SD) = 6.55 (3.12); girls: mean (SD) = 6.12 (2.65), $t = 2.07$, $p = .39$, and the IAT total, boys: mean (SD) = 39.65 (16.58); girls: mean (SD) = 36.16 (12.28), $t = 3.26$, $p = .001$. Increase in age was related to a higher risk of being a problematic Internet user, *OR* (95% *CI*) = 1.11(1.03–1.20), $p = .005$, but not related to a higher risk of being addicted Internet users. More than half of our student participants (51%) had their own computers, and only 7.7% of them did not have a computer at home. Compared with students having no computer at home, those in possession of an own computer had a significantly higher risk of being problematic Internet users, *OR* (95% *CI*) = 2.18(1.15–4.16), $p = .017$. Ownership of computer, nonetheless, was not significantly associated with risks of being addicted Internet user. As discussed earlier, the amount of time spent online was a risk factor for Internet addiction. An hour more spent online during school days and holidays was associated with 1.30 (95% *CI* = 1.20–1.41, $p < .001$) and 1.17 (95% *CI* = 1.12–1.22, $p < .001$) times for being problematic, and 1.48 (95% *CI* = 1.34–1.63, $p < .001$) and 1.37 (95% *CI* = 1.27–1.47, $p < .001$) for being addicted Internet users, respectively. Furthermore, a higher frequency of using Internet was also associated with a higher risk of being problematic, *OR* = 1.23 (95% *CI* = 1.12–1.36), $p < .001$, or addicted Internet users, *OR* = 2.26 (95% *CI* = 1.43–3.55), $p < .001$.

Confirmatory Factor Analysis

CFA was run to compare whether the construct of IAT was best represented by a unidimensional model or multidimensional model suggested in the literature. Table III presents the fit indexes for each of the models. All competing models of IAT only reported moderate goodness-of-fit. No proposed models obtained insignificant results in the SB χ^2 –difference tests, or met the cutoff criteria in the various fit indexes. Nevertheless, to find out the most closely specified model of the construct of IAT, SDCS tests and AIC comparisons were conducted. Regarding the nested models (i.e., Model 1 vs. Model 3a, Model 6a, and Model 6b), significant corrected SB χ^2-difference was found between Model 1 and Model 3a, corrected ΔSB $\chi^2 = 40.78$, $df = 3$, $p = .005$, between Model 1 and Model 6a, corrected ΔSB $\chi^2 = 119.07$, $df = 15$, $p < .001$, and between Model 1 and Model 6b, corrected ΔSB $\chi^2 = 101.00$, $df = 15$, $p < .001$. The results consistently

Table III. *Results of Confirmatory Factor Analyses of the Internet Addiction Test (IAT)*

Model	No. of item	χ^2	SB χ^2	*df*	SB χ^2/*df*	NFI	NNFI	CFI	RMSEA	AIC
One factor (1)	20	1290.99	764.9	170	4.5	0.79	0.81	0.83	0.07	424.9
Three factor (3a)	20	1215.83	721.55	167	4.32	0.8	0.82	0.84	0.07	387.55
Three factor (3b)	18	854.34	502.39	132	3.81	0.85	0.87	0.88	0.06	238.39
Three factor (3c)	18	620.26	367.2	129	2.85	0.89	0.91	0.93	0.05	109.2
Four factor (4)	19	1090.79	650.62	146	4.46	0.82	0.82	0.85	0.07	358.62
Six factor (6a)	20	1075.72	641.77	155	4.14	0.83	0.83	0.86	0.06	331.77
Six factor (6b)	20	1098.28	659.05	155	4.25	0.82	0.82	0.86	0.07	349.05

Note. Estimation method = Maximum Likelihood; SB χ^2 = Satorra–Bentler scaled χ^2; *df* = degree of freedom; NFI = normed fit index; NNFI = non-normed fit index; CFI = comparative fit index; RMSEA = root mean square error of approximation; AIC = Akaike's Information Criterion.

indicated the various 20-item multidimensional model fitted the data better than Model 1.

Because the various multifactor models were not nested, SDCS tests are not feasible. Examination of the various fit indexes of the five multifactor models reflected Model 3b, an 18-item second-order three-factor model, provided the best fit to the data. Converging evidence was observed that Model 3b generated the highest NFI, NNFI, and CFI, and the lowest RMSEA, AIC, and SB χ^2 to *df* ratio. As shown in Table III, the current model obtained a ratio of SB χ^2 to *df* of 3.81, NFI of 0.85, NNFI of 0.87, CFI of 0.88, and RMSEA of 0.06 with 90% confidence interval of 0.055–0.066. Significant and strong factor loadings of the first-order factors to the second-order factor (ranging from 0.90 of withdrawal and social problems to 0.98 of reality substitute) were revealed for Model 3b.

Before accepting Model 3b as the final model, results of the multivariate Lagrange Multiplier Test were further referred to locate the potential sources of ill-fit given that the current model providing marginal fit to the data only. We found that adding the covariances between the error residuals between Item 1 and 2, Item 6 and 8, and Item 16 and 17 of items resulted in the greatest decrease in the estimated chi-square value of the model. It is noteworthy that all the above three pairs of items were hypothesized to load on the same factor time management and performance. We believe that content similarity of the items may contribute to their unique associations that were not accounted for by the latent factors. Therefore, these three specific pairs of error terms were specified to be correlated based on both statistical and theoretical grounds. The modified Model 3b (i.e., Model 3c) fitted the data adequately (SB $\chi^2 = 367.20$, $df = 129$, $p < .001$, NFI = 0.89, NNFI = 0.91, CFI = 0.93, RMSEA = 0.049, 90% CI = 0.043−0.055). Results from the SDCS test (corrected ΔSB $\chi^2 = 106.86$, $df = 3$, $p < .001$) and the change of CFI (ΔCFI = 0.05) (Cheung & Rensvold, 2002) together suggested a significant improvement in goodness-of-fit in Model 3c.

According to the Wald test, the factor loadings of Model 3c were all significant at a level of $p < .05$. The ranges of standardized factor loadings for each factor were as follows: 0.53–0.80 for withdrawal and social problems; 0.61–0.73 for time management and performance; 0.61–0.74 for reality substitute. The respective standardized paths from the three first-order factors to the second-order factor ''Internet addiction'' were 0.90, 0.97, and 0.98. A total of 80.5, 94.7, and 95.9% of the total variances of the second-order factor were accounted by withdrawal and social problems, time management and performance, and reality substitute, respectively. In summary, the construct of Internet addiction assessed by IAT represents a coherent second-order dimension encompassing three first-order inter-related components. The standardized loadings of the modified second-order Model 3b are presented in Figure 1. Consistent with Chang and Man Law's study, the three first-order factors of Model 3c correlated closely with each other, with the inter-factor correlations ranging from 0.70 (between time management and performance and reality substitute) to 0.73 (between withdrawal and social problems and time management and performance).

Item Analysis

IAT demonstrated strong internal consistency estimates. The Cronbach's α of the subscale withdrawal and social problems, time management and performance, reality substitute, and the composite scale of IAT was 0.87, 0.86, 0.70, and 0.93, respectively. The internal reliability of the items was further supported by the strength of the item-total correlations and inter-item correlations among the individual items. The item-total correlations of the item ranged from 0.45 (Item 7) to 0.73 (Item 15). The inter-item correlations (mean = 0.40; *SD* = 0.09) ranged from 0.21 between Item 5 and Item 7, to 0.66 between Item

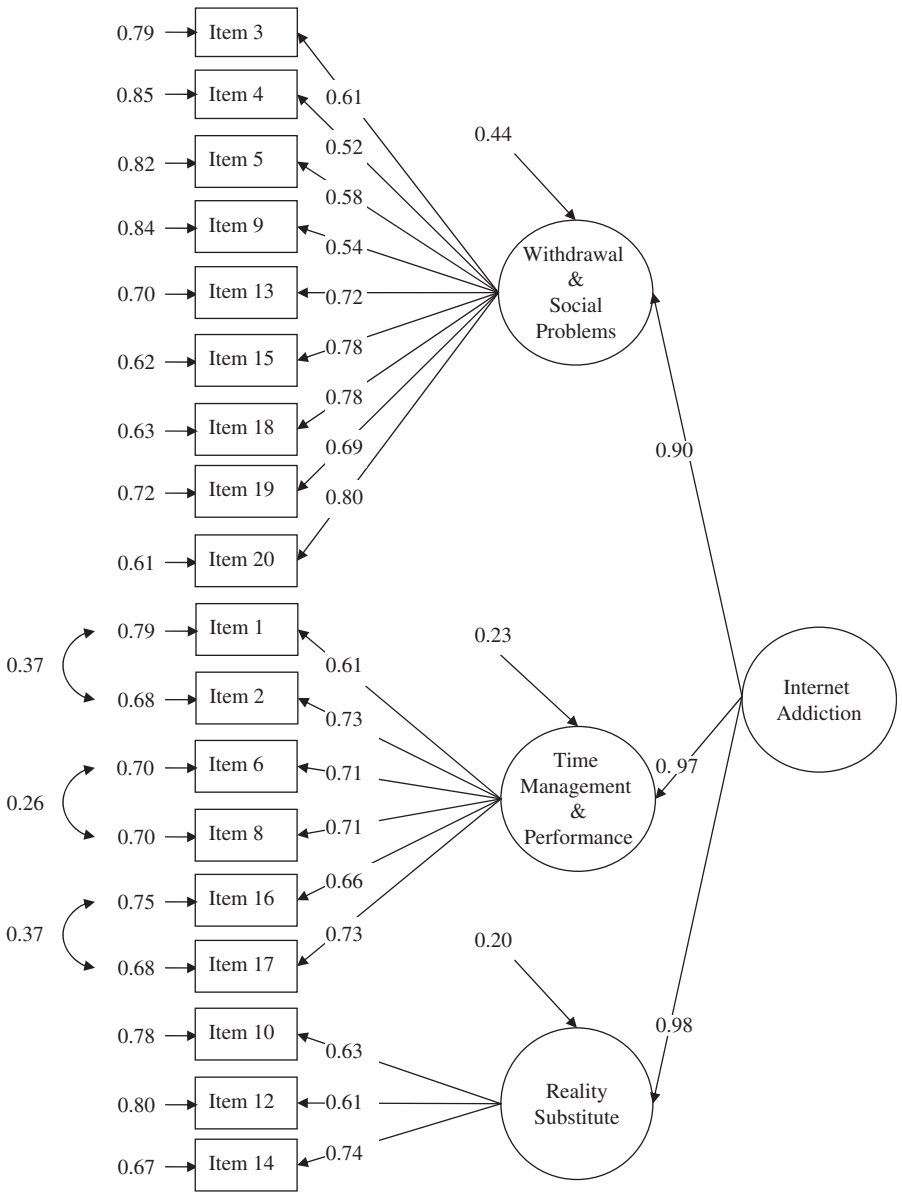

Figure 1. Standardized parameter estimates for the 18-item second-order three-factor model (Model 3c) of the Internet Addiction Test with three error covariances added.

16 and Item 17 ($p < .001$). In addition, the three factors of IAT were all significantly correlated with each other (range = 0.70–0.74) and the total scores (range = 0.84–0.94), indicating an internally coherent construct of IAT (see Table IV).

Concurrent Validity

The correlations between the subscales and total scores of IAT and CIAS-R are presented in Table IV. Positive correlations between the IAT total and the CIAS-R scores ranging from 0.28 (Sym-T) to 0.43 (Sym-C) were found. The correlation between the IAT total and the CIAS-R total was 0.51, $p < .001$. Among the subscales, the strongest correlation was found between withdrawal and social problem and Sym-C, $r = .41$, $p < .001$, whereas the weakest was between reality substitute and Sym-T, $r = .22$, $p < .001$. The moderate effect size of the correlations between IAT and CIAS-R provided evidence for the concurrent validity of IAT.

Convergent Validity

For the association between the IAT scores and academic performance, although no significant correlation was found with the total IAT score, students scoring higher on the

Table IV. *Correlations Between Age, Duration of Internet Use, Daily Internet Use, and Subscales of the Internet Addiction Test (IAT) and the Revised Chen Internet Addiction Scale (CIAS-R)*

	Withdrawal and social problems	Time management and performance	Reality substitute	IAT total
IAT				
Withdrawal and social problems	1			0.93***
Time management and performance	0.73***	1		0.90***
Reality substitute	0.70***	0.70***	1	0.84***
CIAS-R				
RP-IH	0.31***	0.30***	0.23***	0.32***
RP-TM	0.27***	0.27***	0.26***	0.29***
Sym-C	0.40***	0.40***	0.35***	0.43***
Sym-T	0.26***	0.27***	0.21***	0.27***
Sym-W	0.33***	0.30***	0.30***	0.35***
Total	0.48***	0.47***	0.41***	0.51***
Internet use				
Age of first ownership of computer	−0.12**	−0.01	−0.05	−0.08
Daily use during schooldays	0.41***	0.33***	0.37***	0.42***
Daily use during holiday	0.46***	0.38***	0.42***	0.47***
Frequency of Internet use	0.18***	0.22***	0.24***	0.22***
Academic result	0.03	0.08*	−0.004	0.04

Note. Sym-C = compulsive use; Sym-W = withdrawal; Sym-T = tolerance; RP-IH = interpersonal and health-related problems; RP-TM = time management problems.
*$p < .05$, **$p < .01$, ***$p < .001$.

subscale time management and performance tended to report decline in academic performance, $r = .08$, $p = .03$ (see Table IV). The correlations between the IAT scores and Internet use patterns were also computed. Consistent with the results of Widyanto et al. (2011), the IAT total was positively related to hours of Internet use daily. In addition, the IAT total was also related to frequency of Internet use (r ranged from 0.18 for withdrawal and social problems to 0.24 for reality substitute). As the proposed diagnostic criteria of Internet addiction includes the excessive time spent on Internet and the jeopardized work functioning, the significant correlation between IAT and daily Internet use, and time management and performance and declined academic result provides evidence for the convergent validity of IAT.

Discussion and Conclusions

Although a growing number of studies are using IAT to assess the severity of Internet use problems in adolescents, no studies have established the factorial structure of IAT in this population for psychologists' reference. The current study has explored the dimensionality of IAT, and evaluated its psychometric properties in Hong Kong Chinese adolescents using CFA. This adolescent study found an acceptable fit for the second-order three-factor structure (withdrawal and social problems, time management and performance, and reality substitute) of IAT reported in an earlier study in university students (Chang & Man Law, 2008). This replication indirectly suggested the stability of the second-order three-factor structure of IAT from adolescence to adulthood, yet a well-designed longitudinal study is warranted to confirm this suggestion.

IAT was initially designed as a single-dimension instrument. With this notion, respondents are supposed to differ from others on the severity of Internet addiction only. The multidimensional structure of IAT, on the other hand, implies that the problem of Internet addiction may be better represented by a number of correlated symptoms. Theoretically, respondents could be distinguished from each other in terms of both severity and the symptoms possessed. For example, an individual may experience great difficulties or irritated mood when being restricted to use Internet (i.e., withdrawal from use) but have low tendency to regard the Internet space as a substitute of the real world. Results of the present study suggested a hierarchical multidimensional structure is the best-fitting model of the construct of IAT. In this final model, the latent construct Internet addiction causes the lower order factors ''withdrawal and social problems,'' ''time management and performance,'' and ''reality substitute,'' which in turn manifested as the observed behaviors tapped by IAT. While the hierarchical factor structure lends support for using the total score of IAT as a criterion to determine

severity of Internet addiction, multidimensionality of the model provides clinicians with richer information in case formulation. For instance, we found that among the three factors, only withdrawal and social problems was related to age of first personal computer ownership, even after participants' age was controlled ($r = -.13$, $p = .001$). When compared with the single-order model, the hierarchical structure presents a clear and parsimonious model for us to conceptualize Internet addiction. The strong higher-order loadings from the three factors indicate that the respective symptoms are equally important to the construct of Internet addiction, and most variances (~80–95%) of ''Internet addiction'' could be explained by the three respective factors. These provide good evidence of the content validity of IAT in adolescents.

Gender Differences of Internet Addiction

Consistent with the results of a previous study (Chinese YMCA of Hong Kong, 2004), ~30–40% of Hong Kong secondary school students are at risk of Internet addiction when a IAT score of ≥40 is used as the criterion. The present study revealed that older adolescent boys owning a computer personally are particularly at high risk for problematic Internet use. Nonetheless, inconsistent results were obtained in past local studies, whereas Internet addiction was not related to gender or age in adolescents (Shek & Yu, 2012), but related to gender in college students (Chang & Man Law, 2008).

There is no consensus about whether Internet addiction is associated with gender (Chou et al., 2005). We found that males were at higher risk for Internet addiction than females, which has also been reported in other studies (Anderson, 2001; Chou & Hsiao, 2000; Jang, Hwang, & Choi, 2008; Morahan-Martin & Schumacher, 2000). Some researchers attributed the gender difference in prevalence of Internet addiction to different preferences of online applications between males and females (Wang et al., 2011; Weiser, 2000). In the present study, although males obtained a higher total IAT score, there was no difference on time management and performance across gender. These may suggest that the higher vulnerability to Internet addiction in males may be associated with a different pattern of symptom manifestation. These observations are consistent with previous findings suggesting that males tend to engage in dominant online activities such as gaming to pursue feelings of achievement and social networking (Ko, Yen, Chen, Chen, & Yang, 2005). A sense of competence may hence arise, and increase the risks of withdrawal from social life in reality, and overdependence to relieve real-life disturbance. Future studies should be conducted to examine the effect of interaction of gender and age on the risks of Internet addiction among adolescents.

The Impact of Internet Addiction on Adolescent Health

The literature has indicated the negative health impact of Internet addiction or pathological Internet use in adolescents on both physical and psychosocial domains. Due to the excessive time spent online, Internet addiction was well documented to be associated with insomnia and sleep disturbances. Heavy adolescent Internet users generally were reported to have shorter total sleep time and delayed bedtime (Cain & Gradisar, 2010; Cheung & Wong, 2011; Choi et al., 2009). In addition, the sedentary act of prolonged computer use resulting in physical inactivity may increase the level of body fat and risk of obesity (Matusitz & McCormick, 2012). Neuroimaging studies gave even more solid evidence for the impact of excessive Internet use on physical health in adolescents in a way similar to substance use. For instance, two recent experimental studies suggested that Internet addiction is related to poor white matter integration (Lin et al., 2012) and disembodiment in adolescents (Kim et al., 2012).

The association between Internet addiction and poor mental health among adolescents has also been established. Psychiatric comorbidity of Internet addiction such as depression, social anxiety, and attention deficit hyperactivity disorder are commonly reported (Jang et al., 2008; Yen, Ko, Yen, Wu, & Yang, 2007). Furthermore, excessive Internet use was found to be detrimental to family relationships, self-esteem, life satisfaction (Ko et al., 2005; Ko, Yen, Yen, Lin, & Yang, 2007), and academic performance (Kubey, Lavin, & Barrows, 2001; Wainer et al., 2008). Results of this study partially agreed with these preceding findings. We found that students reporting declined academic performance were more likely to score higher on the time management and performance subscale. Nevertheless, in contrast with Chang and Man Law's (2008) study with Hong Kong university students, the correlations of academic result with the IAT subscales and total scores were not significant in the present study. This discrepancy may be due to the methods used to assess academic performance as well as age differences of the samples. Because the current study is cross-sectional, we cannot conclude whether Internet use deprives study time and leads to poor academic results. Nonetheless, research has shown that younger people are more likely to sacrifice their learning or work (Griffiths et al., 2004; Widyanto & McMurran, 2004) as a compensation of the extra time spent on the Internet (Ferraro et al., 2007). Conceivably, it may become a vicious circle that poorer psychological well-being

(Sun et al., 2005), coping strategies (Milani et al., 2009), emotional loneliness (Moody, 2001), and interpersonal relationships (Sanders, Field, Diego, & Kaplan, 2000) was associated with increased Internet use and Internet favorability in adolescents. Poor academic performance may induce a negative evaluation about oneself, and cause the individual to turn to Internet as an escape or a way to withdraw from their low self-esteem (Niemz, Griffiths, & Banyard, 2005).

Internet addiction is a relatively new pediatric mental health disorder. As a result of stigma, the adolescents suffering from Internet addiction may present with physical problems (e.g., daytime drowsiness, musculoskeletal pain, and deep vein thrombosis), which come primarily within the remit of pediatricians. They may present with mental health problems, which are comorbid with Internet addiction (e.g., depression, anxiety, attention deficit, and hyperactivity disorder). The adolescents may be guarded about the extent of their Internet use during the clinical interview. Pediatricians may only be able to assess the general and superficial aspects of Internet addiction due to time constraints. As a result of the above challenges, an instrument yielding valid and reliable scores for screening pathological Internet use among adolescents is an important step for early detection in pediatric practice. It is important to understand the impact of Internet addiction. IAT provides valuable information on the impact on social function and time management. Besides pediatric services, the child and adolescent community mental health services may not have the specialized expertise to assess Internet addiction. A validated IAT will allow multidisciplinary professionals to screen and evaluate Internet addiction in the community and clinical settings. From a research perspective, the pediatric and mental health professionals can perform further correlational analysis between the severity of Internet addiction (i.e., total score of IAT) and severity of physical and mental symptoms.

There are several limitations in this study. There is no relevant construct proposed in adolescents for comparisons. The sensitivity and specificity of the cutoff for IAT were adopted from Western findings. The results from our sample may not be generalizable to the entire Hong Kong adolescent population, although the participating schools were of different school bandings, covering students from low to high academic abilities. Moreover, the content of some items of IAT may not be totally applicable to adolescents, although special attention has been taken in the translation process and respective Chinese terms with intact meanings and more understandable to adolescents were chosen. In addition, the assessment of Internet use patterns relied on self-reports and did not take the use of mobile phones or other portable devices into account. The context or purposes of Internet use of the participants were also not solicited. Therefore, e-learning time was not assessed separately from online leisure time. Discriminant validity of IAT could not be established to differentiate excessive Internet use for study purposes from those for satisfying compulsion among the addicts. Furthermore, temporal stability is an essential criterion for assessing a psychiatric disorder alike substance addiction (Robins & Guze, 1970). Using IAT for screening, Lam (2012) found that only one-fourth of adolescent problematic Internet users were reidentified in the two follow-ups after 3 and 9 months. Nonetheless, the lack of temporal stability of IAT may be due to the transient nature of Internet addiction per se or the scale being used. Limited by our cross-sectional study design, no investigation of the temporal stability of assessments of Internet addiction using IAT was allowed.

In conclusion, this study has provided an empirical foundation of the psychometric properties of the assessment of Internet addiction, which could benefit future research on the life-course risks of Internet addiction. Consistent with previous study in Hong Kong Chinese adults, a higher order latent factor was satisfactorily accounted by the three underlying factors: ''withdrawal and social problems,'' ''time management and performance,'' and ''reality substitute,'' IAT has evidence of being a valid and reliable scale for identifying pathological Internet use in Chinese adolescents. Validation of the Chinese IAT in adolescents is important for the purpose of early detection in clinical practice, and for conducting multiethnic epidemiological studies in research settings.

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