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Predictors of Problematic Internet and mobile phone usage in adolescents

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Summary. *This study uses an innovative statistical strategy to test the role of certain variables as predictors of problematic Internet and mobile phone usage among adolescents in Spain and in the United Kingdom . A paper-and-pencil questionnaire was used, with socio-demographics and patterns of technology usage as variables, and two tests were administered: the Problematic Internet Entertainment Use Scale for Adolescents (PIEUSA) and the Mobile Phone Problem Use Scale for Adolescents (MPPUSA). The overall sample size was 2228 high school students aged between 11 and 18 from Barcelona and London. PIEUSA and MPPUSA scores were transformed into normed scores, and both were then dichotomized according to three statistical criteria as cut-off points (i.e., median, 80th percentile, and extreme scores below the 25th percentile and above the 75th percentile) in order to establish the relationship between the variables above and the excessive use of the Internet or mobile phones, using a binary logistic regression. The results show that the best predictive model for both technologies includes socio-demographic variables as predictors of extreme scores for excessive Internet and mobile phone usage, with good sensitivity, specificity and classification accuracy, as well as a notable capacity for discrimination according to the receiver-operating characteristic curve. Implications of these findings are discussed.*

Keywords: *problematic Internet use; problematic mobile phone use; technological addiction; adolescence; predictors*

Predictors de l'ús problemàtic de l'Internet i els telèfons mòbils a adolescents

Resum. *Aquest estudi utilitza una innovadora estratègia estadística per investigar el paper predictiu que tenen algunes variables en l'ús problemàtic d'Internet i els telèfons mòbils entre els adolescents a Espanya i el Regne Unit. Es va aplicar una enquesta amb factors sociodemogràfics i patrons d'ús de la tecnologia, alhora que es van administrar dues proves: l'Escala de l'Ús Problemàtic d'Internet entre Adolescents (PIEUSA), i l'Escala de l'Ús Problemàtic dels Telèfons Mòbils entre Adolescents (MPPUSA). La mida total de la mostra era de 2228 estudiants d'institut de Barcelona i Londres amb edats entre els 11 i els 18 anys. Les puntuacions en la PIEUSA i la MPPUSA es van transformar en puntuacions normades, i després es van dicotomitzar utilitzant tres criteris estadístics per determinar els punts de tall (és a dir, la mitjana, el percentil 80 i les puntuacions extremes per sota del percentil 25 i per sobre el percentil 75), per tal d'establir la relació entre els variables esmentades i l'ús excessiu de l'Internet o dels telèfons mòbils, a través d'una regressió logística binària. Els resultats indiquen que el millor model predictiu per a ambdós tipus de tecnologia inclou variables sociodemogràfiques com a predictors de puntuacions extremes en l'ús excessiu d'ambues tecnologies, amb un bon grau de sensibilitat, especificitat i precisió de la classificació, a més d'una bona capacitat discriminatòria segons la corba ROC. Es comenten les implicacions d'aquestes troballes.*

Paraules clau: *ús problemàtic de l'Internet; ús problemàtic dels telèfons mòbils; addicció tecnològica; adolescència; predictors*

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Introduction

In studies of problematic Internet and mobile phone use (PIU and PMPU, respectively) the comparison of results and the estimation of (protective or risk) factors, are particularly difficult due to the lack of a standard conceptual definition, the wide disparity in the adoption of classification criteria, the range of instruments for measurement (e.g., as discussed in the review of Internet addiction conducted by Kuss, Griffiths, Karila and Billieux (2014) and the problem mobile phone use review conducted by Pedrero-Perez, Rodriguez-Monje, & Ruiz-Sanchez de Leon, 2012), and the different methods that have been applied to estimate these problems' prevalence (pointed out in an analysis of the cut-off points used in the PIU (Lopez-Fernandez, Honrubia-Serrano & Freixa-Blanxart, 2013).

In the case of PIU, recent systematic reviews (King, Haagsma, Delfabbro, Gradisar & Griffiths, 2013; Lortie, & Guitton, 2013; Pedrero-Pérez et al., 2012) have detected around twenty validated questionnaires for assessing Internet addiction, usually based on previous Diagnostic and Statistical Manual (DSM) tests for addictive disorders from the American Psychiatric Association (APA). The scales that have been most often used from 1998 to the present seem to be those which were created first, such as the Young scales (Young, 1998a, 1998b), despite the criticism levelled at the Internet Addiction Tests (IAT; Young, 1998b) stemming from their factor structure (Chang & Law, 2008; Widyanto, Griffiths & Brunsden, 2011). Moreover, almost all of the scales address adults (Lopez-Fernandez, Honrubia-Serrano, Gibson & Griffiths, 2014), but they are usually also used to estimate the prevalence of adolescent problem users (Lopez-Fernandez et al., 2013). Therefore, adolescent scales to measure Internet addiction are still scarce, although some have been validated simultaneously with their elaboration and dissemination beginning as far back as 2003 with the Chen Internet Addiction Scale (CIAS; Chen, Weng, Su, Wu, Yang, 2003; Ko, Yen, Chen, Chen & Yen, 2005a) and continuing to the present with the Problematic Internet Entertainment Use Scale (PIEUSA; Lopez-Fernandez et al., 2013, Lopez-Fernandez et al., 2014), which is the first scale to be elaborated and adapted for two European countries and cultures (Spain (Lopez-Fernandez et al., 2013) and the United Kingdom (Lopez-Fernandez et al., 2014)).

On the other hand, the PMPU scales have already had practically a decade of scientific life, and while the study of technological addictions has made important progress internationally, a need has arisen for improving conceptualization and criteria and for instruments with validated cut-off points to ensure comparability in the estimation of problematic users. Among the scales constructed or adapted for problematic mobile phone usage (e.g., the Mobile Phone Dependence Questionnaire or MPDQ (Toda, Monden, Kubo & Morimoto, 2006), the Cell-phone Overuse Scale or COS (Jenaro, Flores, Gómez-Vela, González-Gil, & Caballo, 2007) and the Problematic Mobile Phone Use Questionnaire or PMPUQ (Billieux, Van der Linden & Rochat, 2008)) the Bianchi and Phillips's Mobile Phone Problem Use Scale (MPPUS; Bianchi & Phillips, 2005) stands out as the gold standard (Pedrero Pérez et al., 2012). The subsequent MPPUS adaptations used in different countries have obtained excellent reliability and good factorial and construct validities (Leung, 2008a, 2008b; Lopez-Fernandez, Honrubia-Serrano & Freixa-Blanxart, 2012; Lopez-Fernandez, Honrubia-Serrano, Freixa-Blanxart, & Gibson, 2014).

However, few scales have addressed problematic use of the two technologies in different populations, in other words PIU and PMPU for both adolescents and adults; this is the case of the «Cuestionario de Experiencias Relacionadas con Internet» (CERI; Beranuy, Chamarro, Graner, & Carbonell, 2009a; Beranuy, Oberst, Carbonell, & Chamarro, 2009b) and the «Cuestionario de Experiencias Relacionadas con el Móvil» (CERM; Beranuy et al., 2009a, 2009b). The two scales have been used to analyze the predictive capacity of these problematic usages to explain their total scores (Carbonell, Chamarro, Griffiths, Oberst, Cladellas & Talarn, 2012), finding only a few differences in socio-demographics (e.g., gender in CERM) and none in technology usage patterns (e.g., time spent online).

Unlike those for PIU, PMPU studies with adolescents were used more to address an adolescent population, and they have mainly been conducted in Asia (Ha, Chin, Park, Ryu & Yu, 2008; Kawasaki, Tanei, Ogata, Burapadaja, Loetkham, Nakamura & Tanada, 2006; Leung, 2008a, 2008b; Yen, Tang, Yen, Lin, Huang, Liu, & Ho, 2009), Europe (Beranuy, et al. 2009a; Lopez-Fernandez et al., 2012, 2014; Martinnoti et al., 2011) and the Pacific (Walsh, White & McD Young, 2010).

With regard to the treatment of questionnaire scores in the health sciences, the use of standardized scores has been used for the purposes of establishing the concurrent validity of various measurement instruments (Horemans, Nollet, Beelen, & Lankhorst, 2004), as well as to compare the same instrument in culturally different samples (Schmitt, de Wijer, van Genderen, Helders, & van Meeteren, 2009). It is unknown whether there are predictors of PIU or PMPU among adolescents because to date only a few studies on PIU have been published, addressing this issue only partially (Bulut Serin, 2011; Kayri & Gunuc, 2010; Kuss, Griffiths, & Binder, 2013). Therefore, through the use of statistical models, this paper intends to conduct an analysis of the role of variables related to socio-demographics and patterns of usage as predictors of PIU and PMPU in a sample of European adolescents from Spain and the United Kingdom (UK).

The objective is twofold: (1) to prove that socio-demographic variables are better PMPU predictors than those related to patterns of mobile phone usage; (2) to detect the best model for the prediction of excessive Internet and mobile phone use using socio-demographics and usage pattern variables.

Method

Participants

Participants were students from nine public or private secondary schools in the cities of Barcelona (Spain) and London (UK); the two countries are comparable in terms of adolescent socio-demographics and usage pattern characteristics, as well as in terms of scores for the scales used, as the same questionnaire was used and adapted to each language and culture and non-significant differences were detected (Lopez-Fernandez et al., 2012, 2013, 2014a, 2014b). The overall convenience sample was 2228 high school students aged between 11 and 18, who correctly completed both scales:, the Problematic Internet Entertainment Use Scale for Adolescents (PIEUSA (Lopez-Fernandez et al., 2013, 2014b)), which measures the excessive use of social networking and online gaming in adolescents, and the Mobile Phone Problem Use Scale for Adolescents (MPPUSA (Lopez-Fernandez et al., 2012, 2014a)), which addresses addiction problems related to the dysfunctional use of the mobile phone. Therefore, in order to out this study, this overall sample was split into two sub-samples, one for each scale: the PIEUSA and the MPPUSA. For the PIEUSA sub-sample 1685 complete data sets were collected from adolescents (age: mean (*M*) 14.05; standard deviation (*SD*) 1.73), of whom 56% were boys and 44% girls. For the MPPUSA, the sub-sample consisted of 1438 data sets (age: $M \pm SD = 14.20 \pm 1.72$); 53.8% were boys and 48.2% girls.

Materials

A paper-and-pencil questionnaire included the variables examined as predictors in this study, as well as the two scales. The predictors proposed for the models to prove (i.e. socio-demographic and patterns of usage variables) were those have had previously shown statistically significant associations with the criterion variable (the total score for the scale), as described in previous Spanish and English studies using the PIEUSA (Lopez-Fernandez et al., 2013, 2014b) and the MPPUSA (Lopez-Fernandez et al., 2012, 2014a).

Each variable and its values will be briefly described below. The socio-demographic variables were: gender (male; female), «age group» (younger adolescents: 11-14 years old; older adolescents: 15-18 years old), "centre" (state, private), parents' studies (low-intermediate: both parents with primary and/or secondary education; higher: at least one with higher education) and usual tobacco/alcohol consumption (no; yes), this last variable referring to whether the adolescent confirms that he or she smokes or drinks regularly – this variable was called «drugs»; and finally, the «country» (Spain; UK) was also included. However, the usage pattern variables were different for each technology. In the case of Internet use on computers (fixed or portable devices) they were: usual use of online entertainments (no; yes), the age of initiation of Internet use as entertainment (less than 11 years old (childhood); 11 years old or older (adolescence)), frequency of use (if not daily: from 1 to 6 days per week; if daily: 7 days per week), number of hours per week (less than 15 hours; 15 hours or more) and hobbies other than the Internet (no; yes). For the mobile phone: the degree of expertise in the use of the mobile phone (low, high), perception of the problem in others (yes; no), perception of the problem in oneself (yes; no), type of mobile phone use (communication; communication and leisure), and time of mobile phone ownership (less than three years; three years or more).

The PIEUSA contains 30 items rated on a seven-point Likert scale (from 1 «strongly disagree» to 7 «strongly agree»). In this case, the total score ranges from 30 to 201, which is the highest maximum presence of PIU over the past year. The MPPUSA consists of 26 items in which subjects answered on a 10-point Likert scale (from 1, «not true at all», to 10, «extremely true»), so that the total score ranges from 26 to 260, with higher scores being indicative of more PMPU.

Therefore, two models were constructed to predict each of the two kinds of problem technology use. For the first model for the PIU , the selected variables were: gender, age group, type of school, parents' educational level, and habitual tobacco/alcohol consumption. For the second model the selected variables were: online entertainment, initial age of Internet use as entertainment, frequency of use, number of hours per week and hobbies other than the Internet. For the the first model for the PMPU, the selected variables were: gender, age group, type of school, parents' educational level, and habitual tobacco/alcohol consumption. For the second model the selected variables were degree of expertise using the technology, perception of the problem in others, perception of the problem in oneself, type of mobile phone use, and time of mobile phone ownership.

Procedure

A cross-sectional descriptive study was conducted, with field work carried out from 2008-2010, the coding of the two data bases done in 2011-2012, and the design of the proposal of models and analysis techniques used to extract the predictors of PIU and PMPU carried out in 2012-2013. Data collection was subject authorization from the respective head teachers, who to a procedure involving researchers administering the pencil-and-paper questionnaire to students during normal class time. Formal approval was also given by the ethics committee of the Tower Hamlets Research and Performance Development Team. The informed consent form for students was given to them simultaneously with the questionnaire. Anonymity and confidentiality were guaranteed. Participation was voluntary, and all agreed to participate.

Data analysis

The scores on the PIEUSA and the MPPUSA were asymmetrical, as is often the case in psychological question-

naires. Therefore they were standardized by transforming the total scores of each test into «normed data» using the following operation: normed score=((observed score-minimum score))/((maximum score-minimum score))* 100

Therefore, the PIEUSA and the MPPUSA scores ranged from 0 (PIEUSA: for scores of 30; MPPUSA: for scores of 26) to 100 (PIEUSA: for scores of 210; MPPUSA: for scores of 260).

A binary logistic regression analysis using the forward stepwise method was used for each scale.

Two predictive models were proposed for the analysis of the relationships in each scale: (a) socio-demographic variables and (b) variables related to Internet and mobile phone use with the normed PIEUSA or MPPUSA score, respectively.

Prior to the calculation of the logistic model, the bivariate associations between the criterion variable and each of the predictor variables were analyzed.

The sensitivity and specificity of the classification and the overall accuracy were calculated. The Cox & Snell and Nagelkerke R^2 values were also estimated to determine the proportion of variance explained by the model.

Finally, the fit of the model was assessed with the Hosmer & Lemeshow (*H-L*) test, and the classification procedures were evaluated by the Receiver-Operating Characteristic (ROC) curves to assess the test's predictive capacity.

The outcome variable was dichotomized according to the three cited criteria, first with MPPUSA: the median (*Mdn*), which was 18.3761, the 80th percentile (*P*), which was 51.2821, and the extreme scores, selecting those below 25th *P* and above 75th *P*, which were normed scores of 6.8376 and 43.5897 respectively.

The results are presented with a confidence interval of 95%. All data processing and analysis was performed using IBM SPSS 20 for Windows.

Results

MPPUSA: Socio-demographic variables model

As shown in Table 1, with the criterion variable dichotomized according to the *Mdn*, all socio-demographic variables studied were related to the MPPUSA score; however, the estimated risk showed stronger relationships with tobacco and/or alcohol consumption (categorized as «drugs»), gender, age, type of school («center»), and parents' level of education («parent's studies») (see estimated risks, ER, in Table 1).

With the second dichotomization criterion (80th *P*), the examination only showed statistically significant differences in two predictors: alcohol and/or tobacco consumption (χ^2 = 6.783, p <.01), with an ER of 1.416 (CI: 1.089-.841), and parents' level of education (χ^2 = 97.537, p <.001), with a very low ER (.291, CI: .227-.375).

Taking the extreme groups (below 25th/above 75th *P*), the bivariate examination of the 380 adolescents showed statistically significant differences in all demographic variables, although the ER showed stronger relationships with some of them: alcohol and/or tobacco consumption, type of school, age, gender and, finally, a very low risk with parents' level of education (see Table 2).

The logistical modelling of the relationship between the socio-demographic variables and the MPPUSA scores presents similar results for the median and extreme scores criteria to those obtained in the bivariate examination; that is, all predictor variables were statistically associated with mobile phone use. However, with the 80th *P* only three factors were significant: age, type of school, and parents' level of education. For each criterion the most parsimonious model was used, which in the case of the median and 25th/75th *P* proved to be the saturated model. Table 3 shows the results obtained with this first model with extreme scores.

As for the classification provided by the model (see Table 4), there were notable differences between the three criteria; the most acceptable criterion was 25th/75th *P*, which presented relatively good sensitivity and average specificity.

Thus, the best predictive model was the 25th/75th *P*:

$$\text{Logit (p)} = \beta_0 + \beta_1\text{age} + \beta_2\text{centre} + \beta_3\text{drugs} + \beta_4\text{parents' studies} + \beta_5\text{gender}$$

MPPUSA: Variables of mobile phone use model

With the three criteria, the bivariate examination found that only two predictor variables were associated with the normed MPPUSA scores: perception of the problem in oneself (*Mdn*: χ^2 = 9.079, p <.01, ER = 0.5, CI: .316-.789; 80th *P*: χ^2 = 12.722, p <.001; ER = .294, CI: .144-.597, 25th/75th *P:* χ^2 = 8.422, p <.01, ER = .249, CI: .167-.728) and length of time of phone ownership (*Mdn*: χ^2= 15.277, p <.001, ER = 1.797, CI: 1.338-2.413;

Table 1. Bivariate examination of the sociodemographic predictor variables using the Mdn as criterion

Variables	χ^2	*p*-value	Estimated Risk (ER)	Confident Interval (C.I.) 95%	
				Lower	Higher
Age	22.887	.000	1.570	1.113	2.214
Centre	6.326	.012	1.536	1.097	2.149
Drugs	33.672	.000	2.037	1.598	2.596
Parents' studies	16.403	.000	.622	.494	.784
Gender	21.221	.000	1.632	1.325	2.012

Table 2. Bivariate examination of the socio-demographic predictor variables using extreme scores (below 25th/above 75th *P*) as criterion

Variables	χ^2	*p*-value	ER	C.I. 95%	
				Lower	Higher
Age	18.653	.000	2.466	1.631	3.727
Centre	12.242	.000	2.774	1.542	14.990
Drugs	18.578	.000	3.109	1.829	5.284
Parents' studies	47.980	.000	0.225	0.146	0.346
Gender	12.707	.000	2.121	1.399	3.215

Table 3. Socio-demographic predictors of the equation using 25th/75th *P* scores as criterion

	B	S.E.	Wald	df	Sig.	Exp (B)	C.I. 95% EXP(B)	
							Lower	Higher
Age	-.496	.243	4.180	1	.041	.609	.378	.980
Centre	-.875	.335	6.820	1	.009	.417	.216	.804
Parent's studies	1.308	.232	31.724	1	.000	3.699	2.347	5.832
Drugs	-.917	.313	8.561	1	.003	.400	.216	.739
Gender	-.573	.234	5.974	1	.015	.564	.356	.893
Constant	.828	.335	6.096	1	.014	2.288		

Table 4. Summary of the model of socio-demographic variables as a function of the criterion of dichotomisation

Criteria	R^2 Cox Snell	R^2 Nagelkerke	*H-L* Goodness-of-fit	Sensitivity	Specificity	Overall Accuracy
Median	6.4%	8.6 %	.236	66.6 %	53.3%	60.1%
80th P	7.7%	11.3%	.566	12.5%	95.6%	75 %
25th /75th P	19.7%	26.2%	.121	75.4%	64.6 %	70.3 %

80th *P*: $\chi^2 = 13.480$, $p < .001$, ER = 1.904, CI: 1.346-2.692, 25th/75th *P*: $\chi^2 = 16.498$, $p < .001$; ER = 2.334, CI: 1.546-3.524).

As regards the logistic modelling of variables associated with mobile phone use, the three criteria showed relationships identical to those observed in the bivariate examination (see Table 5). The consistency of the results across the two analyses reinforces the quality of the two predictor variables included in the model.

The classification provided by the model (see Table 6) shows that although the overall accuracy remained relatively good, the sensitivity of the three criteria was clearly deficient. So this model does not seem to work as well as the socio-demographic variables model, since the proportion of variance explained by the predictors was low.

MPPUSA: Receiver-operating characteristic (ROC) curves

Finally, according to the area under the ROC curve, the socio-demographic variables model with the criterion of extreme scores performed best; it obtained 76.3% of the maximum value (see Figure 1), indicating a high discriminatory power. The predicted probability of this area was statistically significant ($p < .001$, CI: 71.5% -81.1%), and there was no reason to believe that the estimated results differed from the observed results (any possible discrepancy is due to sampling error according to H-L: $\chi^2 = 12.756$, $p > .05$).

PIEUSA: Models proposed to extract the best option to predict excessive Internet use

As taking the extreme groups (25th/75th *P*) was the best option for MPPUSA excessive predictors, three substantive models were tested in the PIEUSA with the socio-demographic and usage Internet patterns variables.

The first model included all the variables cited in the instruments subsection for PIEUSA (socio-demographics, with the exception of «country», and Internet usage patterns); this was called «The general model». The second model included only the socio-demographic variables (however, the «drugs» variable was substituted for »country»), and was termed «The socio-demographic model». The third model included the patterns of Internet usage, included the «country» variable, and was referred to as «The patterns of Internet usage model».

PIEUSA: The general model

Before applying the logistic regression, the bivariate study between each possible predictor and the criteria

Table 5. Predictors of mobile phone use that were significant for each criterion

Criteria: Predictor variables	*B*	S.E.	Wald	fd	Sig.	Exp(B)	C.I. 95% EXP(B)	
							Lower	Higher
Median:								
perception of the problem in self	1.251	.364	11.801	1	.001	3.495	1.712	7.138
length of phone ownership	-.660	.178	13.707	1	.000	.517	.364	.733
80th P:								
perception of the problem in self	.716	.236	9.203	1	.002	2.047	1.289	3.251
length of phone ownership	-.597	.152	15.537	1	.000	.550	.409	.741
25th /75th P:								
perception of the problem in self	1.198	.386	9.656	1	.002	3.314	1.556	7.055
length of phone ownership	-.913	.215	18.088	1	.000	.401	.263	.611

Table 6. Summary of the variables of mobile phone use model as a function of the criterion of dichotomisation

Criteria	R^2 Cox Snell	R^2 Nagelkerke	H-L Goodness-of-fit	Sensitivity	Specificity	Overall Accuracy
Median	3.4%	4.5 %	.757	54 %	63.8 %	58.9 %
80 *P*	3.9%	5.8 %	.850	0 %	100 %	75 %
25th/75th *P*	6.9%	9.2 %	.596	59.8 %	67.4 %	63.4 %

variable (normed PIEUSA score) showed that statistically significant differences only existed between gender, age, initial age, frequency of use («weekly frequency»), amount of hours per week («weekly hours») and hobbies. The multivariate model proposed to explain excessive Internet use was the following:

$$\text{Logit} = \beta_0 + \beta_1 X_{\text{gender}} + \beta_2 X_{\text{age}} + \beta_3 X_{\text{initial age}} + \beta_4 X_{\text{weekly frequency}} + \beta_5 X_{\text{weekly hours}} + \beta_6 X_{\text{hobbies}}$$

Therefore, an omnibus test was applied to find out whether the set of selected variables predicts the criteria variable, and the result was affirmative because all coefficients were significant ($\chi^2_{(6)}$=113.305, $p < .001$). Then, the intensity of this prediction was calculated. It turned out to be small from a statistical perspective, although theoretically it sufficed, because it explains the 27.8% variability in excessive Internet use, while the other variables explain maladjusted technological use. This model fits under the *H-L* test ($\chi^2_{(7)}$=8.326, p =.305), and the area under the ROC is 76.9%, giving this model a noteworthy discriminant power, which is also statistically significant. This model correctly classifies 208 out of 263 adolescents with excessive Internet use, with a sensitivity of 79.1%; it also classifies 135 out of 223 non-excessive users correctly, with a specificity of 60.5%; the overall accuracy is 70.6%. Therefore, the general model predicts 30.34% of excessive Internet users.

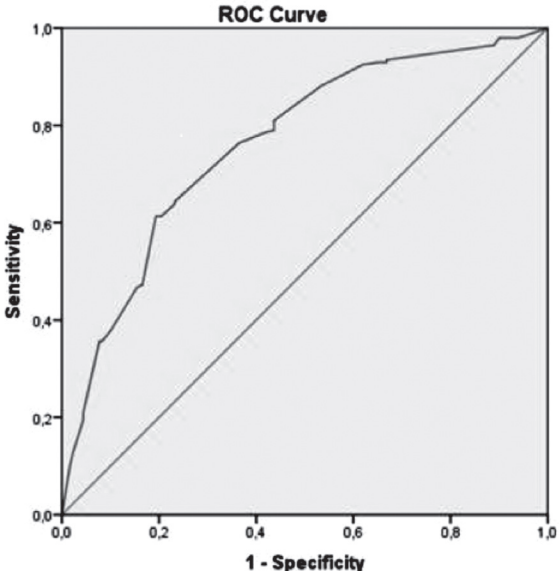

Figure 1. ROC curve of the socio-demographic predictor variables model with the criterion of 25th/75th *P*

PIEUSA: The socio-demographic model

Except for the case of the center, the socio-demographic variables were significant in the bivariate analysis. Therefore, the second model proposed for excessive Internet use was the following:

$$\text{Logit} = \beta_0 + \beta_1 X_{\text{gender}} + \beta_2 X_{\text{age}} + \beta_3 X_{\text{parents'studies}} + \beta_4 X_{\text{country}}$$

The omnibus test was affirmative as well ($\chi^2_{(4)}$=68.050, $p < .001$). The intensity of this second prediction is very small from a statistical perspective: 11.7% of the variability in excessive Internet usage, while the other variables explain maladjusted technological use. This model fits under the *H-L* test ($\chi^2_{(7)}$=8.995, p =.253), although the comment should be made that this classical technique is very restrictive and it is seldom used to draw final conclusions regarding predictors. The area under the ROC is 67.1%, which

shows the discriminant power of this model, and which is also statistically significant. This model correctly classifies 216 out of 373 adolescents with excessive Internet use, with a sensitivity of 57.9%, and classifies 254 out of 370 non- excessive users correctly, with a specificity of 68.9% and an overall accuracy of 63.3%. However, this socio-demographic model predicts 81.29% of the excessive Internet users:

Logit(p)= - .8(gender) -.648(age) - .427(parents'studies) + .406(country)

PIEUSA: The Internet usage pattern model

A similar analysis was done using this last model:

$$\text{Logit} = \beta_0 + \beta_1 X_{\text{initial age}} + \beta_2 X_{\text{weekly frequency}} + \beta_3 X_{\text{weekly hours}}$$

However, although the omnibus test showed that these variables predicted the criteria, the intensity again was small (23.9%), the *H-L* criteria obtained was acceptable with a 75.1% of the area under the ROC and the classification indexes were acceptable (sensitivity: 66%; specificity: 69.2% and accuracy: 67.2%), and the model logit predicted 3.04% of the excessive Internet users.

Discussion

Research into the problematic use of technologies predictors is still new. However, it has proven to be interesting because, in accordance with our main findings, it allows for a comparison of the results obtained with different scales and in different countries. We propose the use of normed scores, since other types of standardization are inappropriate for the type of distribution obtained. This statistical strategy of using the normed total score of a scale has, to the author's knowledge, not been used in this field of technological (behavioral) addictions up to the present, which constitutes a novel contribution that could be helpful in the equal treatment of data from different countries. The variables and the criteria used to dichotomize the population were the same as those used in previous studies on the problematic use of technologies (Sahin, 2011): the median (Kayri & Gunuc, 2010), the 80th *P* (Ko et al., 2005a; Lopez-Fernandez et al., 2012; Sánchez-Martínez & Otero, 2009) and extreme scores (25th/75th *P*; Jenaro et al., 2014).

The bivariate relationships between the demographic variables and the PIEUSA and the MPPUSA scores corroborate the findings obtained in previous studies: higher scores for girls (Beranuy Fargues et al., 2009; Carbonell et al., 2012, but only in the PMPU, Jenaro et al., 2014) (although other predictive studies did not find this gender predictor (Carbonell et al., 2012, but only in the PIU; Kuss et al., 2013)), older adolescents, and those who smoke and/or drink (Lopez-Fernandez et al., 2012; Sánchez-Martínez & Otero, 2009). As for the type of school and the parents' level of education, the results do not replicate those of other studies, but one must not forget that with this criterion we worked with subsamples of 262 and 390 adolescents with extreme scores for PIU and PMPU respectively.

The best predictive model in both technologies proved to be the one that optimized the differences between users: the one using the 25th/75th *P* criterion, that is, the scores of casual users (lowest 25%) and excessive users (highest 75%). These models provide reasonable operating characteristics regarding the classification of casual or excessive Internet and mobile phone users in relation with some of their socio-demographic characteristics, since in a single step it ensures sensitivity and specificity (Löwe et al., 2004). The logistic regression results suggest that being a girl, being an older teen, studying at a private school (this factor is only valid for excessive mobile phone use), having a parent with a university degree (this factor is only valid for excessive mobile phone use; for Internet use the opposite was the case, parents had a low or intermediate degree) and tobacco and/or alcohol consumption (this factor is only valid for excessive mobile phone use) or being British (this factor is only valid for excessive Internet use) are independent possible predictors of excessive Internet and mobile phone use. However, caution must be exercised due to the subsample sizes, as well as the socio-demographic variables selected for this study, which are extracted from the PIEUSA and the MPPUSA validation studies (Lopez-Fernandez et al., 2012, 2013, 2014a, 2014b). In future studies the focus should be directed toward other socio-demographic as well as psycho-social variables in order to improve the profile of a potentially problematic technological user.

Although for socio-demographic factors the model based on extreme scores is the best of the three MPPUSA and PIEUSA models tested and has a high predictive capacity, the explained variance was moderate. The predictor variables related to Internet and mobile phone usage proved to be inappropriate. Further studies should focus on more precise variables. For the study of Internet usage these could be the average amount of online applications used, the number of social networks (SN) usually used, the number of contacts in these SN, the rewards obtained through online applications (e.g., Carbonell et al. (2012) found that 27.8% of the variance in total CERI score was for chat applications and networking). For the study of mobile phone usage these could be the number of calls, the frequency of checking the phone for new calls, the number of text messages sent or downloads, the number of contacts maintained, the time devoted to calls, the monthly expense of maintaining a phone, the use of specific applications (e.g., Carbonell et al. (2012) found that 22.8% of the variance in total CERM score was for text-messaging and games). Psychological variables that may also be worth considering include personal factors such as altered identity communication, which seems to be a predictor of PIU according to Carbonell et al. (2012), because this factor could be an underlying psychological mechanism that facilita-

tes dysfunctional behaviors through technologies (e.g., online networking or gaming).

Other related psychosocial aspects of well-being or loneliness have also proven to be good predictors of PIU (Bullut Serin, 2011), as have factors related to the psychiatric symptoms associated with Internet addiction (Koç, 2011), among which, in adolescents, the most important seem to be obsessive-compulsive disorder and depression (Jang, Hwang & Choi, 2008).

In the literature on PIU, the main predictors detected have been: the reason for using the Internet, the daily number of hours on the Internet, gender, income of users' families, education level of users' parents (Kayri & Gunuc, 2010), and gender (Bulut Serin, 2011; Kayri & Gunuc, 2010); other personality factors detected have been neuroticism, extraversion, psychoticism, lying, life satisfaction, loneliness (Bulut Serin, 2011) and other single or combined options such as a combination of online gaming and openness to experience, frequent online shopping and online social activities, high neuroticism and low agreeableness (Kuss et al., 2013). In PMPU, the only predictors reported are the age of users (young adults), low self-esteem and high extraversion (Bianchi & Phillips, 2015). However, Phillips, Butt and Blaszczynski (2006) did not find any relationship between this problem and personality traits. Billieux et al. (2008) found two factors of impulsivity (urgency and lack of perseverance) related to problematic mobile phone use, as well as to the total time of mobile phone use.

Conclusion

Finally, the validity of the measurement of mobile phone use based on clinical diagnosis has not been tested (with a few exceptions in the study of Internet Addiction (Ko et al., 2005a; Ko, Yen, Yen, Chen, Yen, & Chen, 2005b). Clinical evidence, along with the predictive validity provided by the ROC curve, could help to obtain appropriate cut-off points for the presence of this problem in both screening and diagnostic studies. The PIEUSA and the MPPUSA showed sensitivity above 67% and 75%, respectively, in the predictive model with socio-demographic variables, which may be an argument in favor of the use of the extreme parts of the distribution of normed scores, with the 75th percentile as the cut-off point for future diagnostic classification studies. Moreover, both scales addressed the generalized potentially excessive use of social media applications via computers or mobile phones, respectively.

However, only the first steps have been taken toward the construction of the profile of an excessive Internet and mobile phone user. Also, other considerations must be taken into account when studying the extensive use of smartphones, which offer the opportunity to merge Internet and mobile phone use (on the same device), which opens up a new line of research within the study of technological (behavioural) addictions (Griffiths, 1998). This paper, on the other hand, only sheds light on some new models to be applied to the validated technological addictive scales that are used in cross-cultural studies to achieve the comparability of results and explore possible predictors of these and other possible future technological addictions.

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References

Beranuy Fargues, M., Chamarro Lusar, A., Graner Jordania, C. & Carbonell Sánchez, X. (2009a). Validación de dos escalas breves para evaluar la adicción a Internet y el abuso de móvil. *Psicothema, 21*(3), 480-485.

Beranuy, M., Oberst, U., Carbonell, X., & Chamarro, A. (2009b). Problematic Internet and mobile phone use and clinical symptoms in college students: The role of emotional intelligence. *Computers in Human Behavior, 25*(5), 1182–1187. doi:10.1016/j.chb.2009.03.001

Bianchi, A., & Phillips, J. (2005). Psychological Predictors of Problem Mobile Phone Use. *Cyberpsychology & Behavior, 8*(1), 39-51. doi:10.1089/cpb.2005.8.39

Billieux, J., Van der Linden, M. & Rochat, L. (2008). The role of impulsivity in actual and problematic use of the mobile phone. *Applied Cognitive Psychology, 22*, 1195-1210. doi: 10.1002/acp.1429

Bulut Serin, N. (2011). An examination of predictor variables for problematic Internet use. *TOJET: The Turkish Online Journal of Educational Technology, 11*(3), 54-62.

Carbonell, X., Chamarro, A., Griffiths, M., Oberst, U., Cladellas, R., & Talarn, A. (2012). Problematic Internet and cell phone use in Spanish teenagers and young students. Anales de Psicología, 28(3), 789-796. http://dx.doi.org/10.6018/analesps.28.3.156061

Chang, M. K., & Law, S. P. M. (2008). Factor structure for Young's Internet Addiction Test: A confirmatory study. *Computers in Human Behavior, 24*(6), 2597–2619. doi:10.1016/j.chb.2008.03.001

Chen, S. H., Weng, L. C., Su, Y. J., Wu, H. M, Yang, P. F. (2003). Development of Chinese Internet Addiction Scale and its psychometric study. *Chinese Journal of Psychology, 45*(7), 279-94. doi: 10.1007/s10802-014-9851-3

Chow, S., Leung, G., Ng, C. & Yu, E. (2009). A screen for identifying maladaptive internet use. *International*

Journal of Mental Health and Addiction, 7, 324-332. doi: 0.1007/s11469-008-9170-4

Griffiths, M. D. (1998). Internet addiction: Does it really exists? In J. Gackenback (Ed.), *Psychology and the Internet: Intrapersonal, Interpersonal, and Transpersonal Implications* (pp. 61-75). New York, NY: Academic Press.

Ha, J., Chin, B., Park, D., Ryu, S. & Yu, J. (2008). Characteristics of excessive cellular phone use in Korean adolescents. *CyberPsychology & Behavior, 11*(6), 783-784. doi: 10.1089/cpb.2008.0096.

Horemans, H., Nollet, F., Beelen, A., & Lankhorst, G. (2004). A comparison of 4 questionnaires to measure fatigue in postpoliomyelitis syndrome. *Archives Of Physical Medicine & Rehabilitation, 85*(3), 392-398. doi:10.1016/j.apmr.2003.06.007

Jang, K., Hwang, S., & Choi, J. (2008). Internet addiction and psychiatric symptoms among Korean adolescents. *The Journal Of School Health, 78*(3), 165-171. doi:10.1111/j.1746-1561.2007.00279.x

Jenaro, C., Flores, N., Gómez-Vela, M., González-Gil, F. & Caballo, C. (2007). Problematic internet and cell-phone use: Psychological behavioral, and health correlates. *Addiction Research & Theory, 15*(3), 309-320. doi:10.1080/16066350701350247

Kawasaki, N., Tanei, S., Ogata, F., Burapadaja, S., Loetkham, C., Nakamura, T. & Tanada, S. (2006). Survey on cellular phone usage on students in Thailand. *Journal Of Physiological Anthropology, 25*(6), 377-382. doi: 10.2114/jpa2.25.377

Kayri, M., & Gunuc, S. (2010). An Analysis of Some Variables Affecting the Internet Dependency Level of Turkish Adolescents by Using Decision Tree Methods. *Educational Sciences: Theory and Practice, 10,* 2487-2500.

King, D. L., Haagsma, M. C., Delfabbro, P. H., Gradisar, M., & Griffiths, M. D. (2013). Toward a consensus definition of pathological video-gaming: A systematic review of psychometric assessment tools. *Clinical Psychology Review, 33*(3), 331-342. doi: 10.1016/j.cpr.2013.01.002

Ko, C., Yen, J., Chen, C., Chen, S., & Yen, C. (2005a). Proposed diagnostic criteria of Internet addiction for adolescents. *Journal of Nervous & Mental Disease, 193*(11), 728-733. doi: 10.1097/01.nmd.0000185891.13719.54

Ko, C., Yen, J., Yen, C., Chen, C., Yen, C. & Chen, S. (2005b). Screening for Internet addiction: an empirical study on cut-off points for the Chen Internet Addiction Scale. *The Kaohsiung Journal Of Medical Sciences, 21*(12), 545-551. doi: 10.1016/S1607-551X(09)70206-2

Koç, M. (2011). Internet Addiction and Psychopathology. *Turkish Online Journal Of Educational Technology - TOJET, 10*(1), 143-148.

Kuss, D. J., Griffiths, M. D. & Binder, J. F. (2013). Internet addiction in students: Prevalence and risk factors. *Computers in Human Behavior, 29*(3), 959–966. doi:10.1016/j.chb.2012.12.024

Kuss, D. J., Griffiths, M. D., Karila, L., & Billieux, J. (2014). Internet addiction: A systematic review of epidemiological research for the last decade. *Current Pharmaceutical Design, 20*(25), 4026-4052. doi: 10.2174/13816128113199990617

Leung, L. (2008a). Linking psychological attributes to addiction and improper use of the mobile phone among adolescents in Hong Kong. *Journal of Children and Media, 2*(2), 93-113. doi:10.1080/17482790802078565

Leung, L. (2008b). Leisure Boredom, Sensation Seeking, Self-esteem, Addiction Symptoms and Patterns of Mobile Phone Use. In E. Korini, S. Utz, M. Tanis y S. Barnes (Eds.). *Mediated Interpersonal Communication* (pp. 359-381). New Cork, NY: Routledge.

Lopez-Fernandez, O., Honrubia-Serrano, M. & Freixa-Blanxart, M. (2012). Spanish adaptation of the «Mobile Phone Problem Use Scale» for adolescent population. *Adicciones, 24*(2), 123-130.

Lopez-Fernandez, O., Freixa-Blanxart, M., & Honrubia-Serrano, M.L. (2013). The Problematic Internet Entertainment Use Scale for Adolescents: prevalence of problem internet use in Spanish high school students. *CyberPsychology, Behavior, and social networking, 16*(2),108-118. doi:10.1089/cyber.2012.0250

Lopez-Fernandez, O., Honrubia-Serrano, M.L., Freixa-Blanxart, M., & Gibson, W. (2014b). Prevalence of problematic mobile phone use in British adolescents. *CyberPsychology, Behavior, and social networking, 17*(2), 91-98. doi:10.1089/cyber.2012.0260

Lopez-Fernandez, O., Honrubia-Serrano, M.L., Gibson, W., & Griffiths, M. D. (2014a). Problematic internet use in British adolescents: An exploration of the addictive symptomatology. *Computers in human behaviour,17*(2), 91-98. doi: 10.1089/cyber.2012.0260.

Lortie, C. L., & Guitton, M. J. (2013). Internet addiction assessment tools: Dimensional structure and methodological status. *Addiction, 108*(7), 1207-1216. doi: 10.1111/add.12202

Löwe, B., Spitzer, R. L., Gräfe, K., Kroenke, K., Quenter, A., Zipfel, S., & ... Herzog, W. (2004). Comparative validity of three screening questionnaires for DSM-IV depressive disorders and physicians' diagnoses. Journal Of Affective Disorders, 78(2), 131-140. doi: http://dx.doi.org/10.1016/S0165-0327(02)00237-9

Martinnoti, G., Vilella, C., Thiene, D., Nicola, M., Bria, P., Conte, G., Cassano, M.,… Torre, G. (2011). Problematic mobile phone use in adolescence: a cross-sectional study. *Journal Of Public Health, 19*(6), 545-551. doi:10.1007/s10389-011-0422-6

Pedrero Pérez, E., Rodríguez Monje, M. & Ruiz Sánchez De León, J. (2012). Mobile phone abuse or addiction. A review of the literature. *Adicciones, 24*(2), 139-152.

Phillips, J. G., Butt, S. & Blaszczynski, A. (2006). Personality and Self-Reported Use of Mobile Phones for Games. *Cyberpsychology And Behavior, 9*(6), 753-758. doi:10.1089/cpb.2006.9.753

Sahin, C. (2011). An Analysis of Internet Addiction Levels of Individuals according to Various Variables. *Turkish Online Journal Of Educational Technology - TOJET, 10*(4), 60-66.

Sánchez-Martínez, M. & Otero, A. (2009). Factors associated with cell phone use in adolescents in the community of Madrid (Spain). *Cyberpsychology & Behavior, 12*(2), 131-137. doi: 10.1089/cpb.2008.0164

Schmitt, M., de Wijer, A., van Genderen, F., Y, Helders, P., & van Meeteren, N. (2009). The Neck Bournemouth Questionnaire cross-cultural adaptation into Dutch and evaluation of its psychometric properties in a population with subacute and chronic whiplash associated disorders. *Spine, 34*(23), 2551-2561. doi: 10.1097/BRS.0b013e3181b318c4

Toda, M., Monden, K., Kubo, K. & Morimoto, K. (2006). Mobile phone dependence and health-related lifestyle of university students. *Social Behavior and Personality, 34*(10), 1277-1284.

Walsh, S., White, K. & McD Young, R. (2010). Needing to connect: The effect of self and others on young people's involvement with their mobile phones. *Australian Journal Of Psychology , 62*(4), 194-203. doi: 10.1080/00049530903567229

Widyanto, L., Griffiths, M. D. & Brunsden, V. (2011). A psychometric comparison of the Internet addiction test, the Internet-related problem scale, and selfdiagnosis. *Cyberpsychology, Behavior and Social Networking, 14*(3), 141–149. doi: 10.1089/cyber.2010.015

Yen, C-H., Tang, T-C., Yen, J-Y., Lin, H-C., Huang, C-F., Liu, S-C. & Ho, C-H. (2009). Symptoms of problematic cellular phone use, functional impairment and its association with depression among adolescents in Southern Taiwan. *Journal of Adolescence, 32*(4), 863-873. doi: 10.1016/j.adolescence.2008.10.006

Young, K. (1998a). *Caught in the net*. New York, NY: Wiley.

Young, K. S. (1998b). Internet addiction: the emergence of a new clinical disorder. *CyberPsychology & Behavior, 1*(3), 237–244. doi:10.1089/cpb.1998.1.237

Predictores del uso problemático del Internet y los teléfonos móviles en adolescentes

Resumen. *Este estudio utiliza una innovadora estrategia estadística para investigar el papel predictivo que tienen algunos variables en el uso problemático del Internet y los teléfonos móviles entre los adolescentes en España y el Reino Unido. Se aplicó una encuesta con factores sociodemográficos y patrones de uso de cada tecnología, a la vez que se administraron dos pruebas: la Escala del Uso Problemático de Internet entre Adolescentes (PIEUSA), y la Escala del Uso Problemático de los Teléfonos Móviles entre Adolescentes (MPPUSA). El tamaño total de la muestra era de 2228 estudiantes de instituto de Barcelona y Londres con edades entre los 11 y los 18 años. Las puntuaciones en la PIEUSA y la MPPUSA se transformaron en puntuaciones normadas, y luego se dicotomatizaron utilizando tres criterios estadísticos para determinar los puntos de corte (i.e., la mediana, el percentil 80 y puntuaciones extremas por debajo del percentil 25 y por encima el percentil 75), con el fin de establecer la relación entre las variables citadas y el uso excesivo del Internet o de los teléfonos móviles, a través de una regresión logística binaria. Los resultados indican que el mejor modelo predictivo para ambos tipos de tecnología incluye variables sociodemográficos como predictores de puntuaciones extremasen el uso excesivo de ambas tecnologías, con un buen grado de sensibilidad, especificidad y precisión de la clasificación, además de una buena capacidad discriminatoria según la Curva ROC. Se comentan las implicaciones de estos hallazgos.*

Palabras clave: *uso problemático del Internet; uso problemático de los teléfonos móviles; adicción tecnológica; adolescencia; predictores*