American Psychological Association

Emotion

© 2020 American Psychological Association
ISSN: 1528-3542

2022, Vol. 22, No. 4, 678–689
http://dx.doi.org/10.1037/emo0000769

The Consequences of Compulsion: A 4-Year Longitudinal Study of Compulsive Internet Use and Emotion Regulation Difficulties

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Little is known about how compulsive Internet use (CIU) relates developmentally to different aspects of emotion regulation. Do young people engage in CIU because they have difficulty regulating emotions (the "consequence" model), does CIU lead to emotion regulation problems (the "antecedent" model), or are there reciprocal influences? We examined the longitudinal relations between CIU and 6 facets of difficulties in emotion regulation. Adolescents (N = 2,809) across 17 Australian schools completed measures yearly from Grades 8 (M_{Age} = 13.7) to 11. Structural equations modeling revealed that CIU preceded the development of some aspects of emotion dysregulation, such as difficulties setting goals and being clear about emotions, but not others (the antecedent model). We found no evidence that emotion regulation difficulties preceded the development of increases in CIU (the consequence model). Our findings indicate that teaching adolescents general emotion regulation skills may not be as effective in reducing CIU as more direct approaches of limiting Internet use. We discuss the implications of our findings for interventions designed to reduce CIU and highlight issues for future research.

Keywords: compulsive internet use, internet addiction, emotion regulation, longitudinal, adolescent

Supplemental materials: http://dx.doi.org/10.1037/emo0000769.supp

Global Internet use is estimated to have grown almost tenfold between 2000 and 2018, and as of the end of 2018, 51% of the world's population, or 3.9 billion people, used the Internet (International Telecommunication Union, 2018). This exponential growth is being led by young people. A recent survey found that nearly all U.S. teenagers report having access to a smartphone, and about half report being online almost constantly (Anderson & Jiang, 2018). As adolescents spend increasingly more time online, policymakers and researchers are grappling with the implications of these changes for the well-being and social functioning of young people.

While there is evidence that online activity is, on average, associated with negative mental health among adolescents (e.g., Huang, 2010; Twenge, Joiner, Rogers, & Martin, 2018), other researchers have presented a more nuanced picture—for example, finding curvilinear effects wherein moderate levels of online activity enhance well-being (e.g., via greater social interaction), while more extensive use leads to harmful effects (e.g., Przybylski & Weinstein, 2017). While varying "doses" of online activity have differing effects on adolescent well-being, there is evidence that extensive online activity is associated with difficulty regulating one's use of the Internet and, in turn, the development of compulsive Internet use (van den Eijnden, Meerkerk, Vermulst, Spijkerman, & Engels, 2008; van der Aa et al., 2009). Further, there is emerging evidence that the compulsive use of the Internet has a range of unhealthy consequences, though the breadth and magnitude of these consequences are not yet fully understood. The present investigation focuses on the links between compulsive Internet use and adolescent emotion regulation—the first study we are aware of to do so.

Compulsive Internet use (CIU; also referred to as "problematic internet use" and "internet dependence") is an inability to regulate one's use of the Internet, with associated feelings of guilt about one's lack of control, and reduced enjoyment of and engagement in other activities (Caplan, 2003; Spada, 2014). While there is debate as to whether CIU represents a behavioral addiction or an impulse control disorder (e.g., Ko, Yen, Yen, Chen, & Chen, 2012), conceptually, CIU appears to share similarities with other addictive disorders, such as the experience of withdrawal, intolerance, and negative social consequences (Pies, 2009). Given the emerging evidence regarding the negative consequences of CIU, examining it as a phenomenon in its own right, rather than as a proxy for general addictive behavior, is valuable (Ciarrochi et al., 2016; Muusses, Finkenauer, Kerkhof, & Billedo, 2014; van den Eijnden et al., 2008).

There is mounting evidence that the compulsive use of the Internet across various online uses is associated with negative life outcomes, including worse mental health (Carli et al., 2013; Ciar-

This article was published Online First June 18, 2020.

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rochi et al., 2016), poor self-concept (Donald, Ciarrochi, Parker, & Sahdra, 2019), loneliness (J. Kim, LaRose, & Peng, 2009), stress (Muusses et al., 2014), and decrements in general well-being (Muusses et al., 2014). Further, there is evidence that compulsive Internet use is a product of young people having a preference for online interaction, as a way of maintaining self-esteem (Caplan, 2003; Gámez-Guadix, Calvete, Orue, & Las Hayas, 2015). This suggests that a general compulsive Internet use across the range of Internet uses is worthy of investigation (e.g., Ciarrochi et al., 2016; Muusses et al., 2014; van den Eijnden et al., 2008).

Several recent reviews have called for more longitudinal research to better understand relations between generalized CIU and adolescent well-being and functioning (Carli et al., 2013; Durkee et al., 2012; Ko et al., 2012; Spada, 2014). Longitudinal research on CIU has, to date, focused on the links between CIU and life outcomes such as mental health (Ciarrochi et al., 2016), self-concept (Donald et al., 2019), and well-being (for a review, see Huang, 2010). To our knowledge, no research has examined the extent to which CIU attenuates, amplifies, or has no effect on different dimensions of emotion regulation skills, and vice versa. In the context of youth development, focusing on the issue of emotion regulation is of critical importance given the central role effective emotion regulation plays in adolescent functioning (Garnefski, Kraaij, & van Etten, 2005; Silk, Steinberg, & Morris, 2003) and the negative consequences in later life of emotion regulation difficulties in adolescence (e.g., Bradley, 2000; Cole, Michel, & Teti, L., 1994; Gross, 1998).

Difficulties With Emotion Regulation

Emotion regulation has been described as the process of modifying one's emotions, responses to emotions, or the situations that generate emotions so as to adapt appropriately to environmental demands (Gratz & Roemer, 2004; Gross, 1998; Gross & Munoz, 1995). In studying emotion regulation processes, some scholars have distinguished between efforts to regulate the *form* of emotions (e.g., controlling emotional expression and reducing emotional arousal; see Garner & Spears, 2000; Kopp, 1989; Zeman & Garber, 1996) and efforts to regulate the *function* of emotional experience (e.g., Cole, Michel, & Teti, 1994; Hayes, Strosahl, & Wilson, 1999). These latter approaches form the focus of the present study and suggest that difficulties in experiencing, identifying, and accepting the full range of emotions, as well as acting in situationally flexible ways in the presence of strong emotions, may be just as maladaptive as deficiencies in the ability to attenuate and modulate strong emotions (Cole et al., 1994; Gross & Munoz, 1995; Paivio & Greenberg, 1998).

Several aspects of emotion regulation are arguably reflective of an emphasis on the functionality of individuals' responses to emotions. Gratz and Roemer (2004), in their work on difficulties with emotion regulation, identified six emotion regulation difficulties that have received considerable research attention and also have links to important life outcomes (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Gratz & Roemer, 2004; Neumann, van Lier, Gratz, & Koot, 2010).

Impulsiveness

Individuals can struggle with reactivity to strong emotions (Neumann et al., 2010). Difficulty with impulse control is a key element of emotion dysregulation and has been linked to a host of negative outcomes, including worse mental health (Neumann et al., 2010), interpersonal difficulties (Gratz & Roemer, 2004), and unhealthy substance use (Fox, Axelrod, Paliwal, Sleeper, & Sinha, 2007).

Difficulties Pursuing Goals

In the presence of difficult emotions, individuals may have trouble remaining focused on and persisting toward valued goals (Hayes et al., 1999). Difficulty pursuing goals is often linked to experiential avoidance or the avoidance of distressing thoughts and feelings (Gratz & Roemer, 2004; Hayes et al., 1999). In these situations, the presence of unwanted emotions overwhelms a person's efforts to engage in intentional behavior toward goals (Aldao et al., 2010; Gratz & Roemer, 2004; Neumann et al., 2010).

Difficulties Identifying Emotion Regulation Strategies

Another form of emotion regulation is the capacity to flexibly identify ways of managing emotions, and central to this is feeling self-efficacy in responding to emotions (Gratz & Roemer, 2004). Individuals with such self-efficacy feel they have personal agency and the strategies to respond to their emotional experiences (Parker, Ciarrochi, et al., 2015). Conversely, people who believe they lack efficacy in managing their emotions are more likely to report greater experiential avoidance; women are also likely to report more self-harm, while men are also likely to report greater partner violence (Gratz & Roemer, 2004). Further, among adolescents, an inability to identify strategies for managing emotions is associated with anxiety, depression, and engagement in aggressive behavior (Neumann et al., 2010; Sarıtas-Atalar, Gencoz, & Ozen, 2015).

Nonacceptance of Emotions

Nonacceptance of emotions has been shown to precede strong negative emotions, as well as maladaptive behaviors aimed at suppressing or avoiding emotional experience (Hayes et al., 1999). An accumulating body of evidence indicates that the nonacceptance of emotions is a general process that underpins a host of maladaptive behaviors, including addictive behaviors, antisocial behavior, and reduced well-being (Hayes et al., 1999; Kashdan, Barrios, Forsyth, & Steger, 2006).

Difficulties with Emotional Clarity

Individuals who are unable to identify their emotions are more likely to misinterpret and not accept their emotions and are more likely to engage in unhealthy emotion regulation strategies (Parolin et al., 2018). Difficulties identifying one's emotions, also known as alexithymia, has been linked with a range of psychosocial difficulties, such as substance abuse (Kauhanen, Kaplan, Julkunen, Wilson, & Salonen, 1993) and social and interpersonal problems (Spitzer, Siebel-Jurges, Barnow, Grabe, & Freyberger, 2005); among young people, it has been linked to worse social support (Heaven, Ciarrochi, & Hurrell, 2010), obesity (Baldaro et al., 2003), and greater dissociative tendencies (Sayer, Kose, Grabe, & Topbas, 2005).

Difficulties With Awareness of Emotions

Relatedly, being able to observe one's emotions is arguably a precursor to responding effectively to them (Gratz & Roemer, 2004). Conversely, a lack of emotional awareness has been linked to unhealthy behaviors including problematic gambling (Williams, Grisham, Erskine, & Cassedy, 2012) and substance use (Parolin et al., 2018).

How might generalized CIU relate to these various emotion regulation difficulties over time? We explore three possible models: CIU as an antecedent (the "antecedent" model), a consequence (the "consequence" model), or both a cause and a consequence of emotion regulation difficulties (the "reciprocal influence" model). Next, we discuss each of these models and our associated hypotheses.

Antecedent Model

CIU can be thought of as difficulty regulating Internet behavior in the presence of Internet-related impulses (e.g., "I've got to improve my score") and feelings (e.g., fear of missing out). Engaging in CIU is, in a sense, like practicing poor behavioral regulation. That is, because CIU involves diminished self-regulatory capacities pertaining to Internet use and has been shown to be linked to reduced self-regulation more broadly (Billieux & Van Der Linden, 2012; van der Aa et al., 2009), we hypothesized that CIU leads to difficulties with behavioral control in the presence of strong emotions.

More specifically, we anticipated that CIU will precede difficulties with both the regulation of impulsive behavior (i.e., impulse control) as well as the regulation of persisting with behavior toward valued goals in the presence of negative emotions (i.e., goal pursuit). In support of this, CIU has been correlated with difficulties in impulse control among adolescents (Cao, Su, Liu, & Gao, 2007), emerging adults (Mottram & Fleming, 2009), and online gamers (E. J. Kim, Namkoong, Ku, & Kim, 2008). Further, CIU has been associated with difficulties in seeing the longer-term consequences of present decisions and making values-based decisions (Sun et al., 2009), which speaks to the capacity to pursue valued goals in the presence of emotions (Gratz & Roemer, 2004).

We also anticipated that CIU may precede reductions in the ability to identify and label feelings (emotional clarity). There is considerable evidence that other forms of addiction precede alexithymia, or difficulties identifying emotions (Parolin et al., 2018). Based on this body of alexithymia and addiction research, it may be that the self-regulatory difficulties implicated in CIU lead to broader difficulties processing information and making decisions, which in turn leads to problems identifying emotions (Parolin et al., 2018). This leads to our first hypothesis: CIU will predict less emotional clarity, impulse control, and goal-directed behavior in the presence of emotions.

Consequence Model

Perhaps young people turn to online activity as a form of emotion regulation because their other emotion regulation skills are failing them. If so, then young people who are struggling with emotion regulation in life will find it increasingly difficult to regulate their Internet-related behavior. Evidence from research on other forms of addiction is consistent with this prediction. For example, Berking et al. (2011) found that difficulty in emotion regulation predicted alcohol dependence both during and following a treatment program. Further, Williams et al. (2012) found that emotional regulation difficulties predicted pathological gambling behaviors, while Fox et al. (2007) found a similar effect for cocaine addiction, in relation to impulse control. Also, there is meta-analytic evidence that general social and emotional learning interventions for young people result in reductions in drug use and fewer conduct problems (Taylor, Oberle, Durlak, & Weissberg, 2017), suggesting that socioemotional regulation difficulties will result in maladaptive behaviors, including CIU.

Our leading candidates for the consequence model were emotional clarity, difficulties with impulse control, and difficulties with goal-directed behavior. Poor emotional clarity has been implicated clearly in other forms of addiction (Lindsay & Ciarrochi, 2009; Parolin et al., 2018). Problems with emotional clarity has also been shown to proceed social and emotional problems (Ciarrochi, Heaven, & Supavadeeprasit, 2008; Rowsell, Ciarrochi, Deane, & Heaven, 2014). In addition, young people with difficulties with impulse control and goal-directed behavior may struggle to put long-term goals (e.g., schoolwork) ahead of online activity, consistent with evidence from other forms of addictive behavior (Fox et al., 2007; Williams et al., 2012). This leads to our second hypothesis: Difficulties with emotional clarity, impulse control, and goal-directed behavior will predict the development of CIU. We did not have strong predictions for the other emotion regulation strategies, so we set out to explore the extent to which different aspects of emotion regulation difficulties (i.e., identifying strategies, accepting emotions, and emotional clarity and awareness) predict the development of CIU.

Reciprocal Influence Model

As a final possibility, there may be a reciprocal cycle linking CIU and various emotion regulation difficulties. Specifically, it may be that CIU promotes a narrowing of social skills and meaningful daily activity (Babic et al., 2017; Lin & Tsai, 2002), which leads to an erosion of emotion regulation skills. In turn, this may lead to further CIU as a way of reducing or avoiding the negative thoughts and feelings associated with such experiences.

Method

In the present study, we examined the longitudinal relations between CIU and emotion regulation difficulties among an adolescent sample over 4 years (Grades 8 to 11). Given the limited research in this field, some of our hypotheses were necessarily exploratory.

Participants and Procedure

The present investigation was a part of the Australian Character Study (ACS), a multiyear research project exploring Australian adolescent behaviors, relationships, beliefs, aspirations, and self-evaluations. Study participants were drawn from 17 Catholic high schools in the states of New South Wales and Queensland. Catholic schools make up 20.52% of secondary schools in Australia (Australian Bureau of Statistics, 2012). The schools included in

this study were mainly in cities: Wollongong (New South Wales) and Cairns (Queensland). However, the study included several schools in more rural locations, thereby ensuring the socioeconomic and geographic diversity of study participants. The Australian Government's Index of Community Socio-Educational Advantage (ICSEA) provides an indication of the level of a school's educational advantage relative to other schools (https://docs.acara.edu.au/resources/Guide_to_understanding_icsea_values.pdf). The schools in the present study had an ICSEA ranking (1,025; *SD* = 43) almost identical to the Australian average of 1,000. Of the 17 schools in the current study, one school (ICSEA = 783) had an ICSEA score less than one standard deviation (i.e., ICSEA = 957) below the ICSEA average of 1,000. In contrast, five schools in our sample had ICSEA scores (1,061; 1,062; 1,071; 1,077; and 1,083) that were more than one standard deviation (ICSEA = 1,043) above the ICSEA average. This suggests the schools in this sample were moderately skewed toward a higher socioeducational status, with the majority (11 schools) falling in the "moderate" range (i.e., between one standard deviation above and below the mean ICSEA score).

Study participants completed a battery of survey instruments three quarters of the way through the school year in each of the 4 years of the study (Grades 8 to 11). In Grade 8, the average participant age was 13.7 years (*SD* = .45). A total of 2,809 students participated in the study (1,395 or 49.7% men, 1,399 or 49.8% women, 15 unknown). Statistical power calculations for an effect size of 0.05 (based on effect sizes observed in similar studies of CIU), and to obtain power of 95%, indicated a sample size requirement of $N = 262$. This indicates that the present study was very well powered to detect actual effects. The University of Wollongong provided ethics approval for the study, and all study participants completed consent forms prior to participating. We note that data from the ACS project have been published on the links between compulsive Internet use and mental health (Ciarrochi et al., 2016) and between self-esteem and hope (Donald et al., 2019).

Measures

Compulsive Internet use. CIU was measured with the Compulsive Internet Use Scale (CIUS; Meerkerk, Van Den Eijnden, Vermulst, & Garretsen, 2009). The CIUS was designed to capture the central features of addictive behavior (per the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders* and elsewhere), including elements such as withdrawal symptoms, loss of control, preoccupation, conflict with other activities, and lying to hide addictive behavior (Meerkerk et al., 2009). Due to space constraints, and following similar approaches elsewhere (e.g., Ciarrochi et al., 2016; Donald et al., 2019), we used a 10-item version of this scale (dropping items 11–14; see Meerkerk et al., 2009). The 10-item version has demonstrated acceptable psychometric properties, including factorial stability across time, and good convergent validity (Ciarrochi et al., 2016; Donald et al., 2019). Cronbach's alphas for this measure among the present sample were acceptable (Grade 8, $\alpha = .88$; Grade 9, $\alpha = .89$; Grade 10, $\alpha = .89$; Grade 11, $\alpha = .89$). Scale responses range from 0 (*never*) to 4 (*very often*). Sample items include "Do you find it difficult to stop using the Internet when you are online?" and "Do you feel restless, frustrated, or irritated when you cannot use the Internet?"

Difficulties in emotion regulation. Drawing on the approach taken by Gratz and Roemer (2004), we operationalized the six broad forms of emotion regulation reviewed above using the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). This 36-item scale is comprised of six subscales: (a) difficulties with awareness of emotions ("awareness"; six items, e.g., "I am attentive to my feelings"); (b) difficulty clearly understanding one's emotions ("clarity"; six items, e.g., "I have no idea how I am feeling"); (c) difficulty accepting one's emotions ("acceptance"; six items, e.g., "When I'm upset, I feel guilty for feeling that way"); (d) difficulties with impulsivity ("impulse"; six items, e.g., "When I'm upset, I lose control over my behaviors"), (e) an inability to engage in goal-directed behavior ("goals"; five items, e.g., "When I'm upset, I have difficulty getting work done"); and (f) low levels of self-efficacy in identifying emotion regulation strategies ("strategies"; eight items, e.g., "When I'm upset, I believe that there is nothing I can do to make myself feel better"). Items are scored on a 5-point scale ranging from 1 (*almost never*) to 5 (*almost always*).

The DERS has displayed acceptable psychometric properties, including high internal consistency, good test-retest reliability, and adequate construct and predictive validity (Gratz & Roemer, 2004; Neumann et al., 2010). In factor analyses, the six subscales have been found to have acceptable psychometric properties and be modestly correlated with one another among adults (e.g., Gratz & Roemer, 2004; Neumann et al., 2010) and adolescents (Sarıtas-Atalar et al., 2015). However, we note that in some studies, the awareness DERS subscale has shown divergent correlations with the other DERS subscales and has repeatedly shown a divergent pattern of relations with constructs theoretically related to emotion regulation (Bardeen, Fergus, Hannan, & Orcutt, 2016; Bardeen, Fergus, & Orcutt, 2012; Benfer, Bardeen, Fergus, & Rogers, 2019; Lee, Witte, Bardeen, Davis, & Weathers, 2016). In the present study, we therefore modeled each DERS component separately so as to isolate effects of specific DERS components, following similar approaches elsewhere (e.g., Bardeen et al., 2012; Gratz & Roemer, 2004; Neumann et al., 2010).

Cronbach's alphas for each of the DERS subscales, across the 4 years of the study, had the following ranges: for impulse, $\alpha = .88$ to $\alpha = .91$; for goals, $\alpha = .83$ to $\alpha = .87$; for strategies, $\alpha = .86$ to $\alpha = .90$; for acceptance, $\alpha = .85$ to $\alpha = .89$; for clarity, $\alpha = .65$ to $\alpha = .77$; and for awareness, $\alpha = .81$ to $\alpha = .85$. Cronbach's alphas for the total DERS were $\alpha = .91$ in Grade 8; $\alpha = .92$ in Grade 9; $\alpha = .93$ in Grade 10; and $\alpha = .94$ in Grade 11.

Statistical Analyses

Random intercept cross-lagged panel models. To examine the longitudinal relations among compulsive Internet use and emotion regulation, we used random intercept autoregressive cross-lagged panel (RI-ACP) models (Hamaker, Kuiper, & Grasman, 2015). The RI-ACP modeling approach has several advantages. First, by using latent factor scores (i.e., a structural equation modeling [SEM] approach), measurement error is explicitly modeled, enhancing model fit to the data (Parker, Marsh, Morin, Seaton, & Van Zanden, 2015). Second, the RI-ACP approach explicitly models both the trait and the state components of variables, meaning that within-person (state) changes over time can be estimated without the trait component of variables confounding

within-person effects, which is not done in traditional ACP SEMs (see Hamaker et al., 2015 for a discussion). Third, the autoregressive and cross-lagged components of these models provide a conservative test of temporal precedence by explicitly modeling within-variable change over time (i.e., the autoregressive component of the model). Figure 1 shows the layout of the RI-ACP model.

Together, RI-ACP modeling enabled us to identify the likely temporal ordering of changes in both CIU and difficulties in emotion regulation (DER) over time and the extent to which these changes were uni- or bidirectional (Parker, Marsh, et al., 2015), controlling for trait components of these variables. In the present study, we tested whether (a) CIU predicts difficulties in emotion regulation (i.e., an antecedent model), (b) DER precedes the development of CIU (i.e., a consequence model), or (c) the development of CIU and DER are mutually reinforcing (i.e., a reciprocal influence model).

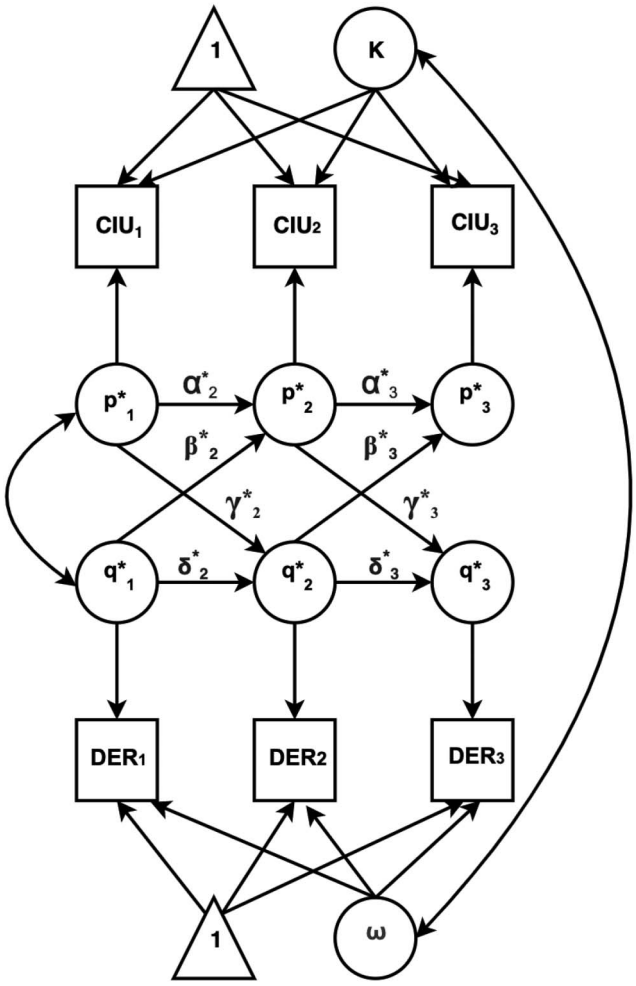

Figure 1. Random-intercept autoregressive cross-lagged panel (RI-ACP) model. Kappa and omega represent the trait component of CIU and DER respectively; p and q represent the within-person component of CIU and DER respectively. Alpha and delta represent the within-person change in CIU and DER over time, respectively. Beta represents the cross-lagged effect of DER on CIU, while gamma represents the cross-lagged effect of CIU on DER. CIU = compulsive Internet use; DER = difficulties in emotion regulation. Within-person variables and effects are indicated with *.

Modeling approach. In the present study, we examined the links between CIU and each of the six facets of emotion regulation difficulties. For each CIU-emotion regulation relationship, we tested a series of five progressively more constrained models. In all five models, we explicitly modeled the trait (κ and ω) and the state (p and q) components of CIU and DER components (see Figure 1). First, we ran a configural confirmatory factor analytic (CFA) model, in which all time-varying model parameters were allowed to vary across time, and the regression paths of interest (i.e., the regression paths between *p* and *q*) were not modeled. If this unconstrained model displays acceptable fit to the data, models with constraints can be tested (Bollen, 1989).

Second, we estimated a measurement CFA model in which we constrained factor loadings to be equal across the four waves of the study, for both CIU and DER components. Support for this model indicates that the constructs being measured (i.e., CIU and DER components) tap the same phenomenon at each time point, which is a central assumption of RI-ACP models and indeed all ACP models (Ciarrochi et al., 2016).

Following tests of CFA models, we ran a series of SEMs, which included regression coefficients between latent variables (i.e., CIU and DERS components). The first SEM was a "fully forward" model wherein regression coefficients for all paths (i.e., autoregressive and cross-lagged) were estimated, including lags across multiple time points (i.e., Time 1 to Time 2, Time 1 to Time 3, and Time 1 to Time 4, etc.). In the second SEM, lags greater than one time interval were removed from the model, and single-lag regression coefficients were estimated (as represented by α, β, γ, and δ in Figure 1). In a final SEM, regression coefficients across single-year lags (i.e., both autoregressive and cross-lagged paths) were constrained to be equal, known as a "developmental equilibrium" model, thereby testing whether effects were consistent across time (see Figure 1).

The data for this study had a nested structure with the 2,809 students nested within 17 schools. As our hypotheses related to individual differences, we controlled for differences in effects due to school membership. To do this, we used a "no pooling" approach, in which each of the 17 schools was included in all models as a set of dummy variables (Gelman & Hill, 2007). This approach is more conservative than a classic multilevel modeling approach ("partial pooling") as it does not force random effects to be normally distributed, thereby allowing for greater heterogeneity in school-level effects (Gelman & Hill, 2007).

Missing data. Participant attrition was a potential problem in this study given its longitudinal design and use of high school students. Of the 2,809 participants, 966 had data from all four waves (50.2% women), 837 had data from three waves (49.2% women), 532 had data from two waves (49.5% women), and 470 (52.0% women) had data from only one wave of the study. Where participant attrition is not due to random factors, this can result in biased parameter estimates if ad hoc methods for handling missing data, such as pair- or list-wise deletion, are used (Baraldi & Enders, 2010). In the present study, we used full information maximum likelihood estimation (FIML) methods for handling missing data in all models. An advantage of the FIML approach is that it uses all the available information for parameter estimation—both complete and incomplete cases—and generates parameter

values with the greatest likelihood of reproducing the sample data (Baraldi & Enders, 2010). There were differences in scores on CIU and DER facets between participants who completed all waves of data and those who did not, though these differences were small. Further details on these analyses are in the online supplemental material.

Fit statistics. Where parameter estimates are consistent with the theory proposed, the solution is well defined, model fit indices are acceptable, and models are considered to fit the data well (McDonald & Marsh, 1990). In the present study, we used three fit indices in addition to the chi-squared statistic: the Tucker–Lewis index (TLI), the comparative fix index (CFI), and the root mean square error of approximation (RMSEA). These three fit indices have the advantage of not being sensitive to sample size in the same way the chi-squared statistic is (Cheung & Rensvold, 2002). For TLI and CFI, generally accepted minimum fit thresholds are .90, while for RMSEA the figure is .08 (Chen, 2007; Cheung & Rensvold, 2002). In comparing the deterioration in fit of successively more restrictive models (i.e., the two CFAs and three SEMs), we used the criteria provided by Cheung and Rensvold (2002), who suggested that invariance exists between nested models if change in CFI is $< .01$ (we used the same criteria for the TLI). For RMSEA, we used criteria provided by Chen (2007), who suggested invariance between nested models exists if change in RMSEA is $\leq .015$.

Results

Preliminary Analyses

Latent means and standard deviations for CIU and DER are shown in Table 1. As Table 1 shows, means were relatively consistent across the four waves of the study for DER and increased moderately for CIU.

Bivariate correlations between CIU and DER components were moderate and positive, except for the awareness component, which displayed a very small positive correlation with CIU and mixed (both positive and negative) correlations with other DER components. Notably, correlations were of a similar magnitude for both men and women. These correlations are illustrated in the online supplemental material (Table S3 for Grade 8 and Table S4 for Grade 11, to reflect the span of the study). Information on test-retest correlations among study variables is in Table S2 in the online supplemental material, noting that these were in the medium range (.29 to .64), and were generally strongest at proximal time points and weakest at distal time points, across all study variables.

To examine the extent of CIU among our sample, we inspected CIU count data across the 4 years of the study (Figure S1 of the online supplemental material shows bar plots of these data). Although the CIUS is a continuous measure of CIU (Meerkerk et al., 2009), ratings of 3 (*often*) and 4 (*very often*) on the CIUS may be taken to indicate relatively high levels of CIU. The percentage of study participants in this category were 5.01% in Grade 8, 6.26% in Grade 9, 6.78% in Grade 10, and 6.30% in Grade 11.

Main Analyses

We next examined our main research question: the longitudinal relations between CIU and the development of difficulties in emotion regulation. As described above, for each CIU-DERS-component relationship, we tested a series of five separate models (two CFA models and three SEMs) wherein each successive model added constraints to the previous one. Where the deterioration in fit was within accepted thresholds, the more restrictive model was preferred.

Model fit. For CIU and DERS variables, there were relatively large covariances between the error terms of items, as indicated by high modification indices. Where items with high modification indices are substantively very similar and linking them in a model makes theoretical sense, and where the sample is relatively large, allowing such items to covary in latent models is acceptable and can substantially improve model fit (Weston & Gore, 2006). Given these conditions were met in the present study, items that were (a) substantively similar and (b) had high interitem modification indices were allowed to covary in all models. There were five such items from the CIU scale and eight items from the 36-item DERS (see online supplemental material for more information on these items and the basis for linking them in our models).

Following adjustment for high modification indices, model fit was acceptable for all models. Notably, for all the CIU-DER models included in this study, the stability of the factor structure across time was supported (i.e., the time-invariant CFA). Second, for all relationships tested, the structural model in which only single lags are estimated had acceptable fit to the data, meaning it was appropriate to test only single-lagged effects across time. Finally, for all CIU-DER relationships we tested, the fit of the developmental equilibrium SEM (i.e., the model in which cross-year lags were specified to be equivalent) did not deteriorate

Table 1
Latent Means and Standard Deviations for Study Variables Across the 4 Study Years

	Grade 8		Grade 9		Grade 10		Grade 11	
Study variables	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
CIU	2.16	1.01	2.18	0.99	2.26	1.00	2.34	1.00
Impulse	2.92	0.94	2.95	0.95	3.00	1.00	2.97	0.98
Goals	3.55	0.88	3.54	0.88	3.62	0.82	3.71	0.90
Strategies	2.30	0.88	2.38	0.98	2.52	1.06	2.54	1.01
Acceptance	2.80	0.78	2.88	0.83	2.99	0.91	3.05	0.88
Clarity	2.67	0.89	2.69	0.94	2.72	0.97	2.71	0.96
Awareness	2.68	0.63	2.55	0.63	2.47	0.67	2.46	0.73

Note. CIU = compulsive Internet use.

beyond the thresholds outlined above, making this the preferred model and providing evidence of stability in year-on-year effects across time (see online supplemental material for further information).

Path coefficients for developmental equilibrium models. Figure 2 displays the cross-lagged relations between CIU predicting changes in all six DER components (i.e., the "CIU-as-antecedent" hypothesis) and DERS facets predicting changes in CIU (i.e., the "CIU-as-consequence" hypothesis) from each of the models we ran. Both 90% and 95% confidence intervals (CIs) are shown around each estimate. Assuming a normally distributed population and known population variance, a 95% CI indicates an 83% likelihood that the effect size estimate of a replication study would lie within the interval, while a 90% CI indicates a 76% likelihood that the effect size estimate of a replication study would lie within the CI (Cumming & Maillardet, 2006; Cumming, 2013).

Figure 2 shows some support for Hypothesis 1. There were modest though consistent effects for CIU predicting difficulties in persisting goals in the presence of distress and being clear about one's emotions (i.e., "impulse" and "clarity" in top panel of Figure 2). We did not find evidence for CIU preceding other aspects of emotional dysregulation. Also, we did not find support for Hypothesis 2 (i.e., the lower panel in Figure 2). Problems with impulse control preceded *less* CIU, as did difficulties identifying strategies to deal with emotions. We did not find evidence that other aspects of emotional dysregulation preceded CIU. Standardized regression coefficients, standard errors, and confidence intervals for these effects are shown in Table 2.

Discussion

Drawing on theories of emotion regulation, the present study tested whether CIU predicts various emotion regulation difficulties (the antecedent model; Hypothesis 1); whether emotion regulation difficulties predict CIU (the consequence model; Hypothesis 2); or whether these effects are reciprocal (the reciprocal influence model). We found some support for the antecedent model and none for the consequence model.

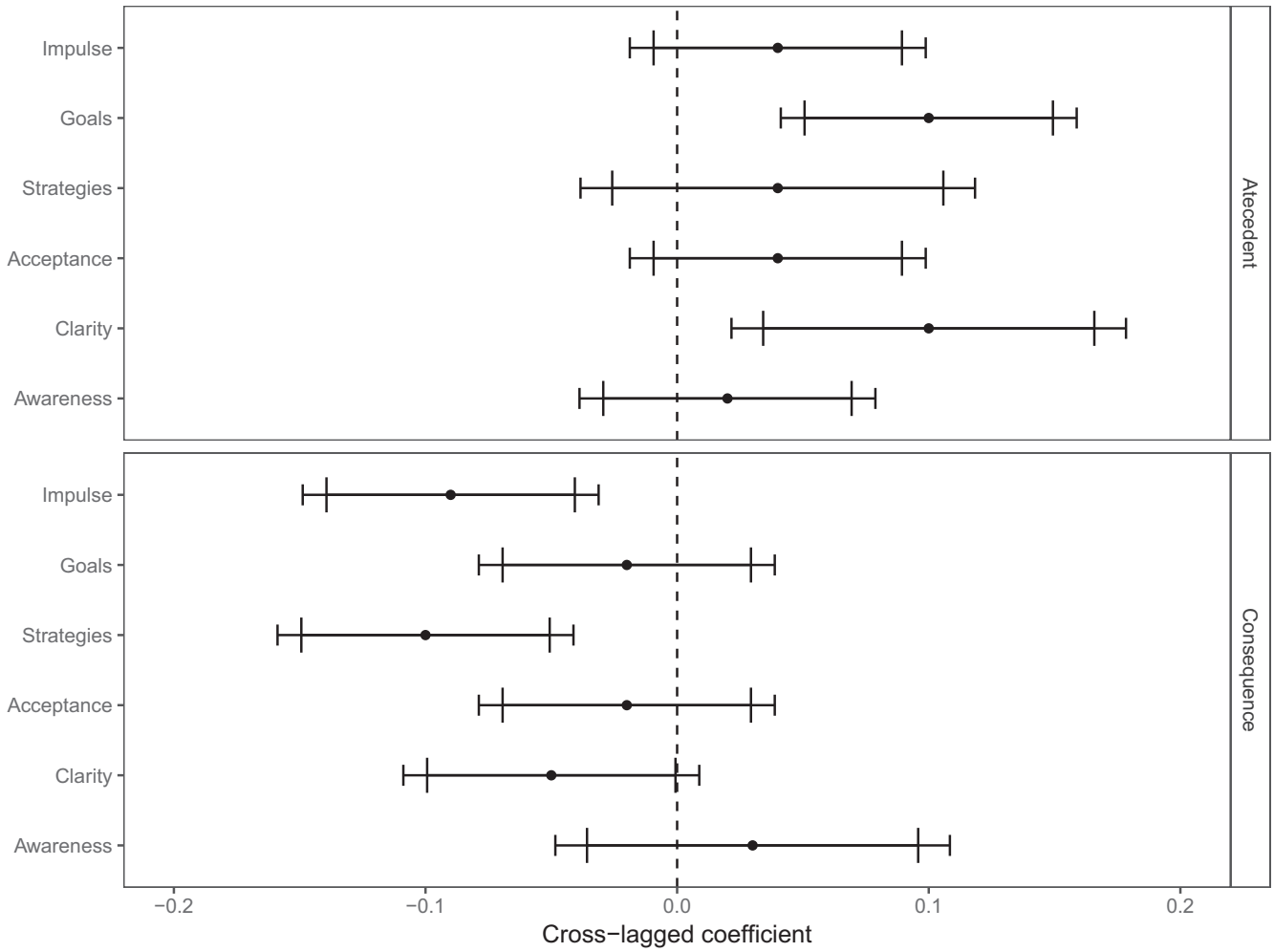

Figure 2. Forest plot of standardized cross-lagged estimates from developmental equilibrium models with CIU predicting the six DER strategies ('antecedent') and vice-versa ('consequence').

Table 2
Standardized Regression Coefficients, Standard Errors, and p Values From Developmental Equilibrium Models, for All CIU-DERS Subscale Models

Time 1	Time 2	β	*SE*	*p*	Time 1	Time 2	β	*SE*	*p*	Time 1	Time 2	β	*SE*	*p*
Impulse	Impulse	0.20	0.04	<.001	Strategies	Strategies	0.32	0.04	<.001	Goals	Goals	0.19	0.04	<.001
CIU	CIU	0.50	0.04	<.001	CIU	CIU	0.52	0.04	<.001	CIU	CIU	0.48	0.04	<.001
Impulse	CIU	−0.09	0.03	.002	Strategies	CIU	−0.10	0.03	.001	Goals	CIU	−0.02	0.03	.482
CIU	Impulse	0.04	0.03	.293	CIU	Strategies	0.04	0.04	.297	CIU	Goals	0.10	0.03	.003
Acceptance	Acceptance	0.24	0.04	<.001	Clarity	Clarity	0.27	0.05	<.001	Awareness	Awareness	0.34	0.04	<.001
CIU	CIU	0.48	0.04	<.001	CIU	CIU	0.49	0.04	<.001	CIU	CIU	0.48	0.04	<.001
Acceptance	CIU	−0.02	0.03	.465	Clarity	CIU	−0.05	0.03	.162	Awareness	CIU	0.03	0.04	.413
CIU	Acceptance	0.04	0.03	.270	CIU	Clarity	0.10	0.04	.007	CIU	Awareness	0.02	0.03	.536

Note. CIU = compulsive Internet use; DERS = Difficulties in Emotion Regulation Scale; β = standardized regression coefficient; *SE* = standard error.

CIU as an Antecedent of Emotion Regulation Difficulties

We found modest though consistent effects of CIU predicting difficulties with regulating behavior in the presence of emotions (i.e., difficulties pursuing goals in the presence of distress; Hypothesis 1). This finding lends weight to the idea that CIU inhibits self-regulatory capacities—in particular, the ability to pursue valued goals and aspirations in the presence of difficult emotions. This is consistent with previous research on the links between CIU and self-regulation (Billieux & Van Der Linden, 2012; J. Kim et al., 2009) but provides multiyear, longitudinal evidence for these effects. Further, these findings suggest that CIU has consequences for adolescent development as self-regulatory difficulties in adolescence have important longer-term consequences for mental health and social functioning (Garnefski et al., 2005).

Further, we found evidence for CIU predicting less clarity regarding emotions. This is consistent with research on other forms of addiction and alexithymia—for example, individuals with substance addictions experience difficulties identifying and labeling their emotions (Kauhanen et al., 1993; Parolin et al., 2018). Our findings suggest that CIU has similar effects, constraining individuals' capacity to clearly identify and label the emotions they are experiencing. Our findings contribute to broader research on alexithymia (e.g., Parolin et al., 2018), providing novel evidence that addiction (i.e., CIU) precedes difficulties identifying and labeling emotions.

The effect sizes of CIU preceding self-regulation toward goals and emotional clarity across a year would generally be considered to be in the small range (i.e., .10), and the policy significance of relatively small effects of CIU obtained across large samples have recently been called into question (e.g., Orben & Przybylski, 2019). However, the effects we identified were stable across all 4 years of our study. This means that if an individual is high in CIU (i.e., two standard deviations above average) in Grade 8 and continues to be at this level through to Grade 10, we would expect that person to lose 0.6 of a standard deviation in emotional clarity and distress tolerance for goals by Grade 11 (0.2 *SD* per year × 3 year lags). Thus, while a single year of CIU may not be particularly detrimental, persistent CIU across adolescence may have more substantial negative effects on these emotion regulation capacities.

Notably, we did not find evidence that CIU precedes other forms of emotional dysregulation (i.e., emotional nonacceptance, lack of awareness, impulsiveness, or difficulties identifying strategies for managing emotions). These findings suggest that CIU has moderate effects on some aspects of emotional dysregulation and not others. Specifically, our findings suggest that CIU influences more effortful and cognitively complex forms of emotion regulation (i.e., difficulties pursuing life goals and accurately understanding one's emotions), rather than regulations that are more spontaneous and closely tied to the affective experience (i.e., impulse control and emotional avoidance).

Further, in contrast to findings from longitudinal studies that CIU precedes decrements in *general* mental health (e.g., Ciarrochi et al., 2016) and well-being outcomes (e.g., Muusses et al., 2014), the present study provides insights into the *specific* types of emotion dysregulation that are longitudinally predicted by (and that predict) CIU. This, in turn, has implications for the evaluation of psychological interventions aimed at reducing CIU, highlighting the kinds of emotion regulation outcomes that are more (vs. less) likely to be impacted by CIU interventions. Our findings suggest that young people who engage in compulsive Internet use may need support with emotional labeling and persisting at goals in the presence of distress.

CIU as a Consequence of Emotion Regulation Difficulties

There is meta-analytic evidence suggesting that developing general emotion regulation skills among young people—for example, through social and emotional learning interventions—reduces maladaptive behaviors such as drug use and antisocial behaviors (Taylor et al., 2017). There is also longitudinal evidence that emotion regulation skills predict the development of social and emotional well-being (Ciarrochi et al., 2008; Rowsell et al., 2014). Based on these past findings, we anticipated that general difficulties with emotion regulation would lead to *increases* in a related maladaptive behavior, namely CIU (Hypothesis 2). We did not find evidence for this hypothesis for any of the six aspects of emotion dysregulation.

A key feature of the DERS (Gratz & Roemer, 2004) is that it is domain general. It does not refer specifically to compulsive Internet use. Future research is needed to examine whether domain-specific forms of emotion dysregulation (e.g., regulating Internet-related emotions) predict CIU over time. Alternatively, perhaps CIU is not driven by poor emotion regulation skill. It may be that CIU is driven more by contextual factors, such as access to the

Internet, access to devices, time spent alone, quality of family and peer support, and the availability of non-Internet pursuits (J. Kim et al., 2009; Yao, He, Ko, & Pang, 2014). Further research is needed to explore these possibilities.

We unexpectedly found that two aspects of dysregulation—impulse control and difficulty identifying strategies for managing emotion—predicted *less* CIU over time. This is clearly inconsistent with the consequence model we proposed in the present study. We speculate here that perhaps difficulties with impulse control and emotion regulation strategies make it less likely for a young person to be able to engage in online activity for extended times and therefore develop CIU. Past research has shown that both impulsivity and difficulty with emotion regulation strategies have negative consequences in general (Evenden, 1999; Gratz & Roemer, 2004), even if they may not lead to compulsive Internet use. Further research is needed to replicate this finding and explore the processes driving it.

Strengths and Limitations

This is the first study we are aware of to examine the longitudinal association between CIU and a range of emotion regulation difficulties. Emotion regulation skills have important consequences for adolescent development and functioning (e.g., Bradley, 2000; Cole et al., 1994; Gross, 1998), making them an important behavior to explore in the context of studying CIU among adolescents. The present study goes beyond previous longitudinal studies of CIU and general well-being (Donald et al., 2019; van der Aa et al., 2009) and mental health (Ciarrochi et al., 2016) to examine *specific* aspects of emotional dysregulation. A methodological strength of this study was the use of state-of-the-art RI-ACP structural equation modeling approaches (Hamaker et al., 2015), wherein we controlled for trait stability in CIU and DER over time and tested whether the within-person longitudinal relations between CIU and emotion regulation were consistent over time. This means we can draw relatively strong conclusions regarding the stability and causal ordering of the effects we have observed (Hamaker et al., 2015). However, this study has several limitations.

First, it is possible that additional, unmeasured variables explain the longitudinal association between CIU and DER. A strength of the RI-ACP models we used was they control for trait levels of both CIU and DER components and also control for within-person autoregressive effects over time (Hamaker et al., 2015). However, we cannot rule out the possibility that unmeasured third variables—for example, demographic factors, environmental factors such as Internet access, time spent alone, family and peer support, and genetic factors—caused the effects observed in this study. Future longitudinal research on CIU could include these additional variables and, ideally, use experimental designs to test the relations between CIU and DER.

Second, this study focused on the compulsive use of the Internet and did not explore the specific *types* of Internet activities that may be predictive of emotion regulation difficulties over time. There is evidence that gaming and social media use are the online activities most strongly associated with CIU in adolescents (Ciarrochi et al., 2016; Muusses et al., 2014). Perhaps, for example, online gaming has bigger effects on aspects of emotion regulation such as pursuing goals and impulse control than browsing the Internet for information gathering. Future research could explore these possibilities.

Third, this study focused on early to midadolescence. There is evidence that CIU begins in the preadolescent years (Lan & Lee, 2013; Vondráčková & Gabrhelík, 2016). It may be that the longitudinal relations between CIU and emotion dysregulation have been established by adolescence, explaining the relatively modest effect sizes we observed in the present study, and that effects are larger among preadolescents. Future research needs to examine the longitudinal effects of CIU and DER over a wider timespan, including among preadolescents.

Fourth, our sample of schools had a socioeconomic ranking (1,025; $SD = 43$) almost identical to the Australian average of 1,000. However, the sample was not fully representative, comprising only Australian Catholic schools and skewing toward somewhat wealthier schools.

Finally, there is a need to focus on ways to most effectively prevent CIU. Reviews of CIU interventions have proposed a range of skills to be targeted in CIU interventions, including educating adolescents' immediate social networks on the development of healthy Internet use practices, training young people in self-regulatory skills, teaching skills in coping with stress, developing face-to-face interpersonal skills, and teaching skills in managing daily routine (Vondráčková & Gabrhelík, 2016). Our findings indicate that interventions targeting CIU specifically may be more effective than training general emotion regulation skills (i.e., we did not find any evidence for the consequence model). More research is needed to understand the most effective CIU interventions, their mechanisms, and their impact on emotion regulation abilities.

Conclusions

We examined the longitudinal effects of CIU on emotion regulation during adolescence, a time of critical importance for the development of healthy emotion regulation skills. Our findings suggest that CIU precedes some aspects of emotion dysregulation (i.e., goal-directed behavior and less emotional clarity), but not others, underscoring the value of examining various components of emotion dysregulation and their relation to CIU. Conversely, we did not find evidence that emotion dysregulation precedes increases in CIU. This suggests that interventions targeting general emotion regulation skills development are unlikely to influence CIU and that either more specific emotion regulation interventions are needed or attention needs to be paid to environmental factors that might influence the development of the compulsive use of the Internet.

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Received July 17, 2019
Revision received February 5, 2020
Accepted March 8, 2020 ■