Neuroticism in the digital age: A meta-analysis

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ARTICLE INFO

Keywords: Internet activities Problematic internet activities Personality Neuroticism Meta-analysis Internet addiction Social media addiction

ABSTRACT

The pervasiveness of the Internet has raised concern about its (problematic) use and the potentially negative impact on people’s health. Neuroticism has been identified as one potential risk factor of Internet and other online addictions. To obtain a comprehensive quantitative synthesis of the association of neuroticism and both overall and problematic Internet activities, a meta-analysis was conducted according to the PRISMA guidelines. A comprehensive search was carried out in nine academic databases. After a stepwise screening procedure, 159 studies were eventually included: 104 studies in the meta-analysis on neuroticism and Internet activities and 64 studies in the meta-analysis on neuroticism and problematic Internet activities, comprising Internet, social media, Facebook, smartphone, and online gaming addiction (9 studies considered both aspects). When it comes to overall Internet activities, effect sizes were generally small and frequently non-significant, with some exceptions (e.g., expression of real me). For problematic Internet activities, a completely different picture emerged: high levels of neuroticism significantly correlated with all measures of problematic Internet activities, with medium size correlations. The differential results for Internet activities in general and problematic Internet activities can be related to problems in the conceptualization and assessment of the latter. More research is needed to overcome current conceptual and methodological issues and investigate the real nature of problematic Internet activities and to be eventually able to evaluate if neurotic people are really an at-risk population.

1. Introduction

Today, Internet pervasiveness has reached a plateau in different affluent societies, with 90% of the U.S. (Pew Research, 2019) and 89% of the European (Eurostat, 2019) population having access to it. At the same time, access rates are growing in developing countries (Pew Research, 2019). Whether through a smartphone or a personal computer, Internet access facilitates the exchange of information and interactions, for example, through social media, and it offers sources of entertainment as well as educational services. Despite benefits of the Internet such as increased social capital, peer and family connection, improved self-expression and self-identity all associated with social media use (Bolton et al., 2013), as well as increased civic engagement related to news media consumption (Pasek, Kenski, Romer, & Jamieson, 2006), adverse outcomes have received far more attention in the scientific and public debate. In particular, the Internet and its problematic or excessive use have been blamed for negatively affecting physical, mental, and psychosocial functioning, especially in younger generations (Ko, Yen, Chen, & Chen, 2012).

Given the worrisome evidence on the detrimental effects of problematic Internet use, scholars have invested their efforts in identifying potential risk factors not only attributable to the Internet but also the users. Neuroticism has been identified as a particularly significant risk factor. Since neurotic people often experience negative feelings and engage in maladaptive coping strategies during stressful situations (Carver & Connor-Smith, 2010), they can be more at risk of using the Internet in an unhealthy way (Hamburger & Ben-Artzi, 2006; Hardie & Tee, 2007). The considerable number of studies on neuroticism and (problematic) Internet use calls for a comprehensive, quantitative synthesis of the empirical findings to provide evidence on the link between the two. Hence, this study aimed to fill the gap by summarizing the existing literature on neuroticism and (problematic) online media activities, using a meta-analytic approach. More precisely, this meta-analysis synthesized 159 studies investigating neuroticism, Internet activities, and problematic or addictive Internet activities. As such, it is an extension of previous syntheses of a much smaller number of studies (e.g., Kayis et al., 2016). Results underline that neurotic persons, although not engaging with the online world extensively, are more likely to show signs of problematic online activities, including Internet, social media, Facebook, smartphone, and online gaming addiction. This poses

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https://doi.org/10.1016/j.chbr.2020.100026
Received 5 February 2020; Received in revised form 25 June 2020; Accepted 4 July 2020
Available online xxxx

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questions on whether problematic online activities actually trigger addictive behaviors or behavioral problems which the person already experienced in other (offline) settings. Methodological and conceptual consideration of neuroticism and problematic online activities are further addressed.

2. Literature review

2.1. Internet activities and Problematic Internet activities

While the concept of Internet use is rather well-defined and generally includes the duration and frequency of the use of the Internet in general, or specific contents and services, there has been a growing and still unsolved debate about what constitutes problematic Internet use, also called “Internet addiction” (Block, 2008; Shaw & Black, 2008). The lack of consensus on the concept— and the terminology used to describe it— may be one of the reasons why Internet addiction has not (yet) been inserted in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5, American Psychiatric Association, 2013) (Block, 2008; Pies, 2009), although Internet gaming disorder is now listed in the third section of the DSM-5 and the diagnosis of Gaming Disorder has been recently introduced in the 11th revision of the International Classification of Diseases (ICD-11) (World Health Organization, 2018). However, different terminologies such as “addictive”, “pathological”, “problematic”, “excessive” or “compulsive” Internet use reflect the unsolved debate about the existence of a well-defined and widely acknowledged Internet addiction or Internet disorder (Shaw & Black, 2008). Thus, the reader will find the different terminologies used interchangeably during the remainder of this meta-analysis to refer to the same concept as described hereafter.

Both the DSM-5 and the ICD-11 describe “addictive use” as a pattern of repetitive behaviors, which can also be applied to characterize Internet addiction and other, more specific forms such as social media addiction. Internet addiction involves (i) a lot of time thinking about Internet-related activities, even when not used (cognitive salience); (ii) experiences of irritability and depressed mood related to not being online (withdrawal); (iii) more time online than before to obtain the same gratification(s) (tolerance); (iv) difficulties in regulating the time spent on Internet activities (regulation problems), and (v) decreased time dedicated to other hobbies and friends. Furthermore, symptoms are (vi) persistent Internet use despite negative consequences at work, school, or in the private sphere (consistent use) up to the point where (vii) the time spent in online activities is hidden from others. In addition, symptoms of Internet addiction include (viii) positive mood when being online, while the mood changes to negative during offline periods (mood regulation), which leads to (ix) a strong desire to engage in such activities (craving) despite (x) interpersonal problems (e.g., with family members or friends, at work or school) due to excessive use (Black, Belsare, & Schlosser, 1999; Jo et al., 2019; Shapira et al., 2003; Shaw & Black, 2008).

However, scholars have progressively questioned the concept of Internet addiction, with critics targeting the lack of focus on specific problematic online behaviors (Starevic & Aboujaoude, 2016), the confusion between addiction to the Internet versus addiction on the Internet (Griffiths & Szabo, 2014), the challenge in delimiting excessive use as people are increasingly always online (Starevic & Aboujaoude, 2016), and the problematic separation between the Internet and the device enabling access to it (e.g., smartphones, computer, tablets, applications). Further critics target the tricky differentiation between proximal causes of Internet addiction, among others, anxiety and depressive symptomatology, and the addiction itself (Aboujaoude, 2010). Additionally, in accordance to the criteria identified to detect behavioral addictions, it seems that any online behavior, if carried out excessively, can be described as problematic, or even pathological (Mihordin, 2012). Indeed, the risk to categorized any exaggerated attachment to the device as addictive is to neglect the pivotal psycho-cognitive processes including motivations, cognitions, and feelings that led and sustained the dysfunctional conduct (Billieux, Schimmert, Khazaal, Maourage, & Heeren, 2015). Such shortcomings lead to the lack of agreement upon proposed terminologies and assessments of problematic Internet use or Internet addiction, and the absence of a recognised definition of what constitutes Internet-related psychopathology (Aboujaoude, 2017). Hence, although recent studies and revisions tried to disentangle different components of Internet (and other media) addiction, a solution has not yet been found.

2.2. Personality and (problematic) internet activities

As stated by the Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2019; Brand Young, Laiier, Wolffing, and Potenza, 2016), different factors contribute to the development and maintenance of specific Internet-use disorders. In particular, a person’s characteristics (including bio-psychological factors, cognition, personality, existing psychopathology, and motives for media use) determine the actual situation of a person, which can lead to using the Internet in a certain way. The resulting Internet usage, in turn, elicits cognitive and affective responses related to the gratifications obtained, which fosters its subsequent use. The stabilization of Internet use can diminish the person’s control of its use over time, leading to negative consequences in daily life, which depend on the person’s predispositions. Hence, one of the crucial points to focus on when explaining (problematic) Internet use are predisposing factors.

Among these factors, previous studies concentrated on a person’s personality, trying to explain if and how personality traits are related to specific Internet use as well as problematic use. Using the Five-Factor Model of personality traits as the main framework, previous reviews and meta-analyses synthesized the relationship between neuroticism (or emotional instability), extraversion, openness to experience, agreeableness, and conscientiousness (Goldberg, 1990), and problematic Internet use (de Francisco Carvalho, Sette, & Ferrari, 2018; Kayis et al., 2016; Liu & Campbell, 2017; Twomey & O’Reilly, 2017), three reviews aimed to infer personality from digital footprints (Azuar, Marengo, & Settanni, 2018; de Francisco Carvalho & Pianowski, 2017; Tkshay & Rule, 2014), and one focused on gaming disorder (Salvarli & Griffiths, 2019). These reviews and meta-analyses come to similar conclusions. For example, based on twelve studies, Kayis et al. (2016) reported correlational effect sizes between Internet addiction and the Big Five personality traits and showed that neuroticism was the only trait that was positively related to Internet addiction. Another meta-analysis, based on four studies, focused on problematic smartphone use and reported that it was associated with neuroticism and impulsivity (de Francisco Carvalho et al., 2018). With respect to general (non-addictive) media activities, only one meta-analysis (Liu & Campbell, 2017) explored social media-related activities and personality. Based on 33 studies, the authors found that extraversion and openness were the strongest predictors of Social Network Site (SNS) activities (e.g. SNS gaming, SNS interactions, posting photos, number of friends, information seeking, and status update), whereas agreeableness and conscientiousness showed few significant correlations with social media use, and neuroticism correlated only with global social media use. They concluded that “researchers might want to focus at an even narrower level than the Big Five traits by looking at aspects or facets” (Liu & Campbell, 2017, p. 237).

2.3. Neuroticism and (problematic) internet activities

Given the results of past reviews and their recommendations for future research, we decided to focus on neuroticism as a personality trait that was not only found to be most frequently related to problematic Internet (or media) use but also relevant from a public health perspective (Lahey, 2009). Neurotic individuals tend to experience negative emotional responses to challenges (McCrae & Costa, 2003), and they are often self-critical and sensitive to the criticisms of others, which foster the perception of feeling inadequate (Watson, Clark, & Harkness, 1994). In
general, core aspects of neurotic people involve negative affectivity (i.e., the inclination to experience negative emotions), cognitive dispositions (e.g., ruminative thoughts), abnormal reactivity to stress (e.g., psychophysiological anxiety or distress), and behavioral or interpersonal problems (e.g., recklessness or hostility) (Kirkegaard Thomsen, 2006; Suls & Martin, 2005; Widiger, 2017). Growing evidence posits neuroticism as a psychological trait of profound public health significance (Friedman, 2019; Jeronimus, Kotov, Riese, & Ormel, 2016; Lahey, 2009; Ormel et al., 2013). In fact, neuroticism correlates with and predicts many distinct mental and physical disorders, including anxiety, mood, and substance use disorders, as well as comorbidity among them and frequent use of health services. High levels of neuroticism increase the risk of having the most impairing and expensive mental health problems (Lahey, 2009). Neuroticism is also a reliable predictor of the quality of life and longevity (Friedman, 2019), and a large amount of research (e.g., Jeronimus, 2015; Ormel et al., 2013; Shackman et al., 2016; Van Os, Park, & Jones, 2001; Vink et al., 2009) hints towards a theoretical explanation called “the vulnerability model”, stating that neuroticism promotes processes that lead to common mental disorders (CMDs). More precisely, high levels of neuroticism may lead to the development of CMDs both directly and indirectly by increasing the negative impact of risk factors such as stressful life events through cognitive processes such as the negativity bias in attention, interpretation and recall of information, and emotional processes such as increased reactivity and ineffective coping (Ormel et al., 2013). Additionally, genetic overlaps have been found for mood disorders and associated symptomatologies and neuroticism, i.e., some genetic variants influence both (De Moor et al., 2015).

Hence, understanding if and how neuroticism is associated with Internet use and – more importantly – problematic Internet activities or addictions is today mandatory. However, a comprehensive quantitative synthesis of the existing literature on neuroticism and (problematic or addictive) Internet use is still missing. The present study aims to understand better how neurotic people interact with the Internet, i.e., if they tend to use it in a specific way, and to which extent they are addicted to it. For that purpose, we carried out a comprehensive meta-analysis, including 159 studies on the relationship between neuroticism, Internet activities, and problematic Internet activities. To our knowledge, this up-to-date meta-analysis is the first that aimed to comprehensively understand the relation between these concepts and, in doing so, it comprises far more studies than previous meta-analyses. In addition, with respect to previous works, it distinguishes between Internet use (overall and specific activities such as social networking) and problematic Internet use, and it discusses differential relationships between these two and neuroticism.

3. Methods

The meta-analysis was conducted according to the PRISMA guidelines (Shamseer et al., 2015), which provide a practical guide on how high-quality systematic reviews and meta-analyses should be carried out, including instructions for each step (e.g., rationale and objectives, search strategy, eligibility criteria, studies selection, data collection, risk of bias assessment, and synthesis and discussion of results).

3.1. Search strategy and study selection

The research was carried out on February 7th, 2019 in titles of articles listed in the following nine academic databases: Communication and Mass Media Complete, Psychology and Behavioral Sciences Collection, PsycINFO, PsychARTICLES, and GINAHL (all via EBSCOhost), ERIC and ProQuest Sociology (both via ProQuest), Medline (via ProQuest, ISI Web of Knowledge, and PubMed), and Web of Science. The search terms used to identify eligible articles are reported in Table 1.

We imported all entries in Zotero to exclude any duplicates. Next, two authors [L.M. and AL. C.] screened all titles and abstracts according to predefined eligibility criteria and downloaded the full text of the retained studies. We calculated Cohen’s kappa statistic (McHugh, 2012) as a measure of inter-coder reliability. Discrepancies after full-text screening were resolved through a consensus meeting with the third author.

3.2. Inclusion and exclusion criteria

We included studies: (i) written in English, (ii) with a measure of neuroticism (or emotional instability), (iii) published in a peer-reviewed journal, (iv) with a measure of general Internet activities (including online gaming) or a measure of problematic Internet use or online addiction, and (v) with a result convertible into an effect size. Studies reporting information on consumer behavior, branding, shopping, learning, multitasking, job contents, marketing, advertisement, cyberbullying, validation, political contents, dating, sexting, therapies/counselling, substance use, or digital footprint were excluded. Reviews, conference papers, book chapters, and studies with an experimental or an intervention design as well as studies that used the construct of anxiety as a proxy of neuroticism were also excluded. We included thesis dissertations when available online.

3.3. Data extraction and preparation

For each study that met the inclusion criteria, we collected information on the following aspects: the country where the study was conducted, study design (longitudinal or cross-sectional), sample size, gender (% of male) and age of participants, type of recruitment (online vs other), type of sampling procedure (random vs not), theoretical background (if reported), the personality scale used to measure neuroticism, and the type of online (addictive) activity with its relative measurement. Once we obtained a list with all the included studies, we grouped the final results into two sections, summarizing conceptually comparable Internet use behaviors into the same category: (i) general Internet use (including online gaming) and (ii) addictive Internet use. A summary of all the extracted information for each retained study can be found in Appendix A.

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negative affect OR negative affectivity OR detachment OR introvert* OR neurotic* OR negative emotional* OR emotional liability OR emotional instability OR emotional stability OR trait anxiety OR personality OR irritability OR big five OR five factor model OR FFM OR big5 OR big 5 OR IPPOR TFIP OR irritability OR PID-5* OR PID-5-IF OR DSM-5 OR MMQ OR MPI OR EPI OR EPQ OR NEO-PI*
3.4. Methodological quality assessment

To assess the methodological quality of each study, we considered: (i) the form of data collection (1 = online, 0 = offline), (ii) the number of items used to measure neuroticism, (iii) the presence of a reliability check for multiple-item measures of neuroticism (1 = present, 0 = absent), NA = not applicable due to single-item measures, and (iv) the information source for the Internet activity measure (i.e., 0 = self-reported, 1 = recorded from the web).

3.5. Meta-analytic procedure

The meta-analysis was carried out using the “esc” (Lädecke, 2018), the “meta” (Schwarzer, Carpenter, & Rücker, 2015), and the “metaphor” (Viechtbauer, 2010) packages in R statistical software. We used Fisher’s r-to-z transformation as a measure of effect size, with results converted back to r correlation coefficient for easier interpretation. We implied different conversion formulas (Bonett, 2007; Peterson & Brown, 2005; Wan, Wang, Liu, & Tong, 2014) to convert raw data into the final effect size. We carried out several meta-analyses, one for each different Internet-related activities. We interpreted the pooled effect according to Cohen (1988), with r = 0.10 as a small, r = 0.30 as a medium, and r = 0.50 as a large effect size. To control for possible study diversities, we used the inverse-variance method with a random-effects model and Hartung-Knapp-Sidik-Jonkman adjustment (IntHout, Ioannidis, & Rothstein, 2010; Higgins, Thompson, Deeks, & Altman, 2003; Ried, 2006). According to the suggestions by Higgins et al. (2003), we interpreted the I² level as low (25%), moderate (50%), and high (75%). Potential publication biases were assessed via Egger’s regression test for funnel plot asymmetry (Egger, Smith, Schneider, & Minder, 1997). Finally, influence analyses (using the leaving-one-out method) and meta-regressions (with bubble plots) were carried out to investigate heterogeneity in the effect size. In meta-regression analyses, we included as predictors the proportion (in %) of male participants and the mean age. We employed meta-regressions only for meta-analyses with a sufficient number of studies, which is preferably ten (Higgins & Green, 2008).

4. Results

The initial research produced 4238 entries, which resulted in 2095 after duplicates were removed. A first title and abstract screening led to the exclusion of publications on neuroticism and consumer behavior (n = 89), learning (n = 40), digital footprint (n = 30), political content consumption (n = 13), bullying and dating (n = 9 and n = 7 respectively) as well as reviews (n = 17) and conference papers (n = 15). Additional 1533 publications were removed as they were out of topic (i.e., they did not include a measure of neuroticism and/or (addictive) Internet use). Full texts of the retained studies (n = 386) were then screened by two authors. At this stage, publications were excluded because they did not include a measure of the constructs of interest or they did not provide raw data to calculate the effect size (n = 160), because full texts were not available or they were books chapters, poster, or other duplicates (n = 62), or because they included clinical samples (n = 5). The remaining 159 articles were eventually included in the meta-analysis and divided into two main categories reflecting conceptually comparable Internet activities. In particular, 104 studies were included in the meta-analysis on general Internet activities (including online gaming), and 64 studies were included in the meta-analysis on problematic Internet activities and specific sub-categories (i.e., Internet, social media, Facebook, smartphone, and online gaming addiction). Some studies were included in both subcategories because they considered general and addictive use. Cohen’s kappa for the title and abstract screening for each category was 0.708 for general Internet activities (including social media activities), 0.739 for online gaming, and 0.836 for problematic Internet activities, reflecting a substantial agreement between the coders (McHugh, 2012). A comprehensive description of the screening process, with reasons for publication exclusion, is reported in the PRISMA flow-chart (Fig. 1).

4.1. Study description

Of the 159 included studies, only two studies, both conducted in China and focusing on Internet addiction, applied a longitudinal design (Dong, Wang, Yang, & Zhou, 2012; Zhou et al., 2018), whereas all the others (n = 157) used a cross-sectional design. The majority of the studies were published in peer-reviewed journals, and seven were dissertation theses. Studies were conducted in North America, including the U.S. (n = 35) and Canada (n = 5); Europe (n = 46), including Germany (n = 10), United Kingdom (n = 8), Poland (n = 7), and Italy (n = 6); Asia and Oceania (n = 41), including Australia (n = 6), China (n = 15), Korea (n = 9) and Taiwan (n = 3); and the Middle East (n = 25), including Turkey (n = 14) and Israel (n = 6). One cross-sectional study investigated inter-cultural differences by using samples from different countries, including China, Greece, Israel, Italy, Poland, Romania, Turkey and the U.S. (Blachnio & Przepiórka, 2016). Sample sizes ranged from n = 40 participants (Amichai-Hamburger, Wainapel, & Fox, 2002) to n = 21’314 (Gil de Zúñiga, Diehl, Huber, & Liu, 2017), with a median of n = 460. Sixty-six studies recruited participants via online platforms, of which six relied on single platforms such as Qualtrics or Amazon Mechanical Turk (MTurk) to collect data. Only twenty-two studies used a random or stratified sampling approach, and seventy-one implied a convenience sample, mostly university students. The remaining 66 studies did not specify the type of recruitment procedure.

Regarding the sample characteristics, the median percentage of male participants was 44%, ranging from 0% (Ezeo et al., 2009; Kakaraki, Tselios, & Katsanos, 2017; Molavi & Pashaei, 2012) to 97% (Nithya & Julias, 2007). The median age across all studies was 21.5 years (range from 13 to 52 years). The majority of the studies included samples with young adults (69% with an age range from 18 to 35 years). Fifteen studies used an underage population (median = 15.5). A summary of the characteristics of all the included studies is reported in Table 3 (Appendix A) and Figs. 2–6 (Appendix B).

4.2. Measures of neuroticism

Neuroticism was labelled in different ways, however, the majority of the studies (n = 113) referred to the construct of “Neuroticism”, whereas forty-one studies labelled it as “Emotional Stability or Emotionality”, and five studies used the updated construct of “Negative Affectivity” as part of the new dimensional personality model proposed by the DSM-5 (American Psychiatric Association, 2013). Table 5 (Appendix B) presents an overview of the measures utilised in the included studies, including the number of items used to assess neuroticism. In general, the following scales were applied the most: the Big-Five Inventory (BFI, John & Srivastava, 1999; n = 41 studies), including the 10-item version BFI-10 (Rammstedt & John, 2007; n = 18 studies), the Ten-Items Personality Inventory (TIPI) (Gosling, Rentfrow, & Swann, 2005; n = 21 studies), the Revised NEO Personality Inventory (Costa & McCrae, 2008; n = 19), the Eysenck Personality Questionnaire (Bodling & Martin, 2011; n = 16), and the International Personality Item Pool (IPIP, Goldberg et al., 2006; n = 16). The utilised scales included a different number of items to measure neuroticism, ranging from two (of the BFI-10 and the TIPI) to 48 items (of the NEO PI-R and the Big-Five adjectives), however, studies usually employed a ten-item scale, and 121 studies calculated a measure of internal consistency.
4.3. Measures of internet activities

Internet activities were measured in different ways, however, the majority of the studies focused on general Internet use (n = 26). In particular, they assessed the frequency of Internet use, the familiarity with the Internet and the computer in general, as well as the use of the Internet for information seeking, entertainment, and leisure activities. The majority of the studies also reported information on online activities through social media (n = 53). To note, thirty-three studies were on Facebook use, and only a minority was focused on other social media platforms, such as Instagram, Pinterest, Twitter, Renren, and Yik Yak. Usually, social media use was investigated not only in terms of having a social media account, frequency of usage, and number of friends, but also in terms of different activities. For example, some studies focused on passive social media use, including information-seeking behaviors and receiving feedback, and others on active social media use, including self-disclosure (in terms of expression of real, hidden, and ideal me) and social media use for communication. Some studies reported information on taking selfies, and others investigated “faux pas” behaviors, i.e. the use of social media to publish compromising material about the self. Eleven studies focused on specific activities of mobile phone use and app usage. To note, one study (Stachl et al., 2017) collected information on app usage directly from the Android phone of participants. Whereas the majority of the included studies used self-reports to collect information on media use, seven studies scraped the data directly from the social media profiles of their participants, collecting information about the number of friends, likes, posts, selfies about the participants’ profiles. Concerning gaming behaviors, although a lot of the studies reported results on the frequency of online gaming activities, some were also focused on engagement in continuing to play, frequency of violent video gaming, teamwork and socialisation on gaming platforms, and engagement in creative tasks.

4.4. Measures of Problematic Internet activities

Problematic Internet use and equivalent concepts, such as Internet addiction, social media addiction (including Facebook and Instagram addiction), and, finally, smartphone addiction, were assessed with 38 different scales. The Internet Addiction Test (Young, 1998) was the most commonly used (n = 23), and items from this scale were adapted in other studies to measure Instagram and smartphone addiction or compulsive use, problematic SNS use, and compulsive smartphone use. The Online Cognition Scale by Davis, Flett, and Besser (2002) and the Chen Internet Addiction Scale (Chen, Weng, Su, Wu, & Yang, 2003) were utilised to assess Internet addiction and problematic Internet use. Furthermore, the Bergen Social Media Addiction Scale (Andreassen, Torsheim, Brunborg, & Pallesen, 2012), including the dimensions of salience, tolerance, mood modification, conflict, relapse, and withdrawal, was adopted to measure social media and Facebook addictive behaviors. Facebook addiction was also measured with the Problematic Facebook Use Scale, adapted from the Generalized Problematic Internet Use Scale 2 – GPIUS-2 (Caplan, 2010), which addresses the core dimensions of the Cognitive-Behavioral Theory (i.e. online interaction, mood regulation, cognitive preoccupation, compulsive use and adverse outcomes). Finally, the Smartphone Addiction Scale (Kwon et al., 2013) was the most frequently scale utilised to measure problematic smartphone use. Concerning online gaming, ten studies focused on online gaming addiction, which was measured, among others, with the Game Addiction Scale (Lemmens, Valkenburg, & Peter, 2009) and the Assessment of Internet and Computer Game Addiction (AICA-S- gaming) (Wölfing, Müller, & Beutel, 2011), an adapted gaming version of the Generalized Problematic Internet Use Scale (Caplan, 2002) (for an overview of all measures see Appendix A; Table 4).
4.6. Theoretical frameworks

Of the 159 included studies, only 9.4% (n = 15) adopted a theoretical framework. The Interaction of Person-Affect-Cognition-Execution (I-PACE) model and the Uses and Gratification Theory were used more than once (Kircaburun, Alhabash, Tosuntaş, & Griffiths, 2018; Kircaburun & Griffiths, 2018; Laier, Wegmann, & Brand, 2018; Wolniewicz, Tamiyiu, Weeks, & Elhai, 2018). The I-PACE model is one of the most recent attempts to explain specific Internet-use disorders (Brand, Young, Laier, Wölfing, & Potenza, 2016). As described in the introduction of this meta-analysis, the I-PACE model aims to give a comprehensive view of the dynamics of the addiction process. On the other side, the Uses and Gratification Theory (UGT; Katz, Blumler, & Gurevitch, 1973) focuses on users’ motivations for and gratifications obtained from specific media use. According to the theory, these two elements influence the selection, the frequency, and the intensity of media use (Kircaburun, Alhabash, Tosuntaş, & Griffiths, 2018). Table 6 (Appendix B) reports a list of all the theories used.

4.6. Meta-analysis

All the meta-analytic results are summarized in Table 2, and Forest plots are reported in Appendix C.

4.6.1. Meta-analytic results for internet activities

Seventy-nine studies were included in the meta-analysis on Internet activities. Overall, no significant results were found between neuroticism and Internet/computer familiarity, Internet frequency, and online information seeking, whereas neuroticism significantly correlated with the frequency of online leisure activities (n = 8, r = 0.040, 95% CI [0.004-0.075], p = .033, I² = 51%, total sample = 18,611), e.g., entertainment contents, including music, videos, and images. With respect to social media use, no significant relationship was found between neuroticism and social media membership, number of friends, and feeds received. However, neuroticism was positively related to the frequency of social media use (n = 25, r = 0.090, 95% CI [0.049-0.131], p < .001, I² = 87%, total sample = 28,000). Interestingly, neurotic people seem to use social media more for self-disclosure than for communicative purposes. In fact, we found a significant relation with social media disclosure (n = 22, r = 0.071, 95% CI [0.016-0.125], p = .013, I² = 76%, total sample = 9130), expression of the real me (n = 6, r = 0.201, 95% CI [0.024-0.365], p = .033, I² = 82%, total sample = 1633), and a marginally significant relation, probably due to the low number of studies, with the expression of the ideal me (n = 4, r = 0.099, 95% CI [-0.01-0.205], p = .062, I² = 53%, total sample = 2190). We did not find any relationships between neuroticism and the use of social media for communication (n = 18, r = 0.003, 95% CI [-0.037-0.043], p = .870, I² = 55%, total sample = 7965). Neurotic people seem to use social media in a more passive way, as reflected by the significant relation with passive social media use (n = 11, r = 0.055, 95% CI [0.009-0.101], p = .024, I² = 55%, total sample = 6426). Eventually, no significant relationships were found between neuroticism and posting selfies, “faux pas” behaviors (i.e., posting personal compromising material), and expression of the hidden me. With regards to different online gaming activities, we did not find any significant relationships with neuroticism.

4.6.2. Meta-analytic results for Problematic Internet activities

Sixty-four studies provided effects sizes for the relationship between neuroticism and problematic Internet use and other online addiction measures (62 cross-sectional and 2 longitudinal). Meta-analytic results showed that neuroticism significantly correlated with all online addiction measures. In particular, neuroticism was found to be significantly positively related to problematic Internet use, with a small-to-medium effect size (n = 34, r = 0.249, 95% CI [0.201, 0.296], p < .001,

### Table 2: Meta-analytic results.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>N</th>
<th>k</th>
<th>r</th>
<th>CI</th>
<th>Q</th>
<th>I²</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internet activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer familiarity</td>
<td>587</td>
<td>3</td>
<td>0.1165</td>
<td>[-0.024, .432]</td>
<td>5.42</td>
<td>63%</td>
</tr>
<tr>
<td>Internet frequency</td>
<td>12,273</td>
<td>11</td>
<td>0.0970</td>
<td>[0.0570, 0.137]</td>
<td>322.97**</td>
<td>97%</td>
</tr>
<tr>
<td>Online information seeking</td>
<td>21,266</td>
<td>10</td>
<td>-0.09</td>
<td>[-0.073, -0.056]</td>
<td>114.64**</td>
<td>92%</td>
</tr>
<tr>
<td>Online leisure activities</td>
<td>18,611</td>
<td>8</td>
<td>0.040*</td>
<td>[0.004, 0.075]</td>
<td>14.42*</td>
<td>51%</td>
</tr>
<tr>
<td><strong>Online gaming</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaming frequency</td>
<td>28,675</td>
<td>10</td>
<td>0.04</td>
<td>[-0.095, 0.095]</td>
<td>4.62**</td>
<td>94%</td>
</tr>
<tr>
<td>Online gaming onset</td>
<td>21,935</td>
<td>3</td>
<td>0.00</td>
<td>[-0.225, 0.226]</td>
<td>38.10**</td>
<td>95%</td>
</tr>
<tr>
<td>Online gaming engagement</td>
<td>2798</td>
<td>3</td>
<td>0.023</td>
<td>[-0.184, 0.229]</td>
<td>6.51</td>
<td>69%</td>
</tr>
<tr>
<td>Online gaming teamwork</td>
<td>509</td>
<td>-0.09</td>
<td>[-0.436, 0.318]</td>
<td>7.39*</td>
<td>73%</td>
<td></td>
</tr>
<tr>
<td>Violent online gaming</td>
<td>763</td>
<td>-0.11</td>
<td>[-0.504, 0.315]</td>
<td>16.11**</td>
<td>88%</td>
<td></td>
</tr>
<tr>
<td>Creative online gaming</td>
<td>417</td>
<td>2</td>
<td>0.140</td>
<td>[-0.734, -0.839]</td>
<td>2.95</td>
<td>66%</td>
</tr>
<tr>
<td><strong>Social media activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social media membership</td>
<td>10,156</td>
<td>5</td>
<td>-0.076</td>
<td>[-0.341, 0.187]</td>
<td>581.18**</td>
<td>99%</td>
</tr>
<tr>
<td>Friends on social media</td>
<td>6998</td>
<td>10</td>
<td>0.025</td>
<td>[0.032, 0.082]</td>
<td>50.52**</td>
<td>82%</td>
</tr>
<tr>
<td>Social media frequency</td>
<td>28,000</td>
<td>25</td>
<td>0.090</td>
<td>[0.049, 0.013]</td>
<td>217.71**</td>
<td>87%</td>
</tr>
<tr>
<td>Expression of real me</td>
<td>1633</td>
<td>6</td>
<td>0.201</td>
<td>[0.024, 0.365]</td>
<td>27.75**</td>
<td>82%</td>
</tr>
<tr>
<td>Expression of hidden me</td>
<td>743</td>
<td>0.219</td>
<td>[0.120, 0.513]</td>
<td>6.84*</td>
<td>76%</td>
<td></td>
</tr>
<tr>
<td>Expression of ideal me</td>
<td>2190</td>
<td>4</td>
<td>0.099</td>
<td>[-0.10; 0.205]</td>
<td>6.37</td>
<td>53%</td>
</tr>
<tr>
<td>Receiving feedbacks</td>
<td>1684</td>
<td>3</td>
<td>0.017</td>
<td>[0.321, 0.351]</td>
<td>17.50**</td>
<td>89%</td>
</tr>
<tr>
<td>Disclosure on social media</td>
<td>9130</td>
<td>22</td>
<td>0.071</td>
<td>[0.016; 0.125]</td>
<td>86.22**</td>
<td>76%</td>
</tr>
<tr>
<td>Social media passive use</td>
<td>6426</td>
<td>11</td>
<td>0.055</td>
<td>[-0.009; 0.101]</td>
<td>22.42*</td>
<td>55%</td>
</tr>
<tr>
<td>Communication on social media</td>
<td>7965</td>
<td>18</td>
<td>0.003</td>
<td>[-0.037, 0.043]</td>
<td>37.47**</td>
<td>55%</td>
</tr>
<tr>
<td>Doing selfies</td>
<td>2031</td>
<td>4</td>
<td>0.038</td>
<td>[-0.121, 0.194]</td>
<td>12.33**</td>
<td>76%</td>
</tr>
<tr>
<td>Faux pas on social media</td>
<td>1275</td>
<td>3</td>
<td>0.073</td>
<td>[-0.189, -0.325]</td>
<td>5.16</td>
<td>61%</td>
</tr>
<tr>
<td><strong>Problematic Internet activities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet addiction</td>
<td>29,637</td>
<td>34</td>
<td>0.249</td>
<td>[.201, .296]</td>
<td>410.39**</td>
<td>92%</td>
</tr>
<tr>
<td>Social media addiction</td>
<td>5949</td>
<td>12</td>
<td>0.277</td>
<td>[1.182, 1.368]</td>
<td>94.70**</td>
<td>88%</td>
</tr>
<tr>
<td>Facebook addiction</td>
<td>9673</td>
<td>9</td>
<td>0.154</td>
<td>[.005, 0.296]</td>
<td>246.28*</td>
<td>97%</td>
</tr>
<tr>
<td>Smartphone addiction</td>
<td>5552</td>
<td>12</td>
<td>0.296</td>
<td>[.224, 0.312]</td>
<td>30.16**</td>
<td>84%</td>
</tr>
<tr>
<td>Online gaming addiction</td>
<td>4935</td>
<td>10</td>
<td>0.180</td>
<td>[.080, .276]</td>
<td>68.98**</td>
<td>87%</td>
</tr>
<tr>
<td>Longitudinal correlations</td>
<td>3384</td>
<td>2</td>
<td>0.217</td>
<td>[-0.055, .459]</td>
<td>1.38</td>
<td>28%</td>
</tr>
</tbody>
</table>

Legend: **p < .01, *p < .05, p < .1. IA = Internet Addiction.

I² = 92%, total sample = 29,637. In a similar way, neuroticism positively and significantly correlates with social media addiction (n = 12, r = 0.277, 95% CI [0.182, 0.368], p < .001, I² = 88%, total sample = 5949), Facebook addiction (n = 8, r = 0.217, 95% CI [0.161, 0.271], p < .001, I² = 75%, total sample = 8779), and smartphone...
addiction (n = 12, r = 0.269, 95% CI [0.224, 0.312], p = .001, \( I^2 = 64\% \), total sample = 5552). Additionally, two studies investigated how neuroticism at Time 1 predicted Internet addiction at Time 2. The meta-analytic results showed a medium positive but only marginally significant correlation (r = 0.217, 95% CI [-0.055, 0.459], p = .062, \( I^2 = 28\% \), total sample = 3384), probably because the analysis was underpowered. Finally, neuroticism significantly correlates with online gaming addiction (n = 10, r = 0.180, 95% CI [0.080-0.276], p = .003, \( I^2 = 87\% \), total sample = 4935).

4.6.3. Publication bias analyses

For each meta-analysis, the Egger's regression test for funnel plot asymmetry was run to identify the presence of possible publication biases. Non-symmetrical patterns were found only in the funnel plot (see sample of physical disorders, as well as predicting the comorbidity among them problems (Kirkegaard Thomsen, 2006; Suls
frequent experience of negative emotions and inadequate coping strate-

4.6.4. Meta-regression analyses

In order to explain the heterogeneity in our meta-analytical results, meta-regression analyses were performed to investigate if and how gender and age influenced the pooled effect sizes. Results showed a very small effect of age in the meta-analysis on neuroticism and online leisure activities (β = 0.0042, p = .05). Furthermore, age negatively impacted the effect size of the meta-analysis on neuroticism and problematic Internet use (β = –0.0134, p = .001), indicating that, in studies with older participants, the effect size was weaker. Additionally, the percentage of males had a significant effect on the final effect size in the meta-analysis on neuroticism and online gaming addiction (β = 0.0067, p = .039), indicating that studies with a larger share of male participants showed larger effect sizes. None of the other analyses revealed any significant results. The results of significant meta-regressions are displayed in the bubble plots (see Appendix C).

5. Discussion

The pervasiveness of the Internet has raised concern about its po-
tential detrimental effects, including problematic Internet use and associated physical, mental, and psychosocial malfunctioning, especially among younger generations (Caplan & High, 2007, pp. 35–53; Gross, Juvonen, & Gable, 2002; Ko et al., 2012). As theorised in the comprehensive I-PACE model (Brand et al., 2016; 2019), personality traits are among the predisposing factors of (specific) Internet use as well as addictive online behaviors (Kuss & Griffiths, 2011). Using the Five-Factor Model of personality traits, including neuroticism or emotional insta-

5.1. Are neurotic people really addicted to the internet?

Given the different pictures for Internet use and problematic Internet use, these results need further discussion. Since we found no or very small significant effect sizes for non-addictive Internet use, it is hard to uphold that neurotic people are addicted to the Internet because they use it more frequently (up to excessively) or because they spend a lot of time engaging in specific online activities (e.g., frequent social media use). In other words, if neurotic people show significant symptoms of Internet, smartphone, social media, and online gaming addiction, they do not show a particular pattern of increased usage related to these different online activities. Instead, it seems that measures of problematic or addictive Internet use point towards dysfunctional aspects of a person's character and behaviors, i.e. by picking up emotional and interpersonal problems, which are frequently experienced by neurotic people. In this case, we already know that neurotic people show these problems in other situations of their everyday life (Suls & Martin, 2005) and Internet use may constitute a helpful, but also maladaptive, coping strategy for already existing problems. Thus, emotional and interpersonal problems used to operationalize Internet addictions (e.g., items focusing on ‘feeling anxious or fretful without access to the Internet’, or ‘having a hard time doing work or studying due to media use’) are not (at least in their totality) a consequence of problematic Internet use. The fact that functional impairment or distress, persistent over time, should be a direct consequence of the behavioral addictive conduct leaves unclear what the real relationship between neuroticism and problematic Internet use is. In fact, according to a recent definition of behavioral addiction (Karde-
felt-Winther et al., 2017), such forms of addictive behaviors should not
be a direct consequence of an underlying disorder nor the result of a coping strategy.

5.2. The challenge of conceptualizing Problematic Internet activities

One possibility to explain the different results for Internet activities and problematic Internet activities and neuroticism is to look at the conceptualization and measurement of the concepts. Conceptualizations and, consequently, measures of Internet-related addictions tend to be too general and superficial, leading to an over-estimation of problems related to problematic Internet use as well as an over-pathologising of daily life activities (Billieux et al., 2015; Kardefelt-Winther et al., 2017). In addition, the conceptualization of diverse behavioral addictions, included Internet-related addictions, is still an ongoing process which needs further specification and research, together with exclusion criteria of what is not a behavioral addiction (Billieux et al., 2017). In particular, highly neurotic people, who are more likely to feel negative emotions and display unsuccessful coping styles, are also more likely to report higher levels of problematic Internet behaviors and addictive symptoms because of their perceptions of themselves and not because they show higher levels of Internet addiction than non-neurotic people. Hence, it is difficult to discern an actual dysfunctional Internet use from an already existing dysfunctional trait. In this respect, also the eleventh edition of the International Statistical Classification of Diseases and Related Health Problems (ICD-11; World Health Organization, 2018) calls for more detailed assessments of behavioral addictions. In particular, in the ICD-11, the first focus is set on the disorder itself (e.g., gambling disorder), without mentioning the context where this disorder occurs, which can be specified only subsequently, e.g., as predominantly offline (i.e. gambling disorder) or online (i.e. online gaming disorder). Hence, using the ICD-11 framework, we should, firstly, describe to which activity people are addicted to, and, only secondly, examine the context where the addictive behavior occurs. In this vein, it is better to talk about addictions on the Internet and not addiction to the Internet (King, Delfabbro, Griffiths, & Gradisar, 2011). To additionally overcome the problem of misinterpretation, future research should include an alternative source of information when measuring problematic Internet use, e.g. digital trace data (Lin et al., 2015), to better understand how neurotics interact on the Internet and social media, and to discover specific Internet-related contents (e.g., social media and online games) and dynamics (e.g., frequency versus duration of use) that are potentially risky for this population. Furthermore, more qualitative studies, such as interviews or ethnographic studies, are needed to add valuable information on how neurotics experience their online activities, and what motivates them to engage in online activities in a potentially problematic way.

5.3. Problematic Internet activities versus other psychological disorders

Internet-related experiences have significant psychological effects, which start in the online world and translate to the offline world, and vice-versa. Hence, the focus on Internet addiction redirects the attention to everyday feelings and experiences, which may affect and be affected, in different ways, by online behaviors, even if users cannot be strictly classified as compulsively attached to the medium (Aboujaoude, 2017). However, there has been very little consideration for the psycho-cognitive effects of the Internet among people whose online behaviors cannot entirely be called “additive” (Billieux et al., 2015). For example, no alternative conceptualization has been contemplated to explain the problematic online behavior, like impulse control disorder, obsessive-compulsive disorder, social anxiety, depression, or maladaptive coping style. Thus, without clearly distinguishing media-related addictive behavior from other existing disorders, the risk is to create new diagnoses and to incorrectly attribute them to people (Kardefelt-Winther et al., 2017). Following this point, two questions arise: As neuroticism is strictly correlated with various mental illnesses (e.g., Ormel et al., 2013), is it possible that the symptoms investigated as part of the concept of Internet addiction are mainly due to pre-existing psychological problems? And, is it possible that a problematic engagement in Internet-related activities, at most, exacerbates or promotes new forms of pre-existing problems? If the answers are “yes”, we should start to question how the symptoms of neuroticism, depression, anxiety, and obsessions (to cite some) are shaped or even triggered by the online environment. For example, is the obsessive-compulsive disorder, as formerly conceptualized in the DSM, the same that we find today, in which the Internet is part of our everyday life? Or could the online environment account for the development of “new” problematic (and pathological) behaviors (e.g., compulsive checking the phone), which cannot be classified as previously identified disorders or addictions? In fact, to develop an online addictive behavior, a certain predisposing factor should meet a specific environmental stimulus which is particularly gratifying, and the engagement in such conduct would lead to impaired control over the rewarding behavior itself (West & Brown, 2013). However, this definition is hardly met when considering online addictions.

In line with the recent updates of the DSM, we argue that general measures of Internet-related addictive behaviors are not useful in explaining to what specific activity people are addicted to, especially considering that many online activities, such as checking e-mails, searching for information, instant messaging, social media use, online shopping, are more and more part of people’s everyday life in many societies and they may (and often need to) be carried out frequently as part of daily personal and work routines. Thus, a more detailed investigation of which kind of dysfunctional behaviors are triggered by certain Internet activities is necessary today. More importantly, the online behaviour should lead to functional impairment in some aspects of the person’s life, due to an abnormal motivational system (West & Brown, 2013), which is tuned to give priority to a particular online activity despite the problems caused by such behavior. Hence, specific focus should be given to negative consequences, which, however, should not be present prior to the pathological online conduct. In addiction, motives operate thanks to low impulse control and inhibition (Choi, King, & Jung, 2019). Hence, the presence of self-regulating processes need to be considered together with personality predispositions like neuroticism. Last but not least, the social and environmental context should be further investigated, since addictive behaviors are frequently reported by people who have traumatic past experiences. Indeed, although Kardefelt-Winther et al. (2017) posed a maladaptive coping style as an exclusion criterion for the identification of behavioral addictions, it is noteworthy that negative life experiences, included interpersonal trauma, can fuel addictive conduct later in life (Caretti, Craparo, & Schimmenti, 2008; Thege et al., 2017), and considering the types of coping, e.g. emotion-versus problem-focus, may further explicate the real nature of such a conduct and help distinguishing it from other disorders (Zhou, Li, Li, Wang, & Zhao, 2017).

5.4. Limitations

This study comes with some limitations. In our selection process, we did not include conference papers and unpublished works. The results are mainly drawn on cross-sectional studies, hence we cannot interpret them in terms of causality. Furthermore, heterogeneity levels were high for the majority of the single meta-analyses, reflecting the ongoing debate on the definitions of Internet activities and Internet addictions, as well as differences due to samples and contexts. We partially addressed them by conducting meta-regression analyses.

5.5. Conclusions and future directions

Our meta-analysis considered a sample of high risk people, but no particular activities emerged as fundamental in explaining the extensive significant results of the meta-analyses on neuroticism and (problematic) Internet use. It is imperative to develop measures focusing on different aspects of addictive behaviors, which include the environment as a
specification of the addiction (as recently highlighted in the ICD-11), once again following the notions of addictions and related symptomatology on the Internet. Until this has not been done successfully, findings on the relationship between neuroticism and Internet-related addictions, should be interpreted with caution. Based on our meta-analytic review, we encourage researchers to invest in the development of measures of problematic Internet use involving third party informants or including objective trace data, focusing on specific Internet-related activities and addictions by avoiding the use of general terms like "Internet" or "social media". Instead, future works should concentrate on what happens on specific media platforms, and which "addictive" mechanisms were triggered by the platforms and carried out through them, as well as to investigate the personal and contextual drivers of such behaviors. At the same time, preventive and intervention programs should tackle at-risk persons, considering their past psychological problems and vulnerabilities.

CRediT authorship contribution statement

Laura Marciano: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing. Anne-Linda Camerini: Methodology, Writing - review & editing, Supervision, Project administration, Funding acquisition. Peter J. Schulz: Conceptualization, Validation, Writing - review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This work was supported by the Swiss National Science Foundation [10001C_175874].

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chb.2020.100026.

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