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Problematic Social Internet Use: Bidirectional Associations with ADHD Symptoms

and the Roles of Attachment Anxiety and Self-Stigma

By

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in

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Abstract

Problematic Social Internet Use: Bidirectional Associations with ADHD Symptoms

and the Contributions of Attachment Anxiety and Self-Stigma

by

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Problematic Internet use (i.e., Internet use that disrupts functioning in other important domains; PIU) is increasingly prevalent worldwide, particularly among youth. One form of PIU relates specifically to interpersonal interaction and communication, deemed *social* PIU. Social PIU has been linked to various forms of psychopathology, including attention-deficit/hyperactivity disorder (ADHD), but with limited longitudinal studies, the direction of this association remains unclear. Moreover, little research has investigated potential mechanisms that may explain the link between ADHD and social PIU. The present study analyzed data from the largest longitudinal study of girls with childhood-diagnosed ADHD in existence (N=228), with four waves of data collection taking place from childhood (ages 6-12) to adulthood (ages 21-29). There were two primary goals: first, to clarify the direction of relations between ADHD symptoms and social PIU, and second, to investigate attachment anxiety and self-stigma as possible mechanisms explaining cross-sectional and longitudinal associations between ADHD and social PIU. Attachment anxiety was examined among the full sample, whereas self-stigma was examined only among the subsample of girls with childhood ADHD due to measurement constraints. Results were consistent with a bidirectional association between social PIU and the inattentive symptoms of ADHD only, with no relation to hyperactive/impulsive symptoms. Inattention in adolescence (but not childhood) was positively associated with social PIU in adolescence, which in turn predicted greater symptoms of inattention six years later. Attachment anxiety accounted for a significant proportion of the variance shared by social PIU and inattention in adolescence, underscoring the importance of relational patterns in understanding social PIU. Among the subsample of girls with childhood ADHD, self-stigma was unrelated to social PIU. Taken together, these findings highlight attention deficits and relationship-related anxiety as two factors that partially explain social PIU in girls, with the former also exacerbated by social PIU over time. Clinically, results point to the importance of monitoring adolescent girls for signs of social PIU, especially those with ADHD or persistent anxiety about navigating close relationships. With the ongoing proliferation and ubiquity of social media platforms, it is essential for researchers to continue identifying the antecedents and consequences of problematic social Internet use.

Dedication

To my advisor, for his support of every research avenue I've tiptoed down
To my parents and grandparents, for the education that got me here
To Kuni, for pretty much everything else
I couldn't have done it without you

It is difficult to overstate the ubiquity of the Internet in modern times. The International Telecommunication Union (ITU), a specialized agency dedicated to information technology, estimates that by the end of 2020, approximately 59% of the global population, or 4.6 billion people, were using the Internet (ITU, 2021). Internet use is especially widespread among youth: globally, over 70% of youth and young adults aged 15-24 years were online by the end of 2020 (ITU, 2021). In economically developed countries, that number was 99% (ITU, 2021).

With the Internet fully integrated into the daily lives of nearly all young people, an emerging subgroup shows signs of problematic Internet use, reflecting the presence of, or potential for, negative repercussions stemming from Internet use. Alternate terms employed by previous researchers include Internet addiction (Young, 1999); Internet dependence (Lavin et al., 1999); compulsive Internet use (Greenfield, 1999); and pathological Internet use (Davis, 2001). The current study uses the term problematic Internet use (PIU) (Caplan, 2002, 2003), as this term conveys the potential for unwanted outcomes resulting from Internet use without necessarily conflating this behavior with a physiological addiction. Crucially, although the amount of time spent online is typically assessed alongside PIU, most Internet researchers agree that PIU is not solely contingent on raw frequency of use but rather reflects a pattern of Internet-related behavior that disrupts the user's functioning in other important domains, such as sleep, interpersonal relationships, and emotional well-being (Anderson et al., 2017).

Communication is one of the most widespread Internet activities across different demographic groups (Valkenburg & Peter, 2007; van Rooij et al., 2010), arguably now more than ever with the coronavirus pandemic prompting increased online activity since 2020. In the context of a global pandemic hindering in-person contact, seeking social interaction and support via the Internet was likely beneficial for overall wellbeing (Canale et al., 2022). At the same time, accumulating evidence suggests that compared to non-social purposes such as information gathering, social Internet use is more strongly related to later dysfunction, including mental health problems (Ceyhan, 2008; Davis et al., 2002; Demirtaş et al., 2020; Leung, 2014; van den Eijnden et al., 2008). As such, this dissertation distinguishes between generalized PIU (related to any Internet-based activity) and social PIU, defined as PIU related specifically to interpersonal communication and social networking over the Internet. Although social Internet use is common across various populations, girls are especially likely to engage in social networking compared to other online activities (Andreassen et al., 2016; Boer et al., 2020; Ciarrochi et al., 2016; Durkee et al., 2012; Lin & Yu, 2016); girls also appear more likely than boys to suffer from poorer mental health as a result of such activity (Haidt & Twenge, ongoing; Kelly et al., 2018; McNamee et al., 2021; Twenge et al., 2022). Therefore, in this dissertation I focus primarily on adolescent girls' social Internet use, encompassing email correspondence, instant-messaging (IM-ing), and posting on group forums, blogs, or social network sites. When relevant, I use the term *social PIU* to denote PIU related to communication or social motivations.

Reviews of generalized PIU have emerged over the last two decades, typically emphasizing associations with demographic characteristics and different domains of psychopathology. Estimated prevalence rates of generalized PIU tend to vary widely by country and measurement approach (Kuss et al., 2014). A recent meta-analysis of "generalized Internet addiction" included data from 113 epidemiologic studies investigating either "Internet addiction" or "problematic Internet use" (Pan et al., 2020). The authors found that the pooled prevalence of generalized Internet addiction was 7% across 31 countries, with a moderation effect of publication year such that prevalence rates have been increasing over time. In addition, their subgroup analysis indicated significantly higher rates of Internet addiction in Eastern societies

(8.9%) compared to Western societies (4.6%), although geographical region was not significant in the meta-regression model. The authors suggest that discrepancies in prevalence rates by country may be shrinking as Internet use progresses worldwide (Pan et al., 2020). Regardless of regional differences, the continued absence of a standardized definition of "Internet addiction," unclear thresholds for "diagnosis," and varying inclusion criteria (particularly the conflation of participants "at risk" for generalized PIU and those who actually meet study criteria) all contribute to the wide range of prevalence rates currently seen in the literature.

As noted above, a major concern related to generalized PIU is comorbid psychopathology, often broadly defined. In the first longitudinal study on this topic, Kraut et al. (1998) investigated key outcomes associated with Internet use among families initially lacking Internet access at home. Greater Internet use for communication predicted increased levels of loneliness and depression over time, adjusting for initial levels of these variables (Kraut et al., 1998) (see also Bessière et al., 2010; Gámez-Guadix, 2014; Ha & Hwang, 2014; Ko et al., 2014). Beyond depression, generalized PIU has been associated with anxiety disorders (Kim et al., 2016), attention-deficit hyperactivity disorder (ADHD) (Wang et al., 2017), and substance use disorders (Lanthier-Labonté et al., 2020). Less attention has been paid to social PIU; however, some studies suggest that excessive online socializing is related to depression (Lin et al., 2016; van den Eijnden et al., 2008), anxiety (Bonetti et al., 2010; Lee & Stapinski, 2012), and potentially ADHD (Bolic Baric et al., 2018; Mikami et al., 2015; Seo et al., 2015). For systematic reviews, see Anderson et al. (2017), Ko et al. (2012), Carli et al. (2013), and Hussain and Griffiths (2018). See also Haidt and Twenge's review of social media and mental health (ongoing).

The above findings align with the *social displacement hypothesis,* which argues that heavy use of the Internet for interpersonal interaction supplants time that could otherwise be spent socializing in-person. Such over-reliance on the Internet for social aims allows users to disconnect from local social networks, fostering a sense of isolation that may trigger or potentiate psychopathology (Kraut et al., 1998). Still, most research on social Internet use and psychopathology is cross-sectional, leaving open key questions about causality (Carli et al., 2013; Hussain & Griffiths, 2018). Indeed, in terms of bidirectionality, pre-existing symptoms of depression or anxiety could promote greater reliance on the Internet for social engagement over time, as users (a) maintain greater control over the interaction, including how they choose to respond (if at all) and (b) do not have to expend internal resources self-monitoring emotional expression, eye contact, or body language (McKenna & Bargh, 1999).

Other research points to multifinality, such that multiple pathways and outcomes emerge from the starting point of online socialization. In other words, some users will experience significant psychosocial benefits from using the Internet for social aims, some will experience negative outcomes, and some will show little if any impact. Follow-up work from Kraut et al. (2002) revealed that, three years after initial results, participants' outcomes varied significantly depending on their baseline levels of social engagement. Greater social Internet use correlated with better psychological outcomes (decreased loneliness, decreased negative affect, and increased self-esteem) for those self-rated as extroverts, whereas introverts and those with low levels of "live" social support reported more loneliness in relation to social Internet use (Kraut et al., 2002). These findings are more consistent with the *"rich get richer" hypothesis* of Internet use, whereby people who already enjoy greater social connectedness offline are more likely to benefit from interpersonal communication via the Internet, compared to those without an existing "safety network" of close friends (Desjarlais & Willoughby, 2010; Kraut et al., 2002).

In direct contrast is the *social compensation hypothesis,* which argues that it is precisely those individuals with interpersonal deficits that benefit most from online communication because it offers users a relatively low-risk avenue for social interaction (Campbell et al., 2006; Desjarlais & Willoughby, 2010; McKenna & Bargh, 2000). Supporting this hypothesis, Szwedo et al. (2012) found that, for young adults who felt more socially accepted by their peers at baseline, greater online communication predicted increased symptoms of anxiety and depression one year later. However, for young adults who felt less socially accepted by their peers, greater online communication predicted decreased symptoms, consistent with a "leveling effect" of online interactions (Szwedo et al., 2012). Other research suggests that online socializing does not benefit these individuals per se but rather does not yield the negative psychological outcomes seen in other samples (e.g., Bessière et al., 2010).

Finally, it is possible that Internet-based communication offers benefits to users in some domains while simultaneously promoting deficits in in other domains (Boies et al., 2004; Selfhout et al., 2009). Weidman et al. (2012) found that Internet users high in social anxiety reported greater feelings of comfort and self-disclosure when socializing online, consistent with the use of the Internet as a compensatory medium. Yet such use was also correlated with lower self-esteem among socially anxious users, suggesting that harnessing the Internet as a safe space for communication does not necessarily translate to greater psychological well-being across the board (see also Lawlor & Kirakowski, 2014). Such effects may be magnified over time if reliance on the Internet for socialization ultimately deprives users of opportunities to experience and learn from in-person interactions.

In all, the literature suggests that problematic social Internet use is generally associated with poorer mental health. However, given few longitudinal data, the direction of influence remains unclear. Moreover, it appears that the bulk of research on social Internet use examines associations with mood and anxiety disorders (see Haidt & Twenge, ongoing), with far less attention paid to neurodevelopmental disorders such as ADHD. Additional research is needed both to identify the specific mental health disorders that emerge as antecedents or consequences of social PIU and to characterize the nature of these links.

Motivating Factors for Online Interaction

As research on social Internet use has progressed, increasing recognition has been given to the user's *motivation* to seek out online interactions as an important predictor of outcomes (Weiser, 2001) (for a longer discussion of "uses and gratifications" theory, see Katz & Foulkes, 1962). Crucially, motivational frameworks allow for the examination of additional mechanisms and pathways to eventual social PIU beyond the traditional focus on intrinsically "addictive" features of the online social environment. Here, I present a modified version of the "push/pull" framework of Internet use, first introduced by Douglas et al. (2008) and elaborated by Anderson et al. (2017). These authors conceptualize "pull" factors as aspects of the Internet that attract or entice people to go online, whereas "push" factors are those that fulfill users' psychological "needs." I argue that a more useful distinction may be made here between factors that actively draw (or "pull") users to the Internet as a means of communication, versus factors that make the Internet appealing as a way for users to avoid (or "push" away) potentially negative social experiences. This latter construct is based on research framing excessive social Internet use as a safety behavior or maladaptive coping strategy employed to reduce feelings of social threat (Kuss et al., 2017; Lee & Stapinski, 2012; Panova & Lleras, 2016).

<u>Pull Factors</u>

Many studies have highlighted innate properties of the Internet that serve to "pull" users online and generally increase vulnerability to problematic use, including the ubiquity of the Internet, its ease of accessibility, and its low- or no-cost nature (Douglas et al., 2008; Wegmann et al., 2018). Another key feature is anonymity and the attendant ability to disconnect entirely from one's offline self. Although anonymity does not necessarily encourage reliance on the Internet for communication, it may well work to magnify the "pull" provided by other virtual activities, as discussed below.

Beyond inherent properties of the Internet itself, the excitement of interacting with people online, both friends and strangers alike, constitutes an active draw for many Internet users. With ever-increasing numbers of websites and new forums for virtual interaction, the Internet constitutes an easily modifiable landscape with nearly infinite potential for novel experiences—which is likely to attract users who value such variety. Frequent Internet users report relatively high levels of sensation-seeking, typically defined as a trait that reflects the individual's need for stimulating, varied experiences and a willingness to take risks to pursue such experiences (Dalbudak et al., 2015; Rahmani & Lavasani, 2011). One study of Taiwanese students revealed that youth classified as "Internet dependents" scored higher in both sensation-seeking and disinhibition relative to their non-dependent counterparts (Lin & Tsai, 2002).

Disinhibition, or the inability to restrain impulsive responses, may be especially enhanced in online interactions, such that Internet users tend to self-disclose more personal information and at a faster pace compared to offline, in-person interactions (Joinson, 2001; Joinson & Paine, 2007). This phenomenon, described as the "online disinhibition effect" (Suler, 2004), may serve as an additional source of stimulation for Internet users who virtually share thoughts, feelings, and experiences that they would typically keep to themselves while offline. Such intimate self-disclosure may lead to intense, "hyperpersonal" communication that feels more spontaneous and thrilling than everyday interactions (Walther, 1996). This excitement may be further enhanced by interacting with novel communication partners (i.e., strangers). Indeed, youth who talk to strangers on the Internet often report being motivated by entertainment (Peter et al., 2006), and youth who meet up in-person with strangers initially encountered online show higher levels of sensation-seeking compared to youth who meet up with friends of friends (Bayraktar et al., 2016). The novelty inherent in interacting with a new person, combined with the social liberation afforded by the Internet (Morahan-Martin & Schumacher, 2000), may offer a potent draw for users motivated primarily by the desire for social stimulation.

A final "pull" of online communication is the opportunity to explore different aspects of one's identity and test out a different version of oneself, another process likely to be facilitated by anonymity. Suler (2004) notes that the Internet allows users to dissociate from their offline identities and create a "compartmentalized self" that may or may not align with how they behave in person. It remains unclear whether communicating online tends to promote the expression of one's "true self" (Bargh et al., 2002), an "idealized self" that feels unattainable offline (Morahan-Martin & Schumacher, 2003), or a different persona entirely (Turkle, 1999). Regardless, using the Internet to "workshop" one's identity may offer novel and gratifying social interactions for young users, especially those who feel stigmatized in their offline environments. In a study of virtual newsgroups, McKenna and Bargh (1999) found that for people who identified as having a concealable stigmatized identity (e.g., being non-heterosexual), greater participation in the attendant newsgroup predicted greater feelings of self-acceptance and less estrangement from society. Similarly, Breuer and Barker (2015) found that engagement in an online support group

reduced depressive symptoms and self-stigma (also known as internalized stigma) among users diagnosed with depression. The malleability of online identities may therefore be an additional motivator for social Internet users, particularly those who experience self-stigma related to their offline identities.

Push Factors

Conversely, the Internet can be conceptualized as a method of avoidance when users are motivated to log on as a means of distracting themselves from offline social stressors. Davis (2001) proposed a cognitive-behavioral model of "pathological Internet use," highlighting existing psychopathology as a "distal necessary cause" of generalized PIU (p.190), which is then reinforced by the temporary reprieve provided to the user. In a study of young adults, Caplan (2002) confirmed that negative mood alteration contributed significantly to generalized PIU, such that individuals with PIU frequently endorsed going online expressly to alter an unwanted affective state. Similarly, Morahan-Martin and Schumacher (2003) found that students in the highest quintile of loneliness were more likely to report using the Internet both to socialize with others and to modulate their negative moods. Lonely users also reported greater satisfaction with online interactions *and* more disturbances in daily functioning (Morahan-Martin & Schumacher, 2003), again revealing apparent discrepancies across different psychosocial outcomes.

Another key "push" factor is the fear of social rejection. Social anxiety disorder, a mental health condition characterized by the intense fear of being appraised or evaluated in social settings, has been found to predict greater Internet use among young adults (Caplan, 2007; Gross et al., 2002; Ko et al., 2009, 2014; Lee & Stapinski, 2012). One explanation for this association is that fears of rejection are typically reduced in online interactions compared to those happening in-person (Caplan, 2003). Indeed, unlike the offline environment, users can easily log off or block another person online if they feel threatened, limiting potential rejection to a single interaction. Interestingly, Lee and Stapinski (2012) found that socially anxious participants preferred online interactions not because the Internet was perceived as particularly safe but because face-to-face interactions were seen as intolerably threatening—in line with avoidance as a primary motivation (see also Erwin et al., 2004; Gross et al., 2002). Still, in a meta-analysis (Prizant-Passal et al., 2016), social anxiety was found to be unrelated to the actual amount of time spent engaging in virtual communication (emailing and IM-ing). The authors note that email and IM are now considered important mediums for communication in the workplace, in contrast to more casual uses from the early Internet era, possibly contributing to inconsistent findings across studies (Prizant-Passal et al., 2016).

A related, potentially more apt "push" factor may be an anxious attachment style, referred to hereafter as attachment anxiety. Briefly, attachment theory is a psychological model of development positing that the early relationship between an infant and their caregiver establishes a blueprint for interpersonal functioning carried forward into future relationships (Ainsworth, 1979; Bowlby, 1978). Unlike a secure attachment style, characterized by a healthy balance between intimacy and independence, an anxious or preoccupied attachment style typically reflects persistent uncertainty around another person's affection and a desire for extreme closeness (sometimes referred to as enmeshment) that is often expressed as clinginess or excessive reassurance-seeking (Shaver et al., 2005).

Although there is conceptual overlap between anxious attachment and social anxiety, several key distinctions are relevant here. First, social anxiety encompasses intense fear and self-consciousness around people in general, including strangers or crowded public places, whereas

attachment anxiety is more limited to close (or at least established) relationships. Second, social anxiety typically emerges when people are concerned about their own behavior and how it may be perceived by others. In contrast, a person with attachment anxiety is more likely to focus on the other person's behavior mainly in the context of the relationship. Finally, although social anxiety can certainly include the fear of rejection, also relevant are fears of embarrassment or humiliation, in contrast to the dominant fear of abandonment and loss that characterizes an anxious attachment style.

Some cross-sectional research has investigated attachment anxiety in relation to generalized and social PIU. Data from European studies suggest that an anxious attachment style does indeed predict both a greater likelihood of generalized PIU (Cacioppo et al., 2019; Schimmenti et al., 2014) and greater problems with social media use (Worsley et al., 2018). Attachment anxiety is also associated with greater comfort-seeking on the social media platform Facebook, as well as more Facebook usage overall (Oldmeadow et al., 2013). Such associations persist even when adjusting for the user's reported social skills, such that attachment anxiety and social competence may be more orthogonal than has been assumed.

In sum, myriad factors motivate young people to turn to the Internet for social interaction. These factors, in turn, may unfold into various and divergent pathways to social PIU. Clarifying these developmental patterns would help to identify mechanisms predicting the emergence of social PIU and enhance our understanding of how social PIU proliferates among youth. Such knowledge may be especially important when looking at young users who experience multiple "push" or "pull" factors, as identifying the primary source of motivation could facilitate the success of subsequent intervention approaches. Next, I focus on one demographic group at high risk for generalized and social PIU—youth with ADHD—for whom several "push" and "pull" factors just noted are particularly relevant.

ADHD and Internet Use

ADHD, or attention-deficit/hyperactivity disorder, is a prevalent neurodevelopmental condition characterized by clinically significant and impairing symptoms of inattention (categorically, the inattentive presentation of ADHD: ADHD-I), hyperactivity/impulsivity (the HI presentation: ADHD-HI), or both (the combined presentation: ADHD-C) (Ahmad & Hinshaw, 2017). To date, the vast majority of research investigating ADHD and generalized PIU suggests a link between the two (Carli et al., 2013; Wang et al., 2017). Elevated rates of generalized PIU have been identified in samples of youth with ADHD (and vice versa), primarily in cross-sectional or case-control studies (Bielefeld et al., 2017; Kim et al., 2016; Kitazawa et al., 2018; Yen et al., 2009; Zhao et al., 2021). One early prospective study of Taiwanese adolescents found that ADHD was the most robust risk factor for new incidents of generalized PIU over two years (Ko et al., 2009). Subsequent longitudinal studies have identified ADHD as predictive of later generalized PIU among adolescents in Taiwan (Chen et al., 2015), South Korea (Choi et al., 2019), China (Zhou et al., 2020), and Japan (Morita et al., 2021).

Although less research has investigated ADHD in relation to *social* PIU, studies on this topic have begun to emerge over the past several years, primarily focusing on problems with regulating social media use. In all, the evidence suggests a positive association between ADHD and problematic use of social media apps such as Facebook, Twitter, and Instagram (Andreassen et al., 2016; Dekkers & van Hoorn, 2022; McNamee et al., 2021; Ra et al., 2018). Outside of social media apps, ADHD has also been linked to greater online interaction with both friends (Bolic Baric et al., 2018; Seo et al., 2015) and strangers (Mikami et al., 2015). In parallel with

the work on generalized PIU, a major limitation of this research is the dearth of longitudinal studies. In their systematic review of longitudinal research on ADHD and digital media use more broadly, Thorell et al. (2022) explicitly call for more longitudinal studies focused on social Internet use, noting that only 2 of the 25 studies they reviewed were addressing social media specifically.

One unanswered question stemming from this lack of longitudinal research is whether the presumed link between ADHD and social PIU is bidirectional. As noted previously, some prospective research indicates that ADHD is a risk factor for later generalized PIU among youth living in Asia (Chen et al., 2015; Choi et al., 2019; Ko et al., 2009; Zhou et al., 2020). However, in a three-wave longitudinal study examining social media use among Dutch adolescents, Boer (2020) found that youth whose ADHD symptoms increased over time did *not* show a parallel increase in problems with their social media use. Yet youth whose social media use problems increased *did* experience a corresponding increase in attention deficits at later time points—suggesting, intriguingly, that dysregulated social media use may exhaust adolescents' attempts at effortful control, ultimately weakening users' abilities to maintain attention in offline settings (Boer et al., 2020). This finding is also consistent with McNamee et al. (2021), who found that prolonged use of social media (>4 hours per day) predicted increased incidence of hyperactivity and inattention offline. By contrast, Morita et al. (2021) found evidence for a bidirectional link between PIU and ADHD over time, although their study addressed generalized rather than social PIU. To my knowledge, no studies to date have shown a bidirectional association between ADHD symptoms and social PIU.

Another unanswered question is the extent to which the partially independent symptom dimensions of ADHD (inattention versus hyperactivity/impulsivity) underlie the ADHD-PIU association documented in prior research. Some studies find that the inattentive symptoms of ADHD (IA) are predominantly associated with PIU (Chou et al., 2016; Yen et al., 2009; Yılmaz et al., 2015), yet others reveal a stronger effect of hyperactive/impulsive symptoms (HI) (Chen et al., 2015; Choi et al., 2019; Ioannidis et al., 2016; Kormas et al., 2011). A key issue is that much of the literature on generalized PIU and psychopathology does not address the actual activities in which users engage online, despite clear relevance for outcomes (Weiser, 2001). Given emerging evidence for an especially robust link between ADHD and online gaming that could obfuscate findings on generalized PIU (Panagiotidi & Overton, 2018; Paulus et al., 2018), additional research focusing on ADHD symptoms in relation to more specific forms of PIU, including social PIU, is highly warranted.

Aside from the question of bidirectionality, if ADHD is indeed predictive of social PIU, are there intermediary variables underlying this association? Existing research tends to presume a direct link between ADHD psychopathology and generalized PIU: impaired inhibition, sensation-seeking, a preference for immediate rewards, and feeling easily bored are all ADHD-related symptoms shown to correlate with generalized PIU (Choi et al., 2019; Wang et al., 2017; Zhou et al., 2020). Moreover, "deficient self-regulation" has been linked to an increased preference for online socialization and greater negative consequences of Internet use over time (Gámez-Guadix et al., 2015). Yet Levine (2013) discovered no significant relations between excessive IM-ing and actual performance measures of attention and information processing. In parallel, Armstrong et al. (2000) found that disinhibition was not associated with Internet-related problems, although low self-esteem was. One possible explanation for discrepant findings is that, as suggested above, many studies linking ADHD to generalized PIU may be tapping into a more specific link between ADHD and online gaming. Given the immediate, incentivizing reward

structure inherently built into online games, this activity may be especially susceptible to problematic use among youth with ADHD, as a disorder hypothesized to stem from dysfunction in the neurobiological reward system (Paulus et al., 2018).

Considering the noted diversity of pathways to social PIU, the above findings suggest a pressing need to challenge the traditional conceptualization of frequent Internet users having "an almost constant need" for stimulation (Shotton, 1991, as cited in Armstrong et al., 2000). Indeed, a number of "push/pull" factors may be especially relevant for youth with ADHD and could function as mechanisms underlying a hypothetical association between ADHD and later social PIU. In this final section, I draw from the reviewed "push/pull" factors to propose two potential mechanisms that may explain how ADHD leads to social PIU, above and beyond the role of symptom dimensions.

<u>Push and Pull: Attachment Anxiety and Self-Stigma</u>

Drawing from the "push/pull" factors reviewed herein, I suggest two mechanisms that may contribute to an association between ADHD symptoms and later social PIU: attachment anxiety ("push") and ADHD-related self-stigma ("pull"). These mechanisms align with the conceptual framework put forth by McKenna and Bargh (1999) proposing two types of motivations for Internet use, including social-related (attachment anxiety) and self-related (self-stigma). Of note, I examine these constructs as mechanisms only for ADHD symptoms predicting social PIU, and not vice versa. Although this dissertation first investigates bidirectional associations between ADHD and social PIU, both attachment anxiety and self-stigma are considered only as they pertain to one hypothesized direction of influence, namely ADHD as a predictor of social PIU.

<u>Attachment Anxiety</u>

It is well documented that youth with ADHD, particularly girls, face high rates of social rejection and often struggle to maintain close relationships with both friends and romantic partners (Babinski & Waschbusch, 2016; Greene et al., 2001; Hinshaw, 2002; Hinshaw et al., 2006; Kok et al., 2016). Compared to their peers, girls with ADHD show significantly higher rates of social anxiety (Biederman et al., 1999, 2010) and insecure attachment (Koemans et al., 2015; Storebø et al., 2016), and they display greater sensitivity to social rejection (Babinski et al., 2019; Scharf et al., 2014). All such factors have been linked with both generalized and social PIU. One study focusing specifically on ADHD and "multi-communicating," or engaging in multiple synchronous conversations at once, found that a need for social assurance was strongly associated with multi-communicating among girls (but not boys) with ADHD. The authors suggest that the desire to be "always connected and available to others" may reflect a need for reassurance that increases girls' motivation to engage in virtual interactions (Seo et al., 2015, p.677). These desires mirror the intense longing for intimacy and connection inherent to attachment anxiety, which is often assessed with questionnaire items such as, "I want to merge completely with another person" (see Collins & Read, 1990). Despite these findings, to my knowledge no research has examined the potential role of attachment anxiety in mediating the link between ADHD and social PIU.

I hypothesize that attachment anxiety mediates an association between ADHD symptoms and social PIU, such that ADHD symptoms predict greater attachment anxiety in adolescence, which then predicts greater social PIU. As noted previously, cross-sectional research suggests that attachment anxiety is correlated with greater comfort-seeking on Facebook, as well as more

Facebook usage overall (Oldmeadow et al., 2013). Given that Internet use for negative mood alteration (i.e., going online to alter an unwanted affective state) predicts generalized PIU (Caplan, 2002), attachment anxiety may contribute to social PIU via heightened comfort-seeking from other Internet users. In other words, anxiety about the status of one's relationships could lead users to spend more time socializing online in pursuit of reassurance and reduced anxiety about those relationships. Anxious users may also prefer the online environment as a space that typically blunts the fear of social rejection (Caplan, 2003), especially in comparison to in-person interaction (Lee & Stapinski, 2012). Finally, anxious users may feel compelled to socialize online as a means to feel (a) more connected to others even when physically apart, and (b) closer to others given the "online disinhibition effect" and accelerated intimacy that often results from virtual interaction (Suler, 2004; Walther, 1996). Given that girls with ADHD show high rates of social rejection and rejection sensitivity (Babinski et al., 2019; Kok et al., 2016) as well as reassurance-seeking and multi-communicating (Seo et al., 2015), such variables may reflect a high degree of attachment anxiety that could partly explain the association between ADHD symptoms and social PIU.

Self-Stigma

   Another ADHD-relevant factor is the persistent stigma attached to the disorder (Nguyen & Hinshaw, 2020). Although surprisingly understudied, existing research suggests the widespread prevalence of ADHD-related stigma, including self-stigma among those with the disorder (Coleman et al., 2009; McKeague et al., 2015; Mueller et al., 2012). Self-stigma about a mental health disorder is often associated with restricted self-disclosure, keeping one's diagnosis a secret, and perceiving oneself as "weird" or different from others (McKeague et al., 2015). Accordingly, negative beliefs about one's ADHD diagnosis could lead individuals to seek out the Internet as a space to hide symptoms from others, experiment with alternative identities, and/or develop a more positive view of themselves. Indeed, low collective self-esteem, or perceiving one's social group to be undesirable, has been linked to adolescents' social compensation motives for Internet use (Barker, 2009). Focus-group research further supports the idea that young users, including those with ADHD, actively harness online socialization as a tool to develop both a personal identity and a sense of belonging to a social group (Bannon et al., 2015; Gajaria et al., 2011). Moreover, given the aforementioned tendency toward disinhibition among most Internet users (Suler, 2004), it may be that girls perceive their ADHD symptoms (especially impulsivity) as less "obvious" and impairing when communicating online, if such disinhibition is more socially acceptable in online compared to offline interactions.

   I hypothesize that among girls with ADHD, self-stigma mediates an association between ADHD symptoms and social PIU, such that ADHD symptoms positively predict self-stigma related to one's disorder, which then predicts greater social PIU. Research suggests that people belonging to stigmatized groups may be more inclined to socialize online for many reasons, including greater access to others with similar identities and more perceived opportunities to develop a positive sense of oneself (Miller, 2017; Norris, 2002). Such participation in online social groups has also been found to reduce self-stigma among Internet users with a wide range of marginalized identities, including those with other mental health disorders (Breuer & Barker, 2015; Godard, 2021; Moore et al., 2020). Although these outcomes (if realized) could certainly be considered beneficial, such a process may also lead to the development of social PIU, if youth with high self-stigma start to depend on their online interactions as their primary source of social support and validation.

In short, youth with ADHD, and particularly girls with ADHD, may come to rely on virtual interactions given their potential to facilitate self-stigma reduction and identity formation, via a medium which supports more frequent communication and reduces the sting of social rejection. Crucially, this conceptualization of the pathways to social PIU differs from the view that PIU necessarily and directly stems from psychopathology (see Davis, 2001), highlighting the potential for additional mechanisms that encompass intentional or even quasi-adaptive behaviors.

Hypotheses

The proposed study will utilize prospective longitudinal data from an observational study of girls with and without childhood diagnoses of ADHD to address the following hypotheses.

1) Girls with childhood diagnoses of ADHD (W1) will report higher levels of social PIU in adolescence (W3) relative to matched neurotypical comparison girls.
2) There will be a bidirectional association between ADHD symptoms (both IA and HI) and social PIU, such that:
    a. ADHD symptoms in adolescence (W3) will be positively associated with social PIU in adolescence (W3), including when adjusting for total screen time and demographic covariates.
    b. ADHD symptom dimensions in childhood (W1) will positively predict social PIU in adolescence (W3), including when adjusting for total screen time and demographic covariates.
    c. Social PIU in adolescence (W3) will positively predict ADHD symptoms in adulthood (W4), including when adjusting for total screen time, demographic covariates, and childhood (W1) ADHD symptoms.
3) Attachment anxiety and self-stigma in adolescence (W3) will each be independently and positively associated with concurrent social PIU (W3), including when adjusting for total screen time and demographic covariates.
4) When included as simultaneous predictors alongside ADHD symptoms, both attachment anxiety and self-stigma will partially mediate the association between ADHD symptoms and social PIU.
    a. Among the full sample of girls (with and without childhood diagnoses of ADHD), attachment anxiety will partially mediate the longitudinal association between ADHD symptoms in childhood (W1) and social PIU (W3).
        i. If ADHD symptoms in childhood do not significantly predict social PIU, I hypothesize that attachment anxiety will partially mediate the cross-sectional association between ADHD symptoms and social PIU in adolescence (W3).
    b. Among the subsample of girls with childhood diagnoses of ADHD, self-stigma will partially mediate the longitudinal association between ADHD symptoms in childhood (W1) and social PIU (W3).
        i. If ADHD symptoms in childhood do not significantly predict social PIU, I hypothesize that self-stigma will partially mediate the cross-sectional association between ADHD symptoms and social PIU in adolescence (W3).

Method

<u>Participants and Procedure</u>

All data were drawn from the Berkeley Girls with ADHD Longitudinal Study (BGALS), an ongoing, prospective study of girls with childhood ADHD and an age- and ethnicity-matched neurotypical comparison group. Participants were recruited at age 6-12 years (M_{age} = 9.6 years) from schools, mental health care centers, pediatric practices, and direct advertisements to participate in research summer programs in 1997, 1998, and 1999. Programs were free of charge and designed to provide enrichment rather than therapeutic intervention, with the objective of collecting ecologically valid participant data. A total of 140 girls with ADHD (47 Inattentive, 93 Combined) and 88 comparison girls were selected to participate after extensive diagnostic assessments conducted via multiple informants and methods. The sample was diverse in terms of racial, ethnic, and socioeconomic status, as detailed below. Common psychiatric comorbidities (e.g., oppositional defiant disorder [ODD], conduct disorder [CD], anxiety disorders, depression, learning disorders) were allowed to promote the generalizability of the ADHD sample. The comparison group was also allowed to have internalizing disorders and ODD in order to prevent creating a supernormal comparison sample. Exclusion criteria for both groups were intellectual disability, pervasive developmental disorders, psychosis or overt neurological disorder, lack of English spoken in the home, and medical problems prohibiting summer camp participation. All procedures were approved by the University's Institutional Review Board. See Hinshaw (2002) for full details.

During the Wave 1 (W1) summer programs, ADHD and comparison girls were intermixed and grouped by age prior to participating in each day's events, which included a variety of classroom and outdoor activities as well as one-on-one testing. Multi-source data were collected from parents, teachers, behavioral observers, and program counselors (the latter two types of informants were unaware of diagnostic group status) on psychological, social, behavioral, cognitive, and familial functioning. The sample was racially and ethnically diverse (53% White, 27% African-American, 11% Latina, 9% Asian-American), and socioeconomic backgrounds ranged from professional parents to receipt of public assistance. Participants and their families were invited to engage in follow-up interviews that took place in three waves (W2, W3, W4), approximately 5, 10, and 16 years after baseline participation. Extensive efforts were made to track all participants, including the use of social media in some cases. Follow-up assessments were conducted by trained post-baccalaureate and graduate students in clinical psychology at our clinical/research site or at participants' homes when they were unable to travel. Retention rates ranged from 92-95% at all follow-up points. Extensive statistical analyses reveal few significant differences between the retained and non-retained participants at each follow-up wave, although non-retained participants did show evidence of lower socioeconomic status and IQ scores as well as greater levels of baseline ADHD symptoms (for details, see Hinshaw et al., 2006, 2012; Owens et al., 2017).

For the current proposal, I utilize data from all 4 time points of data collection, beginning in childhood at W1 (ages 6-12) and including W2 (ages 11-18 years), W3 (ages 17-24 years), and W4 (ages 21-29). See Table 1 for an overview of included study variables by wave.

<u>Measures</u>

ADHD Diagnostic Status & Symptoms

W1 ADHD diagnostic status (present vs. absent) was determined from the Diagnostic Interview Schedule for Children (4th ed., DISC-IV; Shaffer et al., 2000) and the Swanson, Nolan,

and Pelham Rating Scale (4th ed., SNAP-IV; Swanson et al., 1992). The DISC-IV is a well-validated, structured diagnostic interview administered to parents by highly trained research staff. For participants diagnosed with ADHD, the DISC-IV also yields a "presentation" status—that is, Inattentive (ADHD-I) or Combined (ADHD-C), with the latter diagnosis reflecting symptoms of hyperactivity/impulsivity (HI) in addition to symptoms of inattention (IA). The SNAP-IV is a well-validated, reliable measure frequently used as a screener for ADHD symptoms; SNAP-IV data were collected from parents and teachers prior to study enrollment. Participants were diagnosed as having ADHD if they met full diagnostic criteria for either ADHD-I or ADHD-C based on both the DISC-IV and parent SNAP-IV ratings.

At W1, ADHD symptom counts were collected from parents using the DISC-IV and SNAP-IV. At all other waves (W2-W4), ADHD symptom counts were assessed on the SNAP-IV by both participant and parent report. For all measures, respondents were asked to rate ADHD symptoms during periods in which the participant was not taking ADHD medication. See Hinshaw (2002) for full details.

Internet Use (W3)

<u>Social PIU</u>: Use of the Internet for social interaction was measured using a 24-item self-report questionnaire found to be reliable and validated in previous research (Caplan, 2007; Mikami et al., 2015; Szwedo et al., 2011). Items in this measure include statements directly endorsing a preference for socializing online (e.g., "I prefer communicating online than in face-to-face communication") as well as statements describing problems with self-regulating online social behavior (e.g., "I have attempted to spend less time socializing online but have not been able to"). Participants indicated their agreement via a 4-point Likert scale (1 = "strongly disagree" and 4 = "strongly agree").

Factor analysis suggested a 3-factor solution, including one factor reflecting problematic use (7 items); these items were combined to form the subscale of problematic social Internet use (social PIU), the primary variable of interest. This subscale was found to have a Cronbach's alpha of 0.87, 95% CI [0.84, 0.90], indicating good internal consistency. The two remaining factors reflected positive attitudes toward online communication (13 items) and being motivated by a greater sense of control in online interactions (3 items). The Internet use measure also included 10 binary items assessing whether participants had ever engaged in specific Internet-based social behaviors, such as forming a romantic relationship with someone initially met online. See Appendix for full details.

<u>Total time spent online</u>: Total time spent online was measured at W3 with four questions assessing the average daily number of hours spent engaging in both synchronous and asynchronous interpersonal activities online (e.g., emailing friends, IM-ing with friends, posting on social network sites, and updating personal blogs or webpages). Participants rated their daily hours for each of the 4 online social activities on a 5-point scale (0-1 hour; 1-2 hours; 2-3 hours; 3-4 hours; or 5+ hours).

Attachment Anxiety (W3)

Attachment anxiety was measured at W3 with the Adult Attachment Scale (AAS; Collins & Read, 1990), an 18-item self-report questionnaire assessing attachment styles in adults. The AAS includes 3 subscales (comprising 6 items for each), measuring feelings of (a) anxiety, (b) dependence, and (c) security in the context of close relationships. Participants indicated the extent to which each item accurately described them via a 5-point Likert scale (where 1 = "not at all like me" and 5 = "very much like me"). Participants' scores on the anxiety subscale are summed into a total score that reflects their degree of reported attachment anxiety in romantic

relationships. The AAS has been validated in previous research and shows adequate test-retest reliability (Collins & Read, 1990). In the current sample, the anxiety subscale was found to have a Cronbach's alpha of 0.76, 95% CI [0.70, 0.81], indicating acceptable internal consistency.

Self-stigma (W3)

Self-stigma was measured at W3 with an adapted version of the Internalized Stigma of Mental Illness Inventory (ISMI; Ritsher et al., 2003), a 29-item self-report questionnaire assessing levels of internalized self-stigma related to mental health conditions. For each item, participants indicate their agreement via a 4-point Likert scale (where 1 = "strongly disagree" and 4 = "strongly agree"). Items are summed to create a total score and five subscale scores reflecting alienation, stereotype endorsement, discrimination experiences, social withdrawal, and stigma resistance. The ISMI has been shown to have high internal consistency and test-retest reliability, and is well-validated across multiple versions and in different languages (Boyd et al., 2014; Ritsher et al., 2003). In the current sample, the full ISMI scale was found to have a Cronbach's alpha of 0.91, 95% CI [0.89, 0.92], indicating excellent internal consistency. With the exception of stigma resistance, Cronbach's alpha values for subscales were all in the good to acceptable range, from 0.78 (stereotype endorsement) to 0.88 (social withdrawal). The stigma resistance subscale yielded a Cronbach's alpha of 0.60, 95% CI [0.44, 0.71], indicating questionable internal consistency.

For the current study, the ISMI was adapted to refer specifically to stigmatized attitudes around ADHD. For girls with baseline (W1) diagnoses of ADHD, items were adapted to assess self-stigma related to having ADHD (e.g., "I feel inferior to others who don't have a mental illness" was reworded to "I feel inferior to others who don't have ADHD"). For girls in the Comparison group, items were adapted to assess other-related stigma and beliefs about stigma toward people with ADHD (e.g., "I am embarrassed or ashamed that I have a mental illness" was reworded to "It is embarrassing and shameful to have ADHD"; "I feel out of place in the world because I have a mental illness" was reworded to "People with ADHD feel out of place in the world because of their ADHD"). Given these construct differences by diagnostic group, analyses with ISMI data were restricted only to girls with baseline diagnoses of ADHD, to ensure that the ISMI variable was indeed capturing internalized self-stigma.

Covariates

For regression analyses, I included the following covariates: mother's level of education on a 6-point scale (1 = less than 8th grade to 6 = advanced or professional degree), measured at W1; family yearly income on a 9-point scale (from 1 = less than $10,000 to 9 = $75,000 or more), measured at W1; participant age at W3; recent ADHD stimulant medication use (yes vs. no, between W2 and W3); and total time spent online (average number of daily hours engaged in online activities), measured at W3. Demographic covariates were selected due to the diversity in age range and socioeconomic status in our sample, as well as research suggesting that Internet usage may vary significantly based on these factors (Chou et al., 2016; Kim et al., 2016). ADHD stimulant medication was included as a covariate given the unique sample characteristics. Total time spent online was included as a covariate to provide a more conservative estimate of the specific effects of social PIU, rather than Internet use more broadly.

Results

Descriptive findings

Sample characteristics are presented in Table 2. No significant diagnostic group differences were found with respect to the sociodemographic covariates of baseline household

income, maternal education, and current age. A higher percentage of girls in the Comparison group were Asian-American ($p=.040$). Not surprisingly, girls with a baseline diagnosis of ADHD were significantly more likely to be on a stimulant at W3 or since W2 ($p<.000$).

Correlations

      Correlations among the full sample are presented in Table 3; correlations between ISMI subscales and other variables among the ADHD subsample are presented in Table 4. Among the full sample, social PIU (W3) was significantly positively correlated with baseline (W1) ADHD HI symptoms (mother-reported), W3 ADHD IA and HI symptoms (self-reported), and W4 ADHD IA symptoms (self-reported). Attachment anxiety (W3) was significantly and positively correlated with both ADHD symptom dimensions at all three time points (W1, W3, and W4), as well as with social PIU (W3).

      Among the ADHD group, W1 ADHD HI symptoms were positively correlated with scores on the stigma resistance subscale. W4 ADHD IA symptoms were negatively correlated with scores on the withdrawal subscale. No other significant correlations emerged between ISMI factors and ADHD symptom dimensions, social PIU, or attachment anxiety. Social PIU (W3) remained significantly and positively correlated with ADHD IA symptoms at both W3 and W4, but it was not correlated with ADHD HI symptoms at any time point. Attachment anxiety (W3) remained significantly positively correlated with both ADHD symptom dimensions at W3 and W4, but it was not correlated with either symptom dimension at W1.

Hypothesis 1: Group differences in Internet use

      Data on Internet use by baseline (W1) diagnostic group are presented in Table 2. Contrary to Hypothesis 1, girls with baseline ADHD did not report significantly higher levels of social PIU ($p=.29$). However, girls with baseline ADHD reported significantly more positive views of online communication ($p<.000$, $d=.64$). No significant difference was found with respect to control motives ($p=.44$). Girls with baseline ADHD also reported significantly greater overall time spent online ($p=.050$, $d=.29$) as well as more time spent online socializing (e.g., IM-ing and emailing) ($p=.022$, $d=.34$).

      Additional descriptive data on specific Internet behaviors by baseline diagnostic group are presented in Table 5. Girls in the comparison group were significantly more likely than girls with childhood ADHD to use the Internet at W3 to talk to same-aged friends who they initially met in person—both friends whom they saw often ($p=.015$, OR=1.9; 95% CI=1.1, 3.2) and not often ($p=.016$, OR=1.9; 95% CI=1.1, 3.2). In contrast, girls with childhood ADHD were significantly more likely to use the Internet at W3 to talk to people they met online and only knew online ($p<.001$, OR=2.5; 95% CI=1.5, 4.2), and to form close online relationships with people they met online, both platonic ($p=.011$, OR=2.0; 95% CI=1.2, 3.3) and romantic ($p<.001$, OR=2.4; 95% CI=1.4, 4.1). Girls with childhood ADHD were also more likely to report having had an in-person romantic relationship with someone initially met online ($p=.008$, OR=2.0; 95% CI=1.2, 3.4), and using the Internet to talk to age-discrepant friends who they don't see often ($p=.025$, OR=1.8; 95% CI=1.1, 3.0).

Hypothesis 2a: Predicting W3 social PIU

      I first tested whether concurrent (W3) ADHD symptom dimensions, as self-reported by the participant, were significantly associated with social PIU at W3. With only these two symptom dimensions in the model, W3 IA symptoms were significantly positively associated

with social PIU at W3 (β=1.58, *p*=.015), but W3 HI symptoms were not. W3 IA symptoms remained significantly associated with social PIU after adjustment for both sociodemographic covariates and stimulant use. When total time spent online was added to the model, W3 IA symptoms remained a significant predictor of social PIU (β=1.36, *p*=.043). Time spent online was also significantly positively associated with social PIU (β =0.44, *p*<.000). This model explained 10.2% of the total variance and was statistically significant (*F*=3.50, df=148, *p*=.002).

   I next tested whether W1 ADHD symptom dimensions (inattention [IA] and hyperactivity/impulsivity [HI]), as reported by the participant's mother, predicted social PIU at W3. With only these two symptom dimensions in the model, W1 HI symptoms were significantly positively associated with social PIU (β=1.12, *p*=.035), but W1 IA symptoms were not. W1 HI symptoms remained significantly positively associated with social PIU after adjusting for sociodemographic covariates (β =1.15, *p*=.036). However, W1 HI symptoms dropped to marginal significance after adjusting for stimulant use (β =1.08, *p*=.063). When total time spent online was added to the model, only time spent online was a significant positive predictor of social PIU (β=0.48, *p*<.000). This model explained 11.4% of the total variance and was statistically significant (*F*=4.07, df=160, *p*<.000).

   Finally, I tested a model including both ADHD symptom dimensions at both time points, to compare relative robustness of W1 versus W3 symptoms as predictor variables. With all independent variables included in the model, W3 IA symptoms remained significantly positively associated with social PIU at W3 (β=1.44, *p*=.037), as did total time spent online (β=0.44, *p*<.000). This final model explained 9.6% of the total variance and was statistically significant (*F*=2.81, df=145, *p*=.005).

<u>Hypothesis 2b: Predicting W4 ADHD symptoms</u>

   Next, I tested whether W3 social PIU predicted subsequent W4 ADHD symptoms (approximately 6 years later). W4 ADHD symptom dimensions were analyzed as two separate outcomes to elucidate potential differences in the impact of social PIU on each symptom dimension.

   I first examined W4 IA symptoms as the dependent variable. With no other variables included in the model, W3 social PIU significantly predicted W4 IA symptoms (β=0.02, *p*=.024). Social PIU remained a significant predictor of W4 IA symptoms after adjustment for both sociodemographic covariates and stimulant use. Additional significant predictors of W4 IA symptoms were W1 household income (β=-0.06, *p*=.003) and stimulant use between W2 and W3 (β=0.43, *p*<.000). When total time spent online was added to the model, W3 social PIU remained a significant predictor of W4 IA symptoms (β=0.03, *p*=.006), as did W1 household income (β=-0.06, *p*=.002) and stimulant use (β=0.45, *p*<.000). Time spent online was also a significant predictor of W4 IA symptoms, although in the opposite direction than expected (β=-0.04, *p*=.017). This model explained 18.1% of the variance and was statistically significant (*F*=7.02, df=157, *p*<.000).

   I then adjusted the above model for W1 ADHD symptoms as a more conservative approach to predicting W4 IA symptoms. With both W1 IA and HI symptoms included in the model, W3 social PIU remained a significant predictor of W4 IA symptoms (β=0.02, *p*=.026), as did W1 household income (β=-0.04, *p*=.025) and time spent online (β=-0.04, *p*=.006). W1 HI symptoms were an additional predictor of W4 IA symptoms (β=0.20, *p*=.004), but W1 IA symptoms were not. This final model explained 30.6% of the variance and was statistically significant (*F*=9.98, df=155, *p*<.000).

I conducted analysis of variance (ANOVA) to determine whether the final regression model predicting W4 IA symptoms, including W3 social PIU as a predictor, was superior to the previous model including all covariates and W1 ADHD symptom dimensions. ANOVA results showed a significant reduction in residual deviance for the final model including W3 social PIU, suggesting that this final model was more effective in predicting W4 IA symptoms compared to the previous model that excluded W3 social PIU, $F(1, 155)=5.07$, $p=.026$.

I next examined W4 HI symptoms as the dependent variable. With no other variables included in the model, W3 social PIU was unrelated to W4 HI symptoms ($p=.10$). W3 social PIU remained non-significant after inclusion of sociodemographic covariates and stimulant use. Both W1 household income ($\beta=-0.04$, $p=.014$) and stimulant use ($\beta=0.48$, $p<.000$) significantly predicted W4 HI symptoms. When time spent online was added to the model, both W1 household income ($\beta=-0.04$, $p=.013$) and stimulant use ($\beta=0.48$, $p<.000$) retained their significance. Time spent online was unrelated to W4 HI symptoms. This model explained 17.1% of the variance and was statistically significant ($F=6.58$, df=157, $p<.000$).

Finally, I adjusted the above model to account for W1 ADHD symptoms. With both W1 IA and HI symptoms included in the model, only W1 HI symptoms significantly predicted W4 HI symptoms ($\beta=0.29$, $p<.000$). Stimulant use dropped to marginal significance ($\beta=0.18$, $p=.062$). This final model explained 32.6% of the variance and was statistically significant ($F=10.8$, df=154, $p<.000$).

Hypothesis 3: Attachment anxiety and self-stigma

I next examined whether (a) attachment anxiety and (b) self-stigma explained the cross-sectional association between W3 IA symptoms and W3 social PIU. Attachment anxiety was examined using the full sample, whereas self-stigma was examined only within the subsample of participants with ADHD due to measure characteristics (see Method for details).

Hypothesis 3a: Attachment anxiety (full sample)

With no other variables included in the model, W3 attachment anxiety was significantly positively associated with W3 social PIU ($\beta=1.34$, $p=.002$). Attachment anxiety remained significantly associated with social PIU after adjustment for sociodemographic covariates ($\beta=1.58$, $p<.000$) and stimulant use ($\beta=1.55$, $p<.000$). No other variables were significantly associated with social PIU. When time spent online was added to the model, W3 attachment anxiety remained significantly associated with social PIU ($\beta=1.39$, $p=.001$). Time spent online was also significantly associated with social PIU ($\beta=0.49$, $p<.000$). This model explained 16.6% of the variance and was statistically significant ($F=6.30$, df=154, $p<.000$).

I then added W3 ADHD symptoms to the above model to compare the relative robustness of attachment anxiety and concurrent IA symptoms in associations with social PIU. With both W3 IA and HI symptoms included in the model, only W3 attachment anxiety was significantly associated with W3 social PIU ($\beta=1.28$, $p=.004$), along with time spent online ($\beta=0.43$, p<.000). This final model explained 14.5% of the variance and was statistically significant ($F=4.14$, df=140, $p<.000$).

I conducted an ANOVA to determine whether the model including attachment anxiety was superior to the model including all covariates and both W3 ADHD symptom dimensions. ANOVA results showed a significant reduction in residual deviance for the model including attachment anxiety, suggesting that this model was more effective in predicting W3 social PIU compared to the model without attachment anxiety, $F(1, 140)=8.44$, $p=.004$.

<u>Hypothesis 3b: Self-stigma (ADHD sample only)</u>

Among only those participants with ADHD, and with no other variables included in the model, W3 self-stigma was not significantly associated with W3 social PIU. When I examined different subscales of the self-stigma measure, no subscales were significantly associated with social PIU. With both sociodemographic covariates and stimulant use included in the model, no variables emerged as significantly associated with social PIU. When time spent online was added to the model, only this variable was significantly associated with social PIU among participants with ADHD (β=0.33, p=.029). This model explained 3.4% of the variance and was not statistically significant.

I then added W3 ADHD symptoms to the above model to explore whether concurrent ADHD symptoms were significantly associated with social PIU when analyses were restricted to the ADHD subsample, and with adjustment for self-stigma. With both W3 IA and HI symptoms included in the model, only W3 IA symptoms were significantly associated with social PIU among those participants with ADHD (β=1.95, p=.047). Time spent online dropped to non-significance (p=.10). This model explained 4.1% of the variance and was not statistically significant.

Finally, I added W3 attachment anxiety to the above model as an additional test to compare the relative robustness of attachment anxiety and concurrent IA symptoms in predicting social PIU specifically among just the ADHD sample. With W3 attachment anxiety added to the model, only attachment anxiety was significantly associated with social PIU (β=1.44, p=.033). W3 IA symptoms dropped to non-significance (p=.10). This final model explained 8.9% of the variance, with a marginally significant overall effect (F=1.79, df=64, p=.087).

Discussion

The current dissertation consisted of two related parts: First, I investigated bidirectional associations between ADHD symptoms and social PIU, and second, I examined attachment anxiety and internalized self-stigma as potential mechanisms underlying one direction of influence, namely that of ADHD symptoms predicting social PIU. In the first section, I found that concurrent (but not childhood) ADHD IA symptoms were significantly and positively associated with social PIU, which then predicted greater ADHD IA (but not HI) symptoms approximately six years later. In the second section, I found that among the full sample, attachment anxiety was more strongly associated with social PIU than were concurrent ADHD symptoms. Among the subsample of girls with childhood ADHD, all dimensions of self-stigma were unrelated to social PIU. I discuss each set of findings in turn.

<u>Part I: Bidirectionality Between ADHD and Social PIU</u>

First, with respect to W1 group differences in Internet use, I found that although girls with childhood diagnoses of ADHD reported more overall time spent online, they did not show higher levels of social PIU, contrary to the first hypothesis. This finding was unexpected, given some evidence indicating that ADHD (a) prospectively predicts later generalized PIU (Chen et al., 2015; Choi et al., 2019; Ko et al., 2009; Morita et al., 2021; Zhou et al., 2020) and (b) is associated with more problematic social media use in cross-sectional research (Andreassen et al., 2016; Dekkers & van Hoorn, 2022).

One possible explanation is that ADHD could be predictive of later generalized PIU but not social PIU. Given the significance of ADHD in predicting higher rates of online gaming (Panagiotidi & Overton, 2018; Paulus et al., 2018) and the consistent link found between online

gaming and generalized PIU (Anderson et al., 2017), the ADHD-PIU association could partly reflect a more circumscribed prospective link between ADHD and online gaming activity. Another possible explanation pertains to sample differences: all five prospective studies cited above were conducted with East Asian youth, whereas the present data were collected from a sample of American girls. It could be that ADHD is a particularly potent predictor of social PIU among East Asian youth, potentially driven by cultural differences in rates of ADHD recognition, diagnosis, and treatment (Hinshaw et al., 2011; Hong et al., 2013; Ma & Lai, 2014). It could also be that social PIU is so normative among American youth that a childhood diagnosis of ADHD does not confer additional risk beyond the numerous structural factors supporting widespread adoption of the Internet for social purposes. Still, this seems somewhat unlikely given that data for the current study were collected in the early 2010s, just prior to the current ubiquity of social media apps and smartphone ownership.

Regarding more specific online social behaviors, I found that neurotypical girls and girls with ADHD diverged significantly regarding with whom they socialized online. Girls in the neurotypical comparison group were more likely to use the Internet to socialize with people they initially met in-person, whereas girls with ADHD were more likely to initiate and maintain new relationships entirely online. This finding is consistent with previous research that youth with ADHD are more likely to use Facebook to meet new people and to initiate (and terminate) romantic relationships (Gul et al., 2018). Although outside the scope of the original hypotheses, these results provide important descriptive data regarding how social PIU may manifest differently by baseline diagnostic group, even if groups did not significantly differ on *rates* of social PIU.

In line with lack of group differences in rates of social PIU, I found that childhood ADHD symptoms did not significantly predict social PIU after adjustment for covariates. However, concurrent ADHD IA symptoms (but not HI symptoms) were significantly and positively correlated with social PIU. These findings are consistent with cross-sectional research showing a link between generalized PIU and co-occurring ADHD (Carli et al., 2013; Wang et al., 2017) and suggest that *current* symptoms of ADHD, rather than past impairments, are associated with social PIU. Moreover, these findings align with prior research highlighting the role of inattention in predicting generalized PIU (Chou et al., 2016; Yen et al., 2009; Yılmaz et al., 2015). Youth with existing attention deficits may prefer the Internet as a medium that demands less immediate attention to the conversation and attendant social cues. For example, IM-ing and other forms of text-based communication do not require users to remember what was previously said, as users can simply scroll up to reread what was communicated and then craft an appropriate response. Indeed, some research indicates that the inattentive symptoms of ADHD may be especially disruptive for maintaining social relationships (Blachman & Hinshaw, 2002), which could contribute to over-reliance on the Internet for social activities if girls with IA symptoms feel otherwise unable to sustain connections with others.

With respect to bidirectionality, I found that social PIU positively predicted ADHD IA symptoms, but not HI symptoms, approximately six years later, by emerging adulthood—a link that withstood adjustment for sociodemographic covariates, stimulant use, time spent online, and baseline symptom levels. These results add to a growing body of research indicating that social PIU could contribute to later problems with attention and concentration (McNamee et al., 2021; Ra et al., 2018). In one of the few longitudinal studies investigating bidirectionality, Morita et al. (2021) found a bidirectional association over time between generalized PIU and a combined index of hyperactivity/inattention. I found that social PIU in late adolescence (W3) predicted

ADHD IA (but not HI symptoms) in adulthood (W4), perhaps pointing to a narrower link between difficulties self-regulating online social activity and later attention-related problems. Social PIU may deprive users of valuable opportunities to practice maintaining attention and concentration in social interactions, potentially exacerbating preexisting deficits in attention. Such problems could contribute to an unfortunate positive feedback loop, if youth with attention deficits seek out a social environment that facilitates interaction by deemphasizing the very skills that would be most helpful to cultivate.

In the current study, ADHD HI symptoms were neither a predictor nor an outcome of social PIU, contrasting with some prior research indicating a link between HI and generalized PIU (Chen et al., 2015; Choi et al., 2019; Ioannidis et al., 2016). One possible explanation is that HI symptoms are relevant for generalized but not social PIU. As noted previously, generalized PIU encompasses a broad range of online activities, including gaming, shopping, and gambling, all of which have been linked to clinically significant levels of impulsivity (Ayraler Taner et al., 2022; Brunault et al., 2020; Panagiotidi & Overton, 2018; Zhang et al., 2022). It may be that impulsivity contributes to difficulties self-regulating certain online activities while playing a more limited role in online communication patterns. Additionally, HI symptoms could be less relevant in understanding social PIU among adolescent girls compared to boys, who are typically overrepresented in studies of ADHD and generalized PIU. Indeed, one study of computer gaming disorder found that when participants were stratified by gender, inattention was the second most robust predictor of gaming disorder for girls versus hyperactivity/impulsivity for boys (Paulus et al., 2018). In the current all-female sample, HI symptoms could have played a less important role than in studies with all-male or mixed-gender samples—especially regarding social PIU, as males on average report higher levels of all online activities *except* for social networking (Xin et al., 2018).

It is worth noting that in the majority of analyses, overall time spent online was positively correlated with social PIU, consistent with prior research on generalized PIU (Thatcher & Goolam, 2005; Zhang et al., 2008). This finding is not surprising, given that "excessive" use is inherently built into several of the items used to capture social PIU in the current study (e.g., "I have attempted to spend less time socializing online but have not been able to"). Time spent online was additionally predictive of later ADHD IA symptoms, but in the opposite direction than expected, suggesting that social PIU and overall frequency of use are distinct constructs despite being moderately correlated (Boer et al., 2021; Davis et al., 2002; Morahan-Martin & Schumacher, 2000). Indeed, time spent online was unrelated to later ADHD HI symptoms, consistent with Morita et al. (2021), who found that although generalized PIU predicted later IA/HI, there was no association between IA/HI and total time spent online. Similarly, Boer et al. (2020) found that ADHD symptoms were predicted only by *problems* with social media use, not *intensity* (i.e., frequency) of social media use. Thus, although greater time spent online may be a useful marker of potential social PIU, the raw frequency of Internet use may not meaningfully contribute to later ADHD symptoms, especially as Internet use becomes increasingly more normative and integrated into daily life.

A final point worth noting is the significance of baseline household income in relation to later ADHD symptoms. In the final model predicting W4 ADHD IA symptoms, baseline household income remained significantly negatively associated with IA symptomatology. Income was also initially negatively related to W4 ADHD HI symptoms, although it did not retain significance in the final model adjusting for baseline symptoms. The link between early household income and IA symptoms in adulthood is not particularly surprising given how

strongly socioeconomic status affects access to mental health care and support services (Reiss, 2013). Nonetheless, the finding that early household income predicts IA symptoms in adulthood, even after adjustment for stimulant use, suggests that a higher socioeconomic status in childhood may exert a ripple effect that extends beyond access to medication.

Part 2: Attachment Anxiety

Across the full sample, I found that W3 attachment anxiety was significantly positively associated with concurrent social PIU. This finding is consistent with research indicating that an anxious attachment style is associated with both a greater likelihood of generalized PIU (Cacioppo et al., 2019; Schimmenti et al., 2014) and more problematic social media use (Liu & Ma, 2019; Worsley et al., 2018). Interestingly, attachment anxiety was not associated with either overall amount of time spent online nor time spent online socializing (i.e., IM-ing and emailing), suggesting that attachment anxiety is more specifically related to problems self-regulating online social activity than to online socializing more broadly.

When both W3 ADHD symptom dimensions and attachment anxiety were included in the model of social PIU, only attachment anxiety retained significance, with ADHD IA symptoms no longer contributing. Because all three variables were assessed at the same time point, formal mediation cannot be claimed here. Still, these results suggest that a substantial proportion of the variance in social PIU shared by ADHD IA symptoms may be accounted for by co-occurring attachment anxiety. Some research suggests that IA symptoms may interfere with the development of social skills more so than HI symptoms, in that youth with the inattentive form of ADHD tend to be more isolated and withdrawn than those with the hyperactive/impulsive form (Wheeler & Carlson, 1994). Perhaps by adolescence, certain ADHD IA symptoms, such as being forgetful and easily distracted, overlap directly with anxiety about navigating close relationships. High levels of attachment anxiety could very well manifest as attention deficits in social interactions, if intense preoccupation with the relationship itself undermines the ability to remain present and engaged in real time communication (Scharf et al., 2014).

An unanswered question is whether early attachment anxiety, as assessed in infancy or childhood, would prospectively predict social PIU in adolescence. An anxious attachment style in childhood has been linked to later social difficulties with peers (Bohlin et al., 2000), as well as behavioral problems and issues with impulse control (Dubois-Comtois et al., 2013; Glazebrook et al., 2015). However, to my knowledge, all prior research in this area has examined correlations between PIU and *adult* attachment anxiety, similar to the current study. Further longitudinal research would help to clarify the developmental significance of attachment anxiety as a predictor of social PIU. Considering the logistical challenges inherent in following participants from infancy into adulthood, future studies could also investigate key constructs related to attachment anxiety, such as rejection sensitivity or excessive reassurance-seeking, that may be more feasible to assess later in development.

Part 3: Self-Stigma

Contrary to Hypothesis 3b, ADHD-related self-stigma was not associated with social PIU among girls with childhood diagnoses of ADHD. No significant associations were found when examining either the total self-stigma score or the separate subscale scores. These analyses were restricted to the subsample of girls with childhood ADHD given that the stigma measure tapped distinct domains of stigma (i.e., self-stigma versus other-related stigma) for the ADHD versus comparison groups (see Method for details).

Despite research suggesting that socializing online may be particularly compelling for users with marginalized identities (McKenna & Bargh, 1999; Miller, 2017), few studies have explored whether self-stigma significantly contributes to social PIU in these populations. A thorough literature review revealed only one study investigating self-stigma and social PIU in the context of ADHD symptoms (Lee et al., 2023). These researchers found a significant cross-sectional association between problematic social media use and self-stigma among youth with ADHD; however, they interpret these results as an indication of problematic social media use leading to increased self-stigma, rather than the reverse direction (Lee et al., 2023). Indeed, much of the research in this area appears to examine self-stigma as an outcome of social PIU rather than an antecedent, with a particular focus on weight-related stigma following prolonged social media use (see Fung et al., 2021).

There are several possible reasons why self-stigma and social PIU were unrelated in the current study. First, in comparison with past research, our sample of girls with ADHD reported relatively low levels of self-stigma. Previous studies of adults with ADHD have reported average overall self-stigma scores of 2.1 (Masuch et al., 2019) and 2.0 (Quenneville et al., 2020) on the ISMI scale (range=1.0 to 4.0), whereas our sample mean was 1.6. Furthermore, Masuch et al. (2019) noted that 23% of their sample qualified as having high self-stigma (designated by an overall score > 2.5), whereas only 3.3% of our sample would qualify using this same metric. Alternatively, our sample could reflect a trend in the ADHD population more broadly, such that self-stigma tends to be less pronounced and to exert less of an impact on social PIU among those with ADHD compared to those with other disorders. Quenneville et al. (2020) note that in their sample, adults with ADHD reported significantly less self-stigma relative to adults with bipolar disorder and adults with borderline personality disorder. Other research using the ISMI has also found higher average self-stigma (*M*=2.9) among adults with substance use disorders (Can & Tanrıverdi, 2015). Self-stigma regarding an ADHD diagnosis may be lower if adolescents tend to see themselves as less "at fault" for neurodevelopmental disorders compared to other disorders (Moses, 2009).

Intriguingly, exploratory post-hoc analyses revealed that among girls with childhood ADHD, youth who had established a close relationship with someone met online reported *lower* feelings of alienation and *higher* levels of stigma resistance compared to youth without this experience. Although forming a close relationship with someone met online is clearly not an identical construct to social PIU, these results appear to run somewhat counter to the hypothesis that ADHD self-stigma would be positively correlated with social PIU. It could be that youth with low levels of ADHD self-stigma are actually *more* inclined to harness the Internet as a social tool, possibly to meet others with similar dispositions. Gajaria et al. (2011) found that young users in ADHD social groups on Facebook were expressing "a decidedly positive net valence to having ADHD," such that posts discussing the positive elements of ADHD outweighed negative posts by more than three to one (Gajaria et al., 2011, p.17). Such an affirmative online atmosphere could constitute an additional "pull" factor for youth who feel empowered by their diagnosis and want to interact with others who feel the same. Indeed, those with relatively high ADHD self-stigma could even be avoiding these forums if the dominant narrative is one that feels at odds with their own experience.

One final possibility is that ADHD self-stigma does *initially* contribute to higher levels of social PIU, but these online interactions then reduce self-stigma over time. This pattern would help to explain the particularly low degree of self-stigma found among those girls who reported having established at least one close relationship with someone met online. Temporally, the

development of such relationships would necessarily precede the time of data collection when self-stigma measures were completed, potentially yielding the low levels of self-stigma observed at W3. Breuer and Barker (2015) found that for Internet users with diagnoses of depression, participation in online peer support groups led to reductions in both symptom severity and self-stigma, supporting the theory that online interactions may reduce self-stigma in certain contexts. Yet, another study found that the frequency of visits to online support groups corresponded with *diminished* recovery from self-stigma among those with mental health disorders (Lawlor & Kirakowski, 2014). These authors argue that their results point to pre-existing characteristics of active users that facilitate reductions in self-stigma, rather than a systematic effect of support group participation. This interpretation is more consistent with the idea that girls with low ADHD self-stigma could be more inclined to engage in online social interactions, whether by virtue of their stigma resistance or other latent variables.

Altogether, the current findings suggest that the link between ADHD self-stigma and social PIU is likely to be more complex than a simple linear association. It could be that higher ADHD self-stigma contributes to certain patterns of online social activity or behaviors that do not encompass social PIU; that higher self-stigma contributes to social PIU initially but declines over time as users establish more positive identities through online relationships; or that higher self-stigma is truly unrelated to social PIU among girls with ADHD. Longitudinal research with repeated measures of self-stigma will be necessary to untangle relations between self-stigma and social PIU among youth with ADHD.

Methodology: Limitations and Strengths

Several methodological considerations should be highlighted as both limitations and strengths of the current study. First, with respect to limitations, the current sample of adolescent girls living in the Northern California Bay Area is not representative of the general population of youth, or even youth with ADHD. Considering that girls appear more likely both to engage in social Internet use (Andreassen et al., 2016; Boer et al., 2020; Ciarrochi et al., 2016) and to suffer poor mental health as a result (Kelly et al., 2018; McNamee et al., 2021; Twenge et al., 2022), a special focus on this population is warranted. However, the findings reported herein may be of less applicability to boys, given some evidence for sex differences in the etiology of generalized PIU (Deryakulu & Ursavaş, 2014; Ha & Hwang, 2014).

Another limitation is that these data on social Internet use were collected between 2007 and 2010, when adolescents were primarily frequenting online chatrooms and the two major social networking platforms, MySpace (launched in 2003) and Facebook (launched in 2004). This period may be considered an early precursor to the current ubiquity of social media apps (for example, the popular app Instagram did not launch until October of 2010). Thus, the current results cannot speak to the correlates or consequences of social media as it currently exists. Smartphones, moreover, were not nearly as prevalent during the time of data collection as they are now. Indeed, the Pew Research Center only began collecting statistics on smartphone ownership in 2011, when just 35% of respondents owned a smartphone (Pew Research Center, 2021). Although we did not ask our participants how they accessed the Internet, it is reasonable to assume that between 2007 and 2010, the vast majority were logging online via computers, which are inherently less accessible than mobile smartphones. Indeed, given that modern smartphones provide instantaneous access to social media apps and often interrupt users' attention with incoming notifications, it could be that the current findings actually underestimate the strength of associations between social PIU and inattentive symptoms (see Zheng et al.,

2014). Still, that our participants were not engaged with modern-day social media apps via smartphone is important to remember when interpreting the current results.

Further considerations pertain to measures and data collection procedures. Our measure of stigma tapped self-stigma only among girls with childhood ADHD. The version of the ISMI administered to the comparison group asked participants to report on stigmatized beliefs about people with ADHD (e.g., "It is embarrassing and shameful to have ADHD"). Such other-related stigma, or endorsement of negative stereotypes about a particular outgroup, develops and functions differently from self-stigma, which reflects internalized beliefs about the self and one's ingroup (Corrigan & Watson, 2002). Thus, we were limited to analyzing associations between self-stigma and social PIU only among the subsample of girls with childhood ADHD, leading to reduced statistical power for this particular analysis. In addition, our measure of attachment was originally designed to capture attachment styles specifically in the context of romantic relationships and could therefore be less relevant to patterns of online communication with friends. Finally, as noted previously, data on attachment anxiety (and self-stigma) were collected at the same time point as the data on social PIU, leaving open questions about causality and precluding the ability to investigate formal mediation.

A key strength of the current study is the utilization of longitudinal, prospective data, which are unfortunately rare in studies of Internet use and psychopathology (see Schønning et al., 2020). These data allowed for a more nuanced investigation of temporal associations between ADHD symptoms and social PIU, as well as adjustment for baseline symptomatology and sociodemographic factors previously found to influence social media use (McNamee et al., 2021). In addition, ADHD in the current sample was carefully, rigorously diagnosed by clinical experts, with symptoms assessed using multiple informants, minimizing the possibility of inaccurate self-reports of ADHD. Analyses also adjusted for participants' use of stimulant medication, yielding more conservative estimates of the effects of current ADHD symptoms on social PIU. Finally, the inclusion of overall time spent online as a covariate allowed for greater isolation of the specific effect of social PIU on later ADHD symptoms—especially important as PIU is often conflated with the raw amount of time spent online, despite evidence that ADHD is linked to problematic rather than purely excessive use (Boer et al., 2020; Thorell et al., 2022).

Implications and Future Directions

The current results are consistent with a bidirectional association between inattentive symptoms and social PIU. Adolescent ADHD IA symptoms were positively associated with concurrent social PIU, which in turn predicted greater ADHD IA symptoms approximately six years later. Much of the existing research in this area examines anxiety and depression as outcomes of generalized or social PIU. The current study suggests that one form of PIU, namely social PIU, may also exert a negative influence on cognitive functioning, highlighting yet another domain of mental health that may be vulnerable to problematic social Internet use.

Returning to the "push/pull" framework of motivations for Internet use, these findings may indicate that social PIU is more strongly related to "push" factors, or factors that allow users to avoid potentially negative social experiences, at least among adolescents. Attachment anxiety may be a particularly robust correlate of online socializing among adolescent girls. Excessive online communication may allow users to avoid feeling lonely or sitting with the fears of abandonment and rejection that commonly characterize attachment anxiety. Moreover, virtual interactions enable users to limit the pain of rejection by blocking the rejector or simply logging offline; such behavior serves to avoid many threatening aspects of in-person rejection, including

visual cues of embarrassment and being witnessed by other people in the surrounding environment. In the current study, attachment anxiety even outweighed the role of inattentive symptoms in cross-sectional associations with social PIU. This finding, along with the similar rates of social PIU in girls both with and without ADHD, appears to challenge the assertion of Davis (2001) that PIU necessarily and directly stems from psychopathology. Especially as social media use becomes increasingly integrated into modern life, it may be that social PIU is not always a behavioral manifestation of underlying mental health issues. Rather, the relationship-related worries so typical of adolescent girls, in combination with ubiquitous access to social media, may combine to fuel social PIU across populations—whether youth struggle with inattention or not. However, further research is needed to confirm causal links.

With respect to clinical implications, these results underscore the importance of regularly monitoring youth for potential signs of social PIU. It may be especially prudent to monitor these behaviors among adolescent girls, given their susceptibility to downstream effects of social PIU. For youth with ADHD, whose attention deficits may be exacerbated by social PIU, clinicians would do well to ask about social media use and consider recommending limits on usage if youth show signs of social PIU. In one qualitative study, adolescents noted that simply deterring their access to social media (whether by using app-based restrictions or physically removing social media from their immediate environments) helped to improve their self-regulation (Arness & Ollis, 2022). Emotion regulation skills may also be useful: many youth with generalized PIU show deficits in emotion regulation (Gioia et al., 2021; Spada et al., 2017), which is increasingly recognized as a core facet of ADHD (Graziano & Garcia, 2016; Shaw et al., 2014). In theory, improving emotion regulation could help to reduce reliance on virtual social interactions as a coping mechanism, thereby mitigating the development of social PIU (Yu et al., 2013).

Findings also highlight attachment anxiety as a variable that deserves more clinical attention in relation to social PIU, especially among adolescent girls. Although attachment anxiety does not constitute a diagnosable mental health disorder, intervention research suggests that an anxious attachment style is amenable to treatment with psychotherapy (Slade & Holmes, 2019). One randomized controlled trial found that increased attachment security corresponded with reductions in emotional issues and peer problems among adolescents (Barone et al., 2021). Given the robust correlation between attachment anxiety and social PIU in the current study, interventions to improve attachment security could potentially help to mitigate social PIU if they reduce fears of peer rejection and abandonment. Group therapies and school-based interventions may be especially useful as a means of fostering additional social skills and bolstering girls' offline support networks (Dekkers & van Hoorn, 2022). Considering how attachment anxiety often reflects a desire for greater intimacy, strengthening girls' capacity to establish and maintain close relationships may lead to less reliance on the Internet for socialization. Future research should explore the efficacy of different treatment options for youth with social PIU, ideally taking into account users' underlying motivations for prioritizing online interaction.

Taken together, I suggest that the current findings challenge traditional stereotypes about Internet "addicts" being compulsive and driven by a need for constant stimulation. Rather, for social Internet users in particular, anxiety about relationships and difficulties self-regulating attention may underlie patterns of problematic online behavior. These behaviors, in turn, predict increased deficits in attention years later, adding to our understanding of how social PIU affects different domains of psychological functioning. Clinicians and parents alike may want to consider monitoring and restricting social Internet use, especially among girls with ADHD, to break this feedback loop and promote healthier means of finding social support.

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Table 1.

Overview of included study variables by assessment wave (W1-W4) and years of data collection

Study variables	W1 (1997-1999)	W2 (2002-2005)	W3 (2007-2010)	W4 (2013-2016)
Diagnostic group (Comparison vs. ADHD)	X		X	X
Inattentive (IA) ADHD symptoms	X		X	X
Hyperactive/impulsive (HI) ADHD symptoms	X		X	X
Internet use			X	
Attachment anxiety			X	
Identity-related stigma			X	
Maternal education	X			
Income	X			
Current age	X		X	
Stimulant medication use[1]	X	X	X	

[1]Stimulant medication use reflects any reported use of stimulant medication between W1 and W3

Table 2.

Full sample characteristics

Sample characteristics[1]	Range	Full sample (N = 228)	Comparison (N=88)	ADHD (N=140)	p value	Effect size (Cohen's d)
Demographics						
W1 age	6.6 - 13.4	9.6 (1.7)	9.4 (1.7)	9.6 (1.7)	.377	
Race / ethnicity	.				.040	0.36 [0.11, 0.62]
% White (not Latina)		52.6 (120)	46.6 (41)	56.5 (79)		
% Black		27.2 (62)	26.1 (23)	27.9 (39)		
% Latina		11.0 (25)	11.4 (10)	10.7 (15)		
% Asian-American		8.8 (20)	15.9 (14)	4.3 (6)		
% Native-American		0.4 (1)	0.0 (0)	0.7 (1)		
Income	1.0 - 9.0	6.4 (2.6)	6.7 (2.4)	6.2 (2.7)	.105	
Maternal education	2.0 - 6.0	4.8 (1.0)	4.9 (1.0)	4.7 (1.0)	.096	
% on stimulant since W2	.	33.5 (70)	1.2 (1)	54.0 (69)	.000	1.15 [0.85, 1.44]
Internet use						
Social PIU	7.0 - 27.0	13.1 (4.4)	12.7 (4.0)	13.4 (4.7)	.285	
Overall preference	10.0 - 48.0	20.2 (6.5)	18.0 (4.7)	21.8 (7.1)	.000	0.64 [0.35, 0.94]
Desire for control	3.0 - 12.0	7.4 (2.5)	7.6 (2.5)	7.3 (2.5)	.435	
Overall time spent online	4.0 - 19.0	6.7 (3.1)	6.2 (2.5)	7.1 (3.4)	.050	0.29 [0.00, 0.57]
Time spent online socializing	2.0 - 10.0	3.3 (1.7)	3.0 (1.4)	3.6 (1.9)	.022	0.34 [0.05, 0.62]
Attachment anxiety	1.0 - 4.7	2.1 (0.8)	2.0 (0.7)	2.3 (0.8)	.012	0.37 [0.08, 0.65]
Identity-related stigma (ADHD only)[2]						
Alienation	4.0 - 23.0	.	10.8 (3.3)	10.0 (3.1)	.	.
Stereotype endorsement	6.0 - 21.0	.	10.9 (2.8)	10.0 (2.9)	.	.
Discrimination experiences	5.0 - 17.0	.	10.0 (3.1)	8.9 (3.2)	.	.
Social withdrawal	6.0 - 19.0	.	10.8 (3.3)	9.9 (3.5)	.	.
Stigma resistance	5.0 - 20.0	.	9.7 (2.4)	9.4 (2.6)	.	.

[1] Data are presented as mean (SD) for continuous variables and percentage (N) for categorical variables of race and stimulant use
[2] Full sample and comparison statistics not calculated due to differences in construct measurement by diagnostic group

Table 3.

Correlations among the full sample (N=228)

Correlations (full sample)	W1 IA sx	W1 HI sx	W3 IA sx	W3 HI sx	W4 IA sx	W4 HI sx	Social PIU	Attachment anxiety
W1 IA sx	–							
W1 HI sx	.770**	–						
W3 IA sx	.360**	.347**	–					
W3 HI sx	.342**	.409**	.662**	–				
W4 IA sx	.360**	.446**	.612**	.491**	–			
W4 HI sx	.384**	.501**	.537**	.643**	.665**	–		
Social PIU	.069	.151*	.242**	.158*	.169*	.125	–	
Attachment anxiety	.175*	.211**	.237**	.263**	.188**	.211**	.237**	–

* $p < .05$ ** $p < .01$

Abbreviations: inattentive symptoms (IA sx), hyperactive/impulsive symptoms (HI sx)
Note: Wave 1 (W1) symptom dimensions reported by the girl's mother; all other variables self-reported

Table 4.

Correlations among participants with ADHD (N=140)

Correlations (ADHD sample)	W1 IA sx	W1 HI sx	W3 IA sx	W3 HI sx	W4 IA sx	W4 HI sx	Social PIU	Attachment anxiety	ISMI total score	ISMI: alien	ISMI: stereo	ISMI: discrim	ISMI: withdraw	ISMI: stigma resistance
W1 IA sx	–													
W1 HI sx	.294**	–												
W3 IA sx	.181	.190*	–											
W3 HI sx	.061	.246**	.625**	–										
W4 IA sx	.092	.321**	.562**	.417**	–									
W4 HI sx	.021	.362**	.488**	.598**	.587**	–								
Social PIU	.011	.163	.293**	.180	.218*	.135	–							
Attachment anxiety	.053	.178	.266**	.294**	.209*	.238*	.249*	–						
ISMI total score	.105	.061	-.107	-.062	-.106	-.050	.008	-.036	–					
ISMI subscale: alienation	.038	-.014	-.128	-.078	-.072	-.086	-.090	-.041	.850**	–				
ISMI subscale: stereotyping	.110	.020	-.072	-.080	-.070	.016	.145	-.048	.814**	.601**	–			
ISMI subscale: discrimination	.060	-.006	-.162	-.101	-.155	-.102	-.034	-.043	.815**	.647**	.579**	–		
ISMI subscale: withdrawal	.084	.066	-.161	-.085	-.206*	-.112	-.084	-.065	.892**	.735**	.630**	.788**	–	
ISMI subscale: stigma resistance	.108	.182*	.165	.137	.162	.141	.128	.079	.310**	.116	.223*	-.091	.065	–

* p < .05   ** p < .01

Abbreviations: inattentive symptoms (IA sx), hyperactive/impulsive symptoms (HI sx)

Note: Wave 1 (W1) symptom dimensions reported by the girl's mother; all other variables self-reported

Table 5.

Internet-based social activities

Internet-based social activity (% endorsed, N)	Full sample (N=228)	Comparison (N=88)	ADHD (N=140)	p value	Effect size (OR)
Ever talk to family members	59.3 (115)	55.0 (44)	62.3 (71)	.386	
Ever talk to someone first met in person, same age, who you see often	80.0 (156)	88.9 (72)	73.7 (84)	.015	1.90 [1.13, 3.19]
Ever talk to someone first met in person, same age, who don't see often	74.4 (145)	84.0 (68)	67.5 (77)	.016	1.89 [1.13, 3.17]
Ever talk to someone first met in person, different age, who you see often	54.4 (106)	53.1 (43)	55.3 (63)	.877	
Ever talk to someone first met in person, different age, who you don't see often	47.2 (92)	37.0 (30)	54.4 (62)	.025	1.80 [1.08, 3.02]
Ever talk to someone first met online, who you only know online	34.5 (67)	20.0 (16)	44.7 (51)	.001	2.49 [1.47, 4.21]
Ever formed a close online friendship with someone met online	26.2 (51)	16.0 (13)	33.3 (38)	.011	1.95 [1.16, 3.28]
Ever formed an online romantic relationship with someone met online	12.3 (24)	2.50 (2)	19.3 (22)	.001	2.41 [1.43, 4.08]
Ever formed an in-person romantic relationship with someone met online	16.4 (32)	7.40 (6)	22.8 (26)	.008	2.02 [1.20, 3.40]
Ever had casual sexual activity with someone met online	8.7 (17)	4.90 (4)	11.4 (13)	.187	

Factor analysis of online communication scale[1,2]

	Scale item (paraphrased)	Factor 1 (positivity)	Factor 2 (control)	Factor 3 (problematic use)
1	I have more fun with people I know online…	.826		
2	Most of my friends are from online	.801		
3	I am friendlier online than in real life	.768		
4	My online friends understand me better…	.735		
5	I am more myself online than in real life	.735		
6	I open up more to people online…	.637		
7	Going online has made it easier for me to make friends	.634		
8	I have missed in-person social engagements…	.620		
9	Sometimes I pretend I am someone I am not…	.603		
10	I prefer communication online over face-to-face	.508		
11	I have a network of friends made online	.485		
12	I have shared intimate secrets online	.479		
13	I have missed class or work because of online socializing	.471		-.318
14	The anonymity of being online is liberating	.357		
15	Online communication lets me control what…		.858	
16	Online communication lets me control when…		.829	
17	Being online has made it easier to communicate…		.559	
18	I have been told I spend too much time socializing online			-.784
19	I have attempted to spend less time socializing online…			-.760
20	I feel guilty about the time spent socializing online…			-.653
21	I have gone socializing online to make myself feel better…			-.652
22	I have routinely cut short on sleep to socialize online			-.626
23	Hard to stop thinking about what I'm missing while offline			-.561
24	I have gone online to talk to others when feeling isolated			-.463

[1] Pattern matrix
[2] Extraction method: Principle Axis Factoring

Note: final factors included all items with factor loadings > .400

Complete online communication scale

1. My online friends understand me better than other people.
2. I am more myself online than in real life.
3. I open up more to people online than in other communication modes.
4. Most of my friends are from online.
5. I prefer communicating online rather than in face-to-face communication.
6. I am friendlier online than in real life.
7. The anonymity of being online is liberating.
8. I have shared intimate secrets online.
9. Going online has made it easier for me to make friends.
10. I have more fun with people I know online than with others.
11. I have a network of friends made online.
12. Sometimes I pretend I am someone I am not while online.
13. Being online has made it easier to communicate with the people I know.
14. Being online lets me control *when* I want to communicate.
15. Being online lets me control *what* I want to communicate.
16. I feel guilty about the amount of time spent socializing online instead of working.
17. I have been told that I spend too much time socializing online.
18. I have routinely cut short on sleep to spend more time socializing online.
19. I have gone socializing online to make myself feel better when down or anxious.
20. I have used online to talk to others when I was feeling isolated.
21. I have missed in-person social engagements because of online activities.
22. I have missed class or work because of online socializing activity.
23. I have attempted to spend less time socializing online but have not been able to.
24. If it has been a long time since I last logged on, I find it hard to stop thinking about what will be waiting for me when I do.

Complete adult attachment scale[1]

1. I find it relatively easy to get close to others.
2. **I do <u>not</u> worry about being abandoned.[2]**
3. I find it difficult to allow myself to depend on others.
4. **In relationships, I often worry that my partner does not really love me.**
5. **I find that others are reluctant to get as close as I would like.**
6. I am comfortable depending on others.
7. I do <u>not</u> worry about someone getting too close to me.
8. I find that people are never there when you need them.
9. I am somewhat uncomfortable being close to others.
10. **In relationships, I often worry that my partner will not want to stay with me.**
11. **I want to merge completely with another person.**
12. **My desire to merge sometimes scares people away.**
13. I am comfortable having others depend on me.
14. I know that people will be there when I need them.
15. I am nervous when anyone gets too close.
16. I find it difficult to trust others completely.
17. Often, partners want me to be closer than I feel comfortable being.
18. I am not sure that I can always depend on others to be there when I need them.

[1] **Bolded** items are included in the anxiety subscale
[2] Reverse scored.

Complete ISMI scale (ADHD version)

1. I feel inferior to others who don't have ADHD.
2. People can tell that I have ADHD by the way I look.
3. I am embarrassed or ashamed that I have ADHD.
4. I avoid getting too close to people who don't have ADHD to avoid rejection.
5. Nobody would be interested in getting close to me because I have ADHD.
6. Others think that I can't achieve much in life because I have ADHD.
7. People without ADHD could not possibly understand me.
8. I am disappointed in myself for having ADHD.
9. Because I have ADHD, I need others to make most decisions for me.
10. People with ADHD tend to be violent.
11. Negative stereotypes about ADHD keep me isolated from the "normal" world.
12. I stay away from social situations in order to protect my family or friends from embarrassment.
13. Living with ADHD has made me a tough survivor.
14. People often patronize me, or treat me like a child, just because I have ADHD.
15. Being around people who don't have ADHD makes me feel out of place or inadequate.
16. People with ADHD cannot live a good, rewarding life.
17. I feel comfortable being seen in public with a person who obviously has ADHD.
18. I can't contribute anything to society because I have ADHD.
19. People ignore me or take me less seriously just because I have ADHD.
20. People with ADHD make important contributions to society.
21. People with ADHD shouldn't get married.
22. People discriminate against me because I have ADHD.
23. I don't talk about myself much because I don't want to burden others with my ADHD.
24. I don't socialize as much as I used to because my ADHD might make me look or behave "weird."
25. In general, I am able to live life the way I want to.
26. I can have a good, fulfilling life despite having ADHD.
27. Having ADHD has spoiled my life.
28. Stereotypes about people with ADHD apply to me.
29. I feel out of place in the world because I have ADHD.

Alienation subscale (items 1, 3, 7, 8, 27, 29)
Stereotype endorsement subscale (items 2, 9, 10, 16, 18, 21, 28)
Discrimination experience subscale (items 5, 6, 14, 19, 22)
Social withdrawal subscale (items 4, 11, 12, 15, 23, 24)
Stigma resistance subscale (items 13, 17, 20, 25, 26) (reverse coded)

Complete ISMI scale (Comparison version)

1. People with ADHD feel inferior to others who don't have ADHD.
2. You can tell that someone has ADHD by the way they look.
3. It is embarrassing and shameful to have ADHD.
4. People with ADHD avoid getting too close to people who don't have ADHD to avoid rejection.
5. Nobody would be interested in getting close to a person that has ADHD.
6. Others think that people with ADHD can't achieve much in life because of their ADHD.
7. People without ADHD could not possibly understand someone with ADHD.
8. It would be personally disappointing to have ADHD.
9. People with ADHD need others to make most decisions for them.
10. People with ADHD tend to be violent.
11. Negative stereotypes about ADHD keep people with ADHD isolated from the "normal" world.
12. People with ADHD stay away from social situations in order to protect their family or friends from embarrassment.
13. Living with ADHD makes people with ADHD tough survivors.
14. Others often patronize individuals with ADHD or treat them like a child because of their ADHD.
15. People with ADHD feel out of place or inadequate when they are around people who don't have ADHD.
16. People with ADHD cannot live a good, rewarding life.
17. I feel comfortable being seen in public with a person who obviously has ADHD.
18. People with ADHD can't contribute anything to society because of their ADHD.
19. People with ADHD are ignored or taken less seriously because of their ADHD.
20. People with ADHD make important contributions to society.
21. People with ADHD shouldn't get married.
22. People discriminate against individuals because they have ADHD.
23. People with ADHD don't talk about themselves much because they don't want to burden others with their ADHD.
24. People with ADHD don't socialize much because their ADHD might make them look or behave "weird."
25. In general, people with ADHD are able to live life the way they want to.
26. People with ADHD can have a good, fulfilling life despite their ADHD.
27. For people with ADHD, their ADHD has spoiled their life.
28. Stereotypes about ADHD apply to individuals with ADHD.
29. People with ADHD feel out of place in the world because of their ADHD.

Alienation subscale (items 1, 3, 7, 8, 27, 29)
Stereotype endorsement subscale (items 2, 9, 10, 16, 18, 21, 28)
Discrimination experience subscale (items 5, 6, 14, 19, 22)
Social withdrawal subscale (items 4, 11, 12, 15, 23, 24)
Stigma resistance subscale (items 13, 17, 20, 25, 26) (reverse coded)