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REVIEW ARTICLE

Is there a prodrom period in patients with social anxiety disorder? A discussion on the hypothesis of social anxiety disorder development secondary to attention-deficit/hyperactivity disorder

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Abstract

The association between social anxiety disorder (SAD) and attention-deficit/hyperactivity disorder (ADHD) is poorly established. In fact, increasing and converging evidences suggest that there is a close relationship between the two disorders. High comorbidity rate between these two disorders, follow-up studies showing high rates of later development of SAD in ADHD and treatment studies in which ADHD medications have been helpful for both conditions all indicate this relationship. Recently, we have published a hypothesis regarding the development of SAD secondary to ADHD. In this hypothesis, we recognized that patients with SAD seem to go through a prodromal period that we labeled as "pre-social anxiety." Detecting patients in this period before meeting full-blown SAD criteria provides early intervention and prevention of SAD. New, comprehensive follow-up studies which will investigate whether ADHD causes later SAD secondarily are needed. In the current review, taken into account our developmental hypothesis, we will discuss whether high comorbidity of SAD and ADHD is a chance finding (i.e., the two disorders are found in cases with no causal relationship between them) or can SAD develop secondarily due to childhood ADHD. Is there a prodrom period in patients with SAD as in cancer or psychosis patients? We are going to summarize the overlapping features of SAD and ADHD in terms of child/parents interaction and family issues, aversive childhood experiences, social skill deficits, and development of cognitive distortions.

Keywords Social anxiety disorder · Attention-deficit/hyperactivity disorder · Comorbidity · Developmental hypothesis · Anxiety

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Attention-deficit/hyperactivity disorder (ADHD) is a common neurodevelopmental disorder with an estimated prevalence at between 5.3% (Polanczyk et al. 2007) and 7.1% (Willcutt 2012) in children and adolescents and at 3.4% (Fayyad et al. 2007); and 4.4% (Kessler et al. 2006) in adults. ADHD symptoms consist of three components, namely inattention, hyperactivity and impulsivity (American Psychiatric Association: APA 2013). ADHD begins during early childhood and affects patient's functional status in academic and social life and leads to maladaptive behaviors in social settings.

ADHD is not only a disorder of childhood or adolescence, and recent studies have established that ADHD persists into adulthood (Mannuzza et al. 1993; Mancini et al. 1999; Rasmussen and Gillberg 2000; Lara et al. 2009; Biederman et al. 2010a, 2011). As the children with ADHD grow, hyperactivity–impulsivity symptoms tend to decrease at an earlier age than inattention symptoms (Hart et al. 1995; Biederman

et al. 2000; Hinshaw et al. 2006; Larsson et al. 2006; Lara et al. 2009).

In DSM-5, social anxiety disorder (SAD) was described as a persistent and marked fear of one or more social or performance situations in which the person is exposed to unfamiliar people or to possible scrutiny by others. The patients with SAD fear that they will act in a way that will be embarrassing and humiliating (APA 2013). SAD can affect the patients' occupational, social and interpersonal functioning profoundly.

Although no definitive conclusion can be reached at the present regarding its etiology, SAD likely arises from a complex interaction of environmental and internal factors. In their comprehensive review, Rapee and Spence (2004) proposed a model of the etiology of SAD and classified risk factors for SAD into internal (genetics, temperament, cognitive factors and social skills deficits) and environmental factors (parent/child interaction, aversive social experiences and negative life events).

The relationship between ADHD and anxiety

In the past, ADHD and anxiety disorders were most often studied separately, even considered as mutually exclusive (Weiss et al. 2011). However, this point of view has changed with recent studies. Many epidemiological and clinical studies have found high rates of comorbidity between anxiety and ADHD in both children and adolescents (MTA 1999; de la Barra et al. 2013; Yüce et al. 2013), and in adults (Mancini et al. 1999; Van Ameringen et al. 2011). Studies on the treatment effectiveness also revealed a similar pattern. Despite earlier studies suggesting that anxiety may decrease the response to psychostimulants in ADHD (Pliszka 1989, 1998; Tannock et al. 1995), later studies have found that ADHD medications can improve concurrent anxiety symptoms (Sumner et al. 2005; Geller et al. 2007; Adler et al. 2009; Golubchik et al. 2014; Koyuncu et al. 2015a, 2017a).

Today, a close relationship between ADHD and anxiety disorders is well established, and ADHD might be considered as a risk factor for the development of an anxiety disorder (Weiss et al. 2011; Tai et al. 2013). In addition, there are longitudinal studies in which children and adolescents with ADHD followed up for many years indicating higher levels of lifetime anxiety disorders compared to controls (Biederman et al. 1996, 1999, 2006, 2010b; March et al. 2000; Tai et al. 2013). In a follow-up study, Tai and colleagues (2013) reported that more cases of ADHD developed anxiety disorders than did matched control subjects (17.7–1.9%, respectively). Age of onset of anxiety disorders was also younger in patients with ADHD than that of the control group (Tai et al. 2013), and the authors proposed that early detection and treatment for ADHD may offset later development of anxiety disorders.

In addition, it has been reported that attention deficits can be anxiogenic (Roth et al. 2004; Weiss et al. 2011) and vice versa, anxiety may make the inattention symptoms worse (Pliszka 2000; Manassis et al. 2007). The cognitive impairments due to ADHD can trigger anxiety and this anxiety can exacerbate problems of attention (Weiss et al. 2011). As children with ADHD get older, hyperactivity symptoms tend to decrease while inattention symptoms usually persist (Faraone et al. 2006). Accordingly, anxiety might become more dominant in the clinical presentation (Weiss et al. 2011). Among patients with ADHD, it was reported that comorbid anxiety symptoms are much more common in adults than in children and adolescents (Barkley et al. 2008).

The relationship between ADHD and social anxiety disorder

The relationship between ADHD and SAD was neglected for many years. In general, adult ADHD has received lower research attention than ADHD in childhood. However, ADHD comorbidity in SAD has not been comprehensively evaluated in either child–adolescent or adult populations.

There might be several reasons that might explain why adult ADHD research activity falls behind the vast literature for childhood ADHD. First, Structured Clinical Interview for DSM disorders (SCID) does not contain an ADHD section. Since SCID was used to diagnose comorbidity in the most of published clinical SAD studies, ADHD diagnosis could be overlooked. Recently, the studies examining this comorbidity have increased in number and it was suggested that ADHD can be associated with SAD (Koyuncu et al. 2016).

SAD and ADHD comorbidity has been evaluated in two studies conducted with small sample sizes. Mörtberg and colleagues reported that 7.8% of 39 patients with SAD had childhood symptoms of ADHD (Mörtberg et al. 2012), whereas in the other study, the rate of childhood ADHD in 33 patients with SAD was 3% (Safren et al. 2001). Recently we have published three studies conducted on this comorbidity conducted by using different samples. In the first study, we evaluated 130 adult patients with SAD and 72.3% of patients met DSM IV diagnostic criteria for childhood ADHD. In that study, the comorbidity of childhood ADHD was related to increased severity of SAD and decreased functionality (Koyuncu et al. 2015b). Predominantly inattentive type of ADHD (ADHD-I) constituted the majority of patients with ADHD comorbidity.

The second study enrolled 142 adult patients with SAD and reported that 62.1% of the patients met childhood ADHD diagnostic criteria. We found that the group with ADHD-I had higher scores of social fear and avoidance

according to Liebowitz Social Anxiety Scale (LSAS) and ADHD-I had earlier onset of SAD than the group with combined type of ADHD (Koyuncu et al. 2015c). In that study, we suggested that ADHD-I might have a more specific relationship with SAD than the other subtypes of ADHD.

In the third study that examined the relationship between SAD, ADHD and interpersonal sensitivity (Koyuncu et al. 2017b), 90 of 125 (72.0%) adult patients with SAD had met childhood ADHD diagnostic criteria according to DSM-IV. The mean Interpersonal Sensitivity Measure (IPSM) score of the SAD with ADHD group was significantly higher compared to the SAD without ADHD group and IPSM total scores were positively correlated with the severity of SAD symptoms and negatively correlated with mean age of onset of SAD. Considering all three studies, we might hypothesize that ADHD—and especially ADHD-I—is closely associated with SAD. Moreover, Chavira and colleagues (2004) found a relationship between SAD and ADHD in child and adolescent patients and that the generalized type of SAD was highly comorbid with ADHD, while non-generalized subtype of SAD was not (Chavira et al. 2004).

On the other hand, there are also studies suggesting the presence of SAD comorbidity in adult ADHD patients. An epidemiological study found that SAD is the most common anxiety disorder among the comorbidities of adult ADHD patients (Kessler et al. 2006) and another study also reported an association between adult ADHD symptoms and SAD (Park et al. 2011). Various studies concerning adult ADHD found SAD comorbidity rates between 20 and 40% (Edel et al. 2010; Biederman et al. 1993; Millstein et al. 1997; Sobanski et al. 2007). There are also studies in the child and adolescent psychiatry literature that supports the notion that SAD is associated with ADHD (Schmitz et al. 2010; Yüce et al. 2013) including a 10-year follow-up study reporting significantly higher lifetime prevalence of SAD among ADHD subjects compared to controls (Biederman et al. 2006).

Treatment studies have been conducted with patients who have comorbid SAD and ADHD. Atomoxetine monotherapy in adults was found to effectively improve symptoms of both ADHD and comorbid SAD concurrently (Adler et al. 2009). Ravindran et al. (2009) found no significant difference between atomoxetine and placebo treatment in patients who had SAD without comorbid ADHD (Ravindran et al. 2009). In another study, among 21 children and adolescents with ADHD and SAD comorbidity, methylphenidate treatment was found to be associated with a significant improvement in both ADHD and SAD symptoms and the improvement in both symptoms were correlated (Golubchik et al. 2014). In addition, we observed improvement and recovery of symptoms of both ADHD and SAD in patients with comorbid SAD and current adult ADHD using extended-release methylphenidate monotherapy (Koyuncu et al. 2015a, 2017a).

Recently, we have published a hypothesis regarding the development of SAD secondary to ADHD (Koyuncu et al. 2018). In this hypothesis, we recognized that patients with SAD seem to go through a prodrom period that we labeled as "pre-social anxiety." During this period, social anxiety starts to bud, similar to the pre-psychotic period in psychosis. We cannot claim that ADHD is the sole cause of SAD in this kind of patients. Other factors such as parental attitudes and living conditions may have added on to the social difficulties and aversive events caused by ADHD and may contribute to secondary development of SAD. ADHD may be a vulnerability factor for developing SAD and SAD may emerge when it is combined with other vulnerability factors (Koyuncu et al. 2018). Considering this developmental hypothesis, it is important to discuss the following issues:

Firstly, it might raise the question that can the presence of childhood ADHD be a risk factor later development of SAD? SAD patients have been considered as primary SAD in both DSM IV and DSM V, and they are prescribed antidepressants treatment in rutin clinic practise. SAD development secondary to ADHD may be a subgroup of SAD. If this hypothesis is proven, treatment of "patients with SAD secondary to ADHD" will focus on the underlying primary disease. This developmental hypothesis has a potential for changing the SAD classification and treatment algorithms. In addition, the early diagnosis and treatment of childhood ADHD might become more important in order not to later development of SAD.

Moreover, a prodrom period has been described in three stages according to the hypothesis. Is there really a prodrom period in patients with SAD as in cancer or psychosis patients? If this hypothesis is proven, SAD might be captured at prodrom period (called the period of pre-social anxiety) and treated without meeting full blown the SAD criteria.

In the current review, taken into account our developmental hypothesis, we will discuss whether high comorbidity of SAD and ADHD is a chance finding (i.e., the two disorders are found in cases with no causal relationship between them) or can SAD develop secondarily due to childhood ADHD. We are going to summarize the overlapping features of SAD and ADHD in terms of child/parents interaction and family issues, aversive childhood experiences, social skill deficits and development of cognitive distortions. Furthermore, whether the presence of childhood ADHD and aversive life events due to it are risk factors for development of SAD will be argued.

A hypothesis on development of sad secondary to ADHD

In this hypothesis, we divided the development process of SAD secondary to ADHD into three stages (Koyuncu et al. 2018).

The first stage

The first stage mainly describes children with ADHD who are in a vicious cycle of symptoms, criticism and shame (Koyuncu et al. 2018) Children with ADHD struggle in social situations due to disinhibition, forgetfulness, impulsivity and other symptoms of ADHD (Weiss et al. 2011). ADHD is associated with impairment in response inhibition, working memory and all other executive functioning (EF) domains (Barkley 1997; Brown 2005; Doyle 2006; Willcutt et al. 2005). Brown (2005) suggested that the communication difficulties in children with ADHD might be a representation of underlying EF deficits and these deficits can cause hardships in the children's life, rendering them unable to communicate efficiently with peers, family, teachers and less familiar people. Therefore, these behaviors are perceived as intentional and individual gets criticism, insults, humiliation and teasing from parents and social circle.

Considering the SAD literature, the aversive life events that were emphasized in the development of SAD are excessive teasing, criticism, bullying, rejection, humiliation and isolation (Hackmann et al. 1998, 2000; McCabe et al. 2003; Beidel et al. 1999; Rapee and Spence 2004). Reviewing the literature on ADHD, peer victimization, rejection and bullying are found in higher rates in children and adolescents with ADHD when compared to their peers (Bagwell et al. 2001; Bacchini et al. 2008; Holmberg and Hjern 2008; Gardner and Gerdes 2013). Experiences such as peer rejection and bullying have prominent impact on youth with ADHD (Gardner and Gerdes 2013). Through the development of child, poor self-control and impulsivity of the youngster with ADHD may generate marked concern in parents or teachers (Lavin 2008). It is possible for parents and educators to become frustrated over the actions of a child with ADHD. The youngster may be repeatedly flooded by complaints, critiques and warnings, and they may even get beaten by their parents (Lavin 2008). Brown (2005) explained that majority of the individuals with attention-deficit disorder (ADD) encounter significant problems throughout their development. He reported that parents get confused and desperate, and that not only their parents, but even their peers and teachers can give angry responses. Lavin (2008), stated that ADHD youngsters live in a sea of criticism and warnings and that the ongoing peer rejection, floods of criticism and their insufficient performance at the school can result in a persistent state of sadness.

Therefore, the fear of failure and humiliation in the DSM-IV criteria for SAD (APA 1994) and interpersonal sensitivity (IPS), which was reported to be related with SAD (Liebowitz et al. 1985), may have developed secondary to the symptoms of ADHD. The literature on SAD states a significant relationship between SAD and aversive social outcomes, thereby denoting the direction of causality as undefined (Rapee and Spence 2004). The aversive experiences mentioned in childhood ADHD literature overlap with aversive childhood experiences which are suggested to cause SAD. Aversive childhood experiences of patients with SAD may be related to childhood ADHD. Further studies inquiring this possible relationship are needed.

Moreover, studies with SAD patients have revealed the following features in their parents' attitudes: greater parental control, intrusive involvement, less warmth and more negativity during interaction (Dadds et al. 1996; Hudson et al. 2008; Whaley et al. 1999; Rapee and Melville 1997; Hudson and Rapee 2001, 2002; Rapee and Spence 2004; Knappe et al. 2009). Brown (2005) denoted that individuals with ADD have a much greater need for being warned, directed and helped for tasks that many of their peers could easily handle. These features may lead to the development of the aforementioned parental coping styles.

According to the hypothesis of SAD secondary to ADHD, after each aversive life event, the children feel shame, disappointment and guilt. The children with ADHD, who are aware of their social blindness, feel ashamed of their problems. They wish to build healthy relationships, but they cannot control their inappropriate behavior and indiscretion in social situations. As they realize that people do not want to communicate with them and they are isolated due to these behaviors, their shame and guilt increases (Weiss et al. 2011). According to the hypothesis, the more they try to avoid this shame, the more mistakes they make. A vicious cycle emerges in which the children develop a fear of criticism and failure. The more the individual fears criticism and failure, the more they fail and more aversive incidents occur.

The second stage

The second stage of this hypothesis is the acceptance stage of the children's defeat who has been struggling with the symptoms of ADHD. At this stage, the cognitive basis for the development of social anxiety is formed. The children with ADHD develop interpersonal sensitivity, feelings of insufficiency, conditional and unconditional beliefs and other cognitive distortions associated with SAD (Koyuncu et al. 2018).

The mistakes, blunders and maladaptive behaviors in social situations caused by ADHD peak despite children's struggle to prevent them (Weiss et al. 2011). Because of the lack of social skills that will help them to cope with these kinds of situations, these experiences may have deleterious consequences on self-efficacy and the child might feel helpless.

When reviewing the literature on ADHD, it was reported that children and adolescents with ADHD are predisposed to demonstrate inappropriate social behavior and social skill deficits (Wehmeier et al. 2010; Gardner and Gerdes 2013).

Milich et al. (2001) reported that children with ADHD-I had more difficulty with social interaction and active participation in social activities, whereas children who had ADHD-H/I showed more aggressive behaviors. The role of social skill deficits (SSDs) in patients with SAD has been highlighted; however, some authors stated that SSDs did not necessarily point to a core deficiency in these individuals (Rapee and Spence 2004; Spence et al. 1999; Beidel et al. 1999; Cartwright-Hatton et al. 2005). Rapee and Spence (2004), expressed that SSDs may constitute both a cause and a result of SAD, and that they may contribute as a primary causative factor in some individuals, whereas a maintenance factor in others. Consequently, the SSDs observed in patients with SAD and in patients with childhood ADHD overlap. The childhood experiences of patients with ADHD may be the cause for the SSDs in patients with SAD which was mentioned in a review by Rapee and Spence (2004). Possible negative effect of ADHD on development of social skills might be a contributing factor to the high comorbidity rates between SAD and ADHD. Further studies demonstrating this association are required.

Since problems (their family's negative comments and the shame, disappointment and guilt they feel) persist and the children with ADHD do not cope with these experiences, the individuals finally accept the defeat and come to believe in the negative statements about themselves unconditionally. They see themselves as the weird, abnormal kid who cannot understand a thing. They think there must be something wrong with them because they are not getting any better. These beliefs cause further lowering of self-esteem.

Moreover, we suggested that IPS occurs at this stage. The fear of making mistakes and being criticized eventually turn into IPS (Koyuncu et al. 2018). The concept of IPS has been described by Boyce and Perker as a construct of neuroticism and they suggested that IPS may have been an extreme of awareness of the behavior and thinking of other persons (Boyce and Parker 1989). Downey and Feldman (1996) named the concept as rejection sensitivity and suggested that instead of a personality structure, rejection sensitivity might have been a set of cognitive and affective processes. Then, rejection sensitivity model was developed by Levy et al. (2001). They suggested that rejection experiences lead to hypervigilance, which is associated with anxious or hostile expectations of rejection. They proposed that this hypervigilance can distort perceptions of other people's behavior, causing defensiveness that can interfere with social relationships.

Some research has suggested that IPS is associated with social anxiety disorder (Vidyanidhi and Sudhir 2009; Renneberg 2011; Tada et al. 2005). Moreover, IPS may represent an underlying personality feature of patients with SAD, especially patients with the generalized type (Harb et al. 2002). Schneier et al. (2003) reported that 18 of 21 (85.7%) patients with SAD and comorbid major depression fulfilled the criteria for interpersonal rejection sensitivity. Moreover, severity of IPS was correlated with severity of SAD (Tada, et al. 2005; Koyuncu et al. 2017b).

Recently, it has been suggested that IPS is not only associated with SAD, but also may be linked with childhood ADHD (Chang and Chuang 2000; Canu and Carlson 2003; Bondü and Esser 2015; Koyuncu et al. 2017b). Our previous study found that the scores of IPSM in SAD group with comorbid ADHD were higher than in SAD group without comorbid ADHD. We suggested that the presence of childhood ADHD might be associated with even higher IPS in patients with SAD (Koyuncu et al. 2017b).

Moreover, we hypothesized that cognitive distortions related with SAD occurs at this stage. Beck et al. (1985) mentioned the sensitivity of the individual with SAD to appearing silly, clumsy and weak. Clark and Wells (1995) proposed the presence of distorted thoughts such as 'I am peculiar/different/abnormal,' 'I am defected/incompetent' or 'I am stupid…'. (Clark 2001). Beck et al. (1985) suggested that beliefs such as 'I won't be able to speak,' 'I will do a bad job' or 'I will look clumsy' occur in the mind of the person with SAD in social situations. These unconditional beliefs that were suggested to be related to SAD might have emerged during childhood, possibly due to the clinical effects of ADHD (Koyuncu et al. 2018). It is possible for children with ADHD to develop these beliefs considering their past of chronic mistakes and failures. Rapee and Heimberg (1997) emphasized the internal design which patients with SAD create in their minds about how they are perceived by the others and the contribution of long-term memory (their previous experiences in similar situations, memories) in the creation of this design. These designs may have been shaped by the aversive experiences due to ADHD (Koyuncu et al. 2018). Clark (2001) expresses that the patients with SAD have conditional beliefs concerning the consequences of performing in a certain way. For example; 'If I let someone down, they may think I am stupid/they can reject me.' Looking at the ADHD literature, one can suggest that the individuals with ADHD may have been negatively evaluated by others because of the way they behave. The combination of social notoriety and being negatively evaluated among peers is possibly associated with peer neglect, bullying and rejection (Gardner and Gerdes 2013). In conclusion, children who had aversive life experiences because of chronic ADHD symptoms can be considered as candidates for developing beliefs linked with SAD (Koyuncu et al. 2018).

Additionally, Beck et al. (1985) expressed the presence of beliefs such as 'I am annoying them with my talk…They think of me as inferior and weak' in patients with SAD. Other authors mentioned a lack of confidence in oneself and one's own abilities (Clark and Wells 1995; Rapee and Heimberg 1997). Clark and Wells (1995) stated that the most

important feature of an individual with SAD is a desire to leave an exceptionally good impression on others, but also a lack of confidence in their own skills to achieve this. Considering ADHD literature, Lavin (2008) stated that youngsters with ADHD do not disturb people on purpose. They actually wish for the respect and love of others and want to make friendships; however, they have neither the insight nor the capacity to achieve their goals. The development of the aforementioned distortions in SAD may be caused by the chronicity and persistence of the underlying ADHD as well as the attitudes of the people and experiences they faced during their bringing up (Koyuncu et al. 2018). For example, they have 'should' statements, 'all-or-nothing' thinking, selective perception, mind-reading, overestimation and catastrophizing. Then, they may develop a fear of failure, criticism and humiliation in new situations, because they went through these experiences repeatedly due to their ADHD. Their negative beliefs such as 'I will make an error and they will laugh at me,' 'I will fail and they will criticize me,' 'I will embarrass myself again' or 'I will make an error, I will disappoint my parents again' are reinforced with experiences. Clark and Wells (1995) expressed that people with SAD have extremely high standards for their social performance (for example, 'I should not show any signs of weakness.'). These beliefs might also have been formed secondary to experiences of ADHD (Koyuncu et al. 2018).

Beck et al. (1985) state that most of the social experiences, such as eating or speaking in a crowd, feel like a test to a person with social anxiety, a test that grades the individual's maturity and competence. In the individual's mind, each behavior is evaluated by an imaginary crowd of spectators, and the individual feels judged on their confidence and competence. People with social anxiety monitors themselves closely, observing and paying too much attention to feedback from people. Brown (2005) expressed that a group of the individuals with ADHD tend to focus excessively on people's reactions and monitor themselves, and that these people can be introverted and shy in communication. He reported that this could be caused by a difficulty of monitoring and correcting oneself and actions, due to EF deficits. Consequently, the effects of childhood ADHD may be the origin of this condition observed in SAD. Prospective studies are required to establish this possible connection between childhood ADHD and the later development of SAD.

The third stage

We hypothesize that the behavioral component of SAD emerges at this stage. First, the children experience cognitive inhibition, then behavioral withdrawal, and lastly behavioral inhibition (Koyuncu et al. 2018).

Social problems that are encountered by children with ADHD may be related with working memory problems, both directly and indirectly (McQuade and Hoza 2008). A study found a significant relationship between preschool social problems and working memory deficits (Alloway et al. 2005). As known, working memory is where information first gets stored and is employed by retrieving the files in long-term memory. It listens to the input while preparing the answer. Impairment of the working memory impacts both on receptive and expressive components of interaction between individuals and groups. Communication problems are a common complaint among individuals with ADHD. They cause hardships in conversations and discussions (Brown 2005). We suggested that dysfunctional working memory of the person prevents conveying contents for speaking and the person's mind stops and experience cognitive inhibition in social settings. A kind of cognitive inhibition starts that the individuals could not understand in the beginning. Their mind would go blank and a state of tension would emerge suddenly. Patients forget words and freeze. Therefore, they become withdrawn. The cause of this withdrawal is the fear of repeating the same mistakes and the resulting humiliation in new social settings. The inhibition increases gradually as the fear persists and behavioral inhibition occurs in social situations (Koyuncu et al. 2018). To explain this cognitive inhibition, there is a need for studies that show the relationship between working memory or EF deficits and the sypmptoms of SAD.

Several traits in early life were reported to be possible precursors for the development of SAD. According to Kagan et al (1984), behavioral inhibition is one of those constructs. Beck et al. (1985) mentioned automatical defenses such as verbal inhibition, hesitation, forgetting which can reduce the individual's performance. Although individuals with ADHD wish to talk and share, they go through a lockdown or hesitation which keeps them away from normal social interactions and they cannot put themselves under the spotlight in a social situation (Brown 2005). Taking Brown's writings (2005) into consideration, we suggest that this inhibition may be associated with ADHD. Further follow-up studies are required to investigate the relationship between ADHD, SAD and behavioral inhibition.

Later, the patients start to monitor themselves closely and tend to focus excessively on others' feedback regarding their affect and speech (Koyuncu et al. 2018). They listen to themselves while speaking and also watch people's faces. When the feedback is positive they relax, when it is negative they tend to go through a process called post-event processing in which they blame themselves for days in a ruminative manner.

Finally, performance situations in social settings become increasingly associated with arousal for them and they trigger anxiety. Panic attacks/anxiety add to the inhibition and onset of full-blown social anxiety occurs (i.e., onset of social anxiety = inhibition + panic attack/anxiety).

Conclusion

The close association between SAD and ADHD is often overlooked despite the high comorbidity rate between these two disorders, follow-up studies of patients with ADHD revealing high frequency of later development of SAD and treatment studies in which ADHD medications have been beneficial for both conditions.

In our hypothesis, we aimed to state the obvious: SAD and ADHD may be causally linked. However, that does not mean that ADHD is the sole cause of SAD. Parental attitudes and living conditions may be adding on to the social difficulties and aversive events caused by ADHD, and lead to secondary development of SAD. However, these type of patients with SAD secondary to ADHD are generally considered as primary cases of SAD and receive antidepressants in routine psychiatric practice. It is important to put forward treatments that target the primary cause in patients with comorbid ADHD and SAD. New studies are required to demonstrate the effects of ADHD treatments on secondary concurrent SAD.

Moreover, if it is proven that SAD has a period of presocial anxiety, just as cancer is captured and treated in stages such as metaplasia, dysplasia, SAD might also be captured and treated in the prodrom period. New, comprehensive follow-up studies which will investigate whether ADHD and SAD is a comorbidity or ADHD causes later SAD secondarily are needed. Furthermore, If SAD has a prodrom period, there is need for follow-up studies to prove this.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Human and animal rights This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent For this type of study, formal consent is not required.

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