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Traumatic Childhood Events and Autism Spectrum Disorder

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Abstract Traumatic childhood events are associated with a wide range of negative physical, psychological and adaptive outcomes over the life course and are one of the few identifiable causes of psychiatric illness. Children with autism spectrum disorder (ASD) may be at increased risk for both encountering traumatic events and developing traumatic sequelae; however, this topic has been understudied. This review considers the rationale for examining traumatic events and related symptomology in individuals with ASD and summarizes the limited research on this topic. A conceptual framework for understanding the interplay of ASD, trauma and traumatic sequelae is proposed and recommendations for future research presented.

Keywords Autism spectrum disorder · Trauma · PTSD · Traumatic stress · Psychiatric comorbidity

Introduction

The term *trauma* has been ascribed a variety of meanings colloquially as well as in clinical and scientific settings. In this article, *trauma* and *traumatic event(s)* are used interchangeably to describe an event or series of events that are experienced as threatening and that have immediate and/or lasting adverse effects on the individual's functioning (SAMHSA 2014). Per this definition, the same event may

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be considered a trauma for one person, but not another depending upon individual appraisals and reactions to the event [akin to Lazarus and Folkman's (1987) transactional model of stress and coping].

Put another way, trauma can be thought of as psychological injury—an event that damages or harms the individual even though the severity, longevity and permanency of that harm may vary widely. Like injury, traumas can be minor—a stressor that is easily surmountable for the individual (e.g. teasing that an individual is able to dismiss); moderate—a stressor that requires additional time and intervention to overcome (e.g. bullying that leads to social anxiety and self-doubt); or severe—a stressor that results in chronic illness, degraded functioning and an altered life course (e.g. severe emotional abuse that leads to major depression, social anxiety disorder and drug abuse). Like injuries, traumas can be acute (e.g. a single incident sexual assault) or chronic (e.g. relentless teasing; repeated childhood sexual abuse). And also like injuries, the severity and long-term impact of traumas reflects an interaction between the potency and chronicity of the stressor and the susceptibility of the individual (see diathesis-stress models of psychopathology; Ingram and Luxton 2005). Finally, just as a potentially injurious event refers to an event that might reasonably cause injury (e.g. a punch, a fall, a car accident) whether or not injury ultimately results, a *potentially traumatic event* refers to an event that might reasonably result in psychological trauma (e.g. divorce of parents, sexual abuse, a car accident), whether or not trauma is actually experienced or reported.

The most commonly recognized effects of trauma are *traumatic stress, a* persistent disturbance of mood, arousal and behavior following a traumatic event, and *post-traumatic stress disorder* (PTSD), a specific set of traumatic stress symptoms (e.g. flashbacks, nightmares, avoidance,

memory lapses, emotional numbing) that persist for more than a month following a trauma (Diagnostic Statistical Manual—5th Edition; American Psychiatric Association 2013). Yet, these are not the only effects of chronic trauma or the most common (Copeland et al. 2007; Ford and Courtois 2009; Schilling et al. 2007; van der Kolk et al. 2005). Trauma has many diverse signs and symptoms and may include impairments in psychological, social, physical and adaptive functioning (Cook et al. 2005). Though every child with symptoms of traumatic stress or PTSD has experienced trauma, not every child exposed to trauma will show symptoms of traumatic stress, nor will all those experiencing traumatic stress meet full criteria for PTSD (Cook et al. 2005; Ford and Courtois 2009; van der Kolk et al. 2005). This is true in the population at large and may be particularly true for youth with autism spectrum disorder (ASD), a rapidly growing subpopulation whose response to trauma may be even more varied and difficult to recognize.

Public Health Risk of Traumatic Childhood Events

Traumatic childhood events are one of the few environmentally identifiable causes of psychiatric illness and are associated with a multitude of immediate and life long challenges (Felitti et al. 1998; Gerson and Rappaport 2012). More than 60 % of US youth will experience a potentially traumatic event before adulthood (Copeland et al. 2007; Finkelhor et al. 2005). Such events include single-incident traumas (e.g. terrorist attack, natural disaster; single episode of experiencing violence, injury or abuse) and complex, chronic or repetitive traumas (e.g. ongoing maltreatment, domestic or community violence, war, or their combination). Commonly, youth may experience chronic stressors and then a subsequent severe event such as an assault. Most youth exposed to a trauma display immediate, but transient behavioral, mood, daily living and arousal disturbances; approximately a third manifest enduring traumatic stress (Ackerman et al. 1998; Fitzpatrick and Boldizar 1993; Gerson and Rappaport 2012). The risk of developing PTSD is greater for those with complex or repeated as opposed to single-incident traumas (e.g. 33–75 % risk vs. 10–20 % risk, respectively; Ford and Courtois 2009). Further, Copeland et al. (2007) found that youth exposed chronically to potentially traumatic experiences had almost double the rate of psychiatric disorders, particularly anxiety and depressive disorders, relative to those not exposed, as well as more functional impairments, interpersonal and school-related problems. Chronic trauma exposure as well as prolonged traumatic stress symptoms can result in changes in neural structures and sensory systems that are central to arousal, executive functioning,

memory, affect and behavioral regulation, setting the stage for later psychiatric and somatic illness (Ford and Courtois 2009; Tyrka et al. 2013; van der Kolk et al. 2005). Consistently, exposure to multiple potentially traumatic events in childhood is associated with greater psychiatric, cardiac, metabolic, immunological, and gastrointestinal illness later in life as well as neurobiological abnormalities (Anda et al. 2006; Bremner and Vermetten 2001; Danese and McEwen 2012). It is also predictive of repeated traumatization and early death (Felitti et al. 1998; Finkelhor et al. 2005).

ASD as a Risk Factor for Potentially Traumatic Events

Certain subpopulations of children are more likely to encounter potentially traumatic events. Studies suggest that youth with intellectual and developmental disabilities are 1.5 to over 3 times more likely to be maltreated than their peers (Hibbard and Desch 2007; Reiter et al. 2007; Sullivan and Knutson 2000). In general, children are more vulnerable to being maltreated than are adults due to their dependence on others—a risk factor heightened in children with development disabilities. Additional issues such as social isolation, family stress and poor communication skills increase maltreatment risk and are also more common in developmentally disabled children (Howlin and Clements 1995; Sullivan and Knutson 2000).

Many of these risk factors are particularly prevalent in children with ASD. Latest estimates suggest that 1 in 68 youth are affected by ASD, a developmental disorder characterized by restricted interests and behaviors, social and communication deficits, and—in 40–50 % of affected individuals—intellectual disability (Centers for Disease Control and Prevention 2014). Children and adults with ASD are characteristically socially naïve and sometimes socially inappropriate, suggesting they may be at risk for victimization as well as increased interactions with the legal system and law enforcement. Their care is associated with numerous financial and psychological stressors (Newschaffer et al. 2007) and social isolation of the individual is common (Orsmond et al. 2004). Moreover, communication deficits are a core feature of the disorder— 63 % of children with ASD meet criteria for a language disorder and even those with large vocabularies and strong verbal abilities often to struggle to communicate their emotional struggles and experiences to others (Levy et al. 2010).

In addition to these vulnerabilities, research suggests that youth with ASD encounter a number of distinct daily stressors related to their diagnosis that may have untoward effects on their emotional functioning. In their hypothetical model of clinical anxiety in ASD, Wood and Gadow (2010) proposed that certain ASD-related stressors, such as social

confusion, peer rejection, prevention or punishment of preferred behaviors (e.g. restricted, repetitive interests) and sensory sensitivity to daily stimuli (e.g. lights, loud sounds) may engender a "traumatic conditioning process" in youth with ASD that leads to clinically significant anxiety. This hypothesis has been supported, in part, by research into sources of stress for individuals with ASD (Gillott and Standen 2007; Groden et al. 2001; Corbett et al. 2006). The *Stress Survey Schedule* (Groden et al. 2001) is an instrument specifically designed to assess sources of stress in the lives of individuals with ASD and other developmental disabilities that may not be addressed by other instruments. Studies utilizing this survey suggest that difficulties coping with change, aversive sensory stimuli, unpleasant events (e.g. being reprimanded), and social demands (e.g. public speaking or communicating needs to others) are more often appraised as stressful by youth and adults with ASD than by typically developing individuals and those with intellectual disability (Corbett et al. 2006; Gillott and Standen 2007; Jansen et al. 2003; Groden et al. 2001). How these distinct sources of stress may contribute to the development of trauma and other comorbid psychopathology in ASD requires further research.

ASD as a Risk Factor for Trauma-Related Psychopathology

Predictors of traumatic stress and poorer outcomes following trauma include a preexisting psychiatric disorder (particularly anxiety disorder), lower IQ, limited social support and repeated traumatization (Breslau et al. 2013; Cohen et al. 2010; Koenen et al. 2007; Mevissen and De Jongh 2010; Turner et al. 2010). Many of these risk factors contribute to the regulation of emotions and arousal and have a transactional relationship with traumatic sequelae. For example, poor emotion regulation increases the risk of developing traumatic stress and other negative psychological outcomes, which, in turn, exacerbate already impaired emotion regulation. This cycle inhibits the child's ability to cope with future stressors, which they may increasingly experience, in part, due to their growing psychological instability and social dysfunction (Turner et al. 2010). A similar pattern can be seen in biologic systems [e.g. limbic–hypothalamic–pituitary–adrenal (LHPA) axis] that underlie stress response and contribute to the downstream neurobiological consequences of trauma (Yehuda 2001). In this way traumatic childhood events insinuate themselves into the cognitive, physical and psychological development of youth, perpetuating a cascade of detrimental sequelae over the life course.

Many risk factors for traumatic stress and related sequelae are also associated with ASD. As discussed previously, a substantial portion of youth with ASD experience intellectual impairments and social isolation. Further, their risk for experiencing a greater number of potentially traumatic events may confer risk for multiple, potentially repeated traumas. Many youth with ASD present with psychiatric comorbidities—most prominently anxiety disorders, which occur in approximately 40 % of this population (van Steensel et al. 2011). Still more present with nonspecific difficulties regulating emotion and coping with stress (e.g. emotional meltdowns, outbursts, anxiety attacks; Mazefsky et al. 2013). This vulnerability to psychiatric illness is especially salient in youth with ASD relative to children with other developmental disabilities, underscoring the particular risk of this group. Studies suggest that youth with ASD are significantly more likely to present with symptoms of anxiety, depression and behavior problems than youth with Down Syndrome, specific language impairments and other forms of atypical development (Bakken et al. 2010; Brereton et al. 2006; Davis et al. 2010; Gillott et al. 2001). All this suggests that youth with ASD may be particularly susceptible to be adversely affected by childhood trauma, which can deliver additional insults to an already taxed neuropsychological system (Wicks et al. 2005).

Neurobiological Correlates of ASD and Traumatic Stress

A series of neurological abnormalities have been detected in patients with chronic childhood trauma and traumatic stress (Hart and Rubia 2012; Sherin and Nemeroff 2011). These findings offer insight into the pathophysiology of traumatic stress as well as into the particular vulnerability of children with ASD to develop trauma-related pathology. Several pathological features found in patients with traumatic stress overlap with features found in ASD. For example, alterations in the functional connectivity of the amygdala and prefrontal cortex, areas central to the regulation of emotion, are indicated in neuroimaging studies of ASD (Mazefsky et al. 2013). Such anomalies are also observed in individuals with histories of chronic childhood adversity, PTSD and other trauma-related psychopathology (Grant et al. 2011; Williams et al. 2006). Notably, the amygdala is particularly sensitive to early life stress (Pechtel and Pizzagalli 2011), and disruptions in the connectivity and regulation of the amygdala–prefrontal cortex circuit have been associated with reduced fear extinction following a stressful exposure (Akirav and Maroun 2007; Gilboa et al. 2004).

As another example, dysregulation of the LHPA, which regulates stress and many bodily functions (mood, emotion, digestion, immune response), has been documented in both ASD and PTSD (Bremner and Vermetten 2001; Baumeister

et al. 2014; Danese and McEwen 2012). Chamberlain and Herman (1990) proposed that ASD might reflect a dysfunction in the pineal–hypothalamic–pituitary axis. More recent research suggests that ASD is associated with dysregulated circadian changes in LHPA activity as well as day-to-day rhythms—known characteristics of chronic stress (Corbett et al. 2008, 2009). Compared to children without ASD, children with ASD have also been shown to display an exaggerated cortisol response to novel and threatening stimuli (e.g. psychosocial stress, sensory stimuli) as well as elevated salivary cortisol levels when anticipating re-exposure to a perceived stressor (Corbett et al. 2008; Jansen et al. 2003). Disruption to these neurobiological substrates of stress in youth with ASD could indicate a pre-existing vulnerability to future trauma (e.g. an inherently weak stress response system) or that trauma has already occurred, setting a cycle of biological and behavioral dysregulation in motion.

In addition to these key systems, several researchers have posited that deficits in emotion regulation may predispose to the development of anxiety disorders and other, more diffuse difficulties (i.e. tantrums, emotional meltdowns) in ASD (White et al. 2014; Mazefsky et al. 2013). Biological anomalies implicated in emotion regulation deficits, such as structural anomalies of the brain (e.g. medial prefrontal cortex, amygdala, cingulate cortex and orbitofrontal cortex) and physiological anomalies (e.g. enhanced startle response) are also implicated in ASD (White et al. 2014). These neurobiological vulnerabilities to emotion and arousal dysregulation represent a likely pathway for traumatic stress.

Cognitive and Psychosocial Mechanisms Associated with ASD that May Predispose to Traumatic Stress

Socio-cognitive features of ASD, such as mental rigidity, information processing/perception differences, impaired emotional insight and reduced goal-directedness, may diminish the use of cognitive coping and other adaptive strategies to modulate emotion leading to an exaggerated trauma response (Bleil Walters et al. 2013; Mazefsky et al. 2013; Groden et al. 2006; Wood and Gadow 2010). Impairments in cognitive flexibility and the ability to shift focus are well-documented in ASD and may impair coping in various ways (Hill 2004; Ozonoff et al. 2004). Youth with ASD may struggle to disengage from thoughts or memories of distressing stimuli due to their difficulties shifting attention. Similarly, they may lack the ability to adapt flexibly to adversity, trauma or unexpected events due to overly rigid, "black and white" thinking, and rule-governed behavior (Pugliese and White 2014; Hill 2004). Shifts in perspective that can promote recovery from trauma may be particularly difficult for individuals with

ASD to achieve, leading to emotional rumination. Further, overarching perceptual and information processing differences in ASD, such as reduced attention to the social subtext or the global meaning of a context (e.g. Weak Central Coherence; Happé and Frith 2006) may lead individuals with ASD to appraise a distinct array of events as traumatic, to experience more feelings of confusion and powerlessness, and to generate ineffective coping strategies. For example, Wood and Gadow (2010) proposed that individuals with ASD may rely on repetitive behavior to regulate intense emotions given their difficulties with other, more adaptive strategies, such as altering thoughts or finding effective ways to change distressing circumstances. In this way, differences in how individuals with ASD appraise and process events may influence how and when they experience trauma and limit their use of effective strategies (cognitive reappraisal, problem solving) to cope with stress.

Emotion recognition and insight play a key role in emotion regulation ability and the processing of trauma (Jones et al. 2011). They also often represent an area of weakness for individuals with ASD. Theoretical models indicate that young children develop emotion regulation skills via observation, social referencing and modeling (Morris et al. 2007). Reduced attention to such social cues in ASD may disrupt this learning process (White et al. 2014). Consistently, research supports the presence of emotion recognition deficits in individuals with ASD, though deficits may be emotion-specific (e.g. fear and sadness) and subtle (Tell et al. 2014; Rump et al. 2009; Uljarevic and Hamilton 2013). Some individuals present with alexithymia (i.e. the inability to identify and describe emotions in the self) as well as a general tendency to intellectualize rather than experience and process emotions (Mazefsky and White 2014; Rieffe et al. 2007). Such avoidance of or inability to access one's emotional life may prevent individuals with ASD from recognizing, communicating and effectively coping with traumatic experiences.

Taking a broader view, individuals with ASD may also experience more devastating effects of trauma due to limited social coping skills and psychological resources. Mansell et al. (1998) proposed that immaturity as well as communication, self-esteem, problem solving, and psychological difficulties may limit coping in individuals with developmental disabilities. Individuals with ASD may also lack the social interest, skill, or network to feel understood and comforted by others when faced with adversity (Orsmond et al. 2004). Finally, difficulties with executive functioning, such as planning, initiating and carrying out goal directed behavior, may prevent individuals with ASD from effectively utilizing the coping strategies and resources that are available to them (White et al. 2014). As noted previously, such emotion regulation difficulties,

whether biological or psychological in nature, are deeply intertwined with mental illness and the development of trauma-related disorders (Mazefsky et al. 2013; Stevens et al. 2013; Tull et al. 2007).

Summary of Potential Risk

In sum, it is plausible that the neuropsychological mechanisms that predispose youth with ASD to psychiatric illness generally are also likely to (a) increase their susceptibility to the effects of severe or chronic stress and (b) alter the range and quality of experiences they perceive to be traumatic. Individuals with ASD may experience a different or greater array of life events as threatening than youth without ASD due to their heightened arousal, limited coping skills and their potentially anomalous perceptions and appraisals of the world around them. Yet, there is limited research on the quality, quantity or effects of traumatic events experienced by youth with ASD.

Review of the Literature on Trauma and Related Symptoms in ASD

The prevalence of trauma and related sequelae in ASD is unknown; however, a few studies have assessed the occurrence and impact of some potentially traumatic events, including maltreatment, severe injuries, medical ordeals, and bullying. The limited studies to assess rates of maltreatment in ASD offer mixed results. Whereas Sullivan & Knutson (2000) found rates of maltreatment for children with autism in special education to be similar to youth in the general population (approximately 9 %), Mandell et al. (2005) reported maltreatment of over 30 % of youth with ASD served in community health clinics. Spencer et al. (2005) found no association between autism and overall child-protection registration, but the ASD sample was too small to examine rates of specific sub-categories of abuse. By comparison, Hall-Lande et al. (2014) found children with ASD were more likely to be involved in child protective services than other children in Minnesota, particularly for cases of physical abuse.

With regard to other potentially traumatic events, studies suggest that youth with ASD are more likely to experience serious physical injuries, particularly poisoning and self-inflicted injuries than their unaffected peers (Lee et al. 2008; McDermott et al. 2008). They are also more likely to face more frequent and extended inpatient psychiatric hospitalizations, more bullying and more encounters with law enforcement (Bryson et al. 2008; Croen et al. 2006; Curry et al. 1993; Lokhandwala et al. 2012; Zablotsky et al. 2013; Solomon and Peltz 2008). How youth with ASD experience and cope with these stressors is unclear;

however, phobias of needles, medical offices, and medical procedures are common along with other more unusual anxieties, such as fears of loud sounds or minor changes in routine (Evans et al. 2005; Kerns et al. 2014; Muris et al. 1998; Settipani et al. 2012). These unusual fears are consistent with findings that individuals with ASD experience different sources of stress relative to typically developing individuals as well as individuals with intellectual disability (Groden et al. 2001; Corbett et al. 2006).

Research on the effects of trauma in individuals with ASD is even more limited, but suggests enhanced risk. Physically and sexually abused children on the spectrum in the Mandell et al. (2005) study were over six times more likely to attempt suicide and over eight times more likely to engage in sexual acting out and abusive behaviors than youth with abuse histories. In a study of adolescent sexual offenders with abuse histories, Bleil Walters et al. (2013) found that offenders with ASD, particularly those with histories of severe emotional abuse and neglect, reported significantly more symptoms of depression than those without ASD. Valenti et al. (2012) reported dramatic declines in the adaptive functioning of youth with ASD who were exposed to a severe earthquake in Italy. Finally, in the only study to broadly assess trauma and posttraumatic stress symptoms in ASD, Mehtar and Mukaddes (2011) found a history of various traumas in 26 % of youth attending an outpatient ASD clinic in Istanbul. Sixty-seven percent of those exposed to potentially traumatic events displayed symptoms of posttraumatic stress (17 % of overall sample)—over twice the rate seen in children exposed to potentially traumatic events in the general population. Though intriguing, these studies are preliminary. Research with epidemiological samples and sufficient measures will be needed to assess the true risk of PTSD and trauma-related psychopathology in ASD.

Summary of the Literature

These limited studies provide support for the notion that individuals with ASD are at increased risk to experience and be detrimentally affected by traumatic childhood events. They also raise questions about the comparatively low rates and regular omission of PTSD and traumatic stress from studies of psychiatric comorbidity in ASD (Leyfer et al. 2006; Muris et al. 1998; Simonoff et al. 2008). In contrast to the findings of Mehtar and Mukaddes (2011), de Bruin et al. (2007) and Storch et al. (2013) reported PTSD rates of 0–3 % respectively in two independent samples of treatment seeking youth with ASD. PTSD, when present, was associated with suicidality, a prevalent issue in adults with ASD (Cassidy et al. 2014; Storch et al. 2013). Notably, it is difficult to estimate the

true prevalence of traumatic stress and PTSD in ASD from these studies given their reliance on samples of convenience (rather than population-based samples) and measures of trauma that have not been validated in ASD samples. Outside of these three studies, information on the occurrence of PTSD in ASD is extremely limited. In a recent meta-analysis (van Steensel et al. 2011), only 2 out of 86 prevalence studies on anxiety disorders in ASD provided data on PTSD, a trend also apparent in broad studies of psychiatric comorbidity in this population (Leyfer et al. 2006; Simonoff et al. 2008).

More research on the presentation and prevalence of traumatic stress in individuals with ASD is needed, particularly given the notion that stressors and thus also the presentation of co-occurring psychopathology (e.g. anxiety) may vary in this group (Kerns and Kendall 2012; Mazefsky et al. 2013; White et al. 2014; Wood and Gadow 2010). How trauma may contribute to the prevalence of traumatic stress and other psychiatric comorbidity in ASD is poorly understood. Individuals with ASD may manifest symptoms of traumatic stress in a distinct manner from typically developing individuals and traditional PTSD criteria. Research suggests that an alternative, more developmentally sensitive algorithm of symptoms is needed to detect PTSD in young children, who typically manifest most (but not all) of the traditional DSM criteria (Cohen and Scheeringa 2009). The same is likely to be true for individuals with ASD and to contribute to the low prevalence of PTSD reported in youth with ASD in some studies.

Unresolved Questions and a Hypothetical Model

That youth with ASD should be at increased risk for almost every psychiatric comorbidity but PTSD in the majority of studies to date is puzzling, particularly given the risks for increased exposure and poor response in this population. PTSD and traumatic stress are a narrowly defined band of traumatic sequelae that may not be a sufficient or appropriate proxy for examining the incidence of trauma in certain groups, such as young children and those with developmental delays (Scheeringa et al. 2003). Further, it is concerning that PTSD and other sequelae of trauma should be understudied in youth with ASD relative to other comorbidities given the known rates and detriments of childhood trauma in the normal population. While unlikely, it is possible that traumatic childhood events are less common or hazardous for individuals with ASD. Some youth with ASD may be less likely to be unsupervised and thus exposed to potentially dangerous situations given their vulnerabilities and social immaturity. Some may be less susceptible to trauma, potentially due to their inward focus and distinct or piecemeal perceptions of the world around

them (e.g. a child may be protected from social ridicule if they fail to perceive it; Happé and Frith 2006). As discussed, whether an event is traumatic as well as whether a traumatic event leads to traumatic stress and other downstream consequences depends on an individual's appraisal of the event and their ability to regulate their emotional responses. As such, differences in perception, social awareness and global understanding in ASD may alter what events and stimuli are experienced as traumatic as well as the quality and severity of sequelae. Yet, it is also clear that some youth with ASD are painfully aware of their differences from others and hypersensitive to stimuli in the world (Ben-Sasson et al. 2009; White and Roberson-Nay 2009). Regardless, understanding if and how youth with ASD are protected against or predisposed to such injuries holds the potential to lend new insight into the mechanisms of trauma.

To provide an initial framework for this research, we provide a hypothetical model of the transactional relationship between trauma and ASD (see Fig. 1). It is likely that symptoms of ASD influence the experience of trauma at all levels—moderating what events the child is exposed to, what they then experience as harmful, and what effects or symptoms they will manifest. There are indications that youth with ASD may be more likely to both encounter and also perceive certain experiences as traumatic compared to typically developing individuals (e.g. bullying, aversive treatments, hospitalizations; Grosso 2012; Solomon and Peltz 2008; Zablotsky et al. 2013). Similarly, existing studies, though few, do suggest a varied profile of symptoms associated with trauma in youth with ASD, including increased disruptive behavior, activity level, social isolation, academic failure, self-injury, stereotypies and somatic symptoms, and declines in adaptive functioning (e.g. enuresis, encopresis; Mandell et al. 2005; Mehtar and Mukaddes 2011; Valenti et al. 2012). This potentially dissimilar array of traumatic events and symptoms in individuals with ASD is not well understood and may not be adequately represented in existing trauma measures.

As discussed previously, severe or chronic trauma has the capacity to alter the developmental trajectory of an individual. For this reason, a transactional relationship between trauma and ASD should be considered. Just as ASD may influence all aspects of how trauma is experienced and processed by a child, the effects of trauma may, in turn, alter a child's clinical profile via new trauma-related symptoms or the exacerbation of existing ASD-related problems (e.g. self-injury, sensory abnormalities, anxiety) and neurological abnormalities (e.g. altered functional connectivity of the amygdala; again, see Fig. 1). This feedback may occur either directly, or through the development or worsening of psychological difficulties (e.g. anxiety or depressive disorders, poor emotion
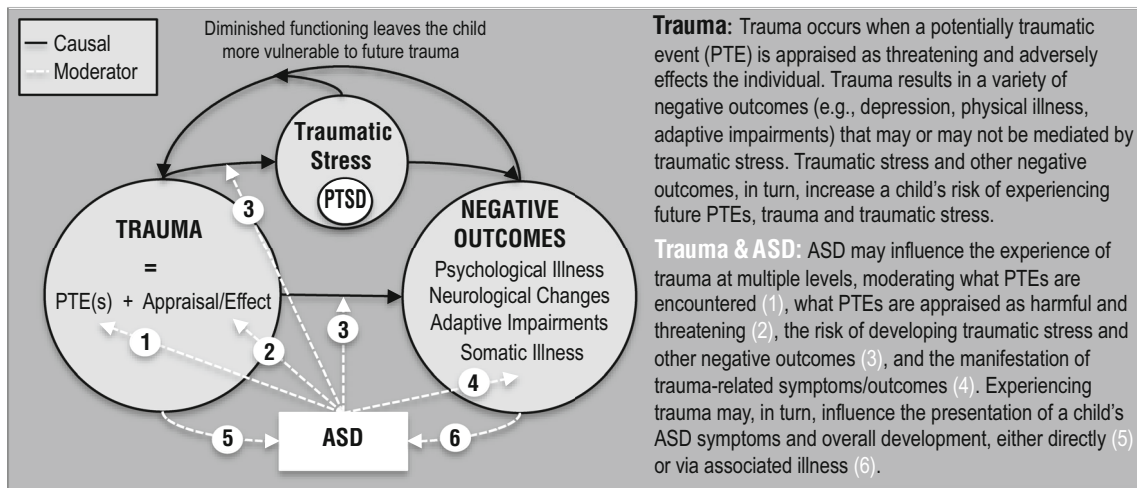
Fig. 1 Transactional model of trauma, trauma-related difficulties and ASD. This hypothetical model is informed by prior theoretical models proposed by Lazarus and Folkman (1987), Felitti et al. (1998) and Wood and Gadow (2010)

regulation). Moreover, as in youth without ASD, this cycle is likely to be self-perpetuating and escalating. The enhanced psychological vulnerability incurred by trauma may enhance a child's chances of experiencing future traumas and diminish his or her capacity to cope with them. This hypothesized relationship extends Wood and Gadow's (2010) model of clinical anxiety in ASD to the phenomenon of trauma in ASD. Particularly, Wood and Gadow (2010) suggest that youth with ASD may turn to maladaptive coping strategies, such as repetitive behavior and social avoidance, as a means of escaping negative affect. These attempts to cope with stress consequently escalate and negatively reinforce the occurrence of ASD symptoms, while also reducing adaptive functioning and flexibility. The same pattern may arise when youth attempt to cope with or escape the raw and painful emotions associated with trauma, resulting in a more severe ASD profile.

Recommendations for Future Research

There are likely many reasons why the issue of trauma has been understudied in ASD. The ethical and methodological complexity of assessing potentially traumatic experiences and their influence on individuals with ASD is daunting. For a regretfully lengthy period in its early research history, ASD was erroneously attributed to cold, emotionally abusive parenting (most notoriously Bettleheim's 1967 concept of the 'refrigerator mother'). Given this history, efforts to examine the issue of trauma in ASD will come with many ethical and moral considerations and responsibilities.

Issues of measurement will also be paramount. Efforts to assess internal and emotional phenomena in youth with ASD are complicated by a limited number of appropriate and valid measures for this population (Kerns and Kendall 2012; Matson and Nebel-Schwalm 2007; Mazefsky et al. 2011; Mazefsky et al. 2012; but see also Lecavalier et al. 2014). There are many reasons why measures developed for other populations may not be as effective in ASD. As an example, diagnosis of comorbid anxiety disorders in youth with ASD is complicated by (a) ASD-related social and communication deficits (which prohibit youth report), (b) the overlap of anxiety and ASD symptoms, and (c) the potential atypical expression of anxiety symptoms in this population (Kerns and Kendall 2012; Scahill 2012; Wood and Gadow 2010). Similarly, symptoms of traumatic stress and ASD are behaviorally defined, potentially overlapping (e.g. hyperarousal, inattention, flattened affect) and often assessed via parent and individual insights, perceptions and observations.

In addition to these issues of measurement—and in part because of them—the intermingling of neuropsychological mechanisms underlying trauma and ASD has also been under-investigated. What is the impact of traumatic events on the short and long-term functioning of individuals with ASD? How do acute and prolonged symptoms of trauma manifest in this population, and how do these symptoms interact with characteristics of ASD to influence a child's learning and development? For example, what role might traumatic events play in the formation of neural pathways, the processing of emotions, social cues and threat, the building of cognitive schemas (e.g. the world is dangerous), and—over time—the expression of core ASD symptoms, comorbid psychiatric and physical illnesses?

Exploration of these questions will require a multi-disciplinary and multi-faceted (i.e. mixed-method, multi-informant, multi-dimensional) approach that includes the

careful development of appropriate measurements. Given that the quality of traumatic events and responses may vary in youth with versus without ASD, measures designed to assess a broader array of trauma-related symptoms, such as the *Trauma Symptom Checklist for Children* (TSCC; Briere 1996) and *Trauma Symptom Checklist for Young Children* (TSCYC; Briere et al. 2001) may be more appropriate for youth with ASD than those designed around specific PTSD criteria. Similarly, considering items from traumatic event surveys, such as the *Traumatic Events Screening Inventory for Children* (Ford and Rogers 1997), as well as ASD-specific tools, such as the *Stress Survey Schedule* (Groden et al. 2001), may help clinicians and researchers alike query a more comprehensive and relevant array of potentially traumatic events in ASD.

Guidelines for assessing PTSD in young children may also inform the assessment of PTSD in individuals with ASD. Research suggests that criteria should be more behaviorally anchored and developmentally sensitive to detect PTSD in young children who, like youth with ASD, are likely to have immature abstract cognitive and verbal expression capabilities (Scheeringa et al. 1995, 2001). For example, as in young children, significant changes in arousal regulation and functioning (social, adaptive, play) following a trauma may be easier to recognize and suggestive of traumatic stress in ASD than more verbally mediated symptoms (e.g. fears of foreshortened future, difficulties with recall, avoidance or thoughts associated with trauma), though this must be tested. Certain PTSD symptoms, such as restricted range of affect and social detachment, may also be difficult to disentangle from core ASD deficits. In such cases, assessing for clear *changes* in functioning may be critical—for example, increased isolation, inflexibility or withdrawal of the child with ASD into their circumscribed interests or inner world. Examination of these clinical hypotheses regarding the presentation of traumatic stress in ASD and the appropriateness of existing trauma tools will be important in future research.

Though the use of existing trauma measures as well as epidemiological and clinical datasets holds the potential to shed some immediate, albeit imperfect light on the relationship of trauma and ASD, a more comprehensive understanding may hinge on the development of new measures. Researchers venturing into this area will need to proceed cautiously, as any gold standard, whether an adapted research tool (originally developed in other populations) or comprehensive clinical interview, is likely to have limitations. Revelations regarding the limited accuracy and inclusiveness of extant child anxiety and mood assessments in ASD populations have already led to the creation of adapted and novel measures of these psychiatric comorbidities in ASD (Grondhuis and Aman 2012; Kerns

et al. 2015; Mazefsky et al. 2011, 2012). This may encourage future investigators to look beyond neurotypical definitions of trauma and stress and consider mixed-method approaches (e.g. both qualitative and quantitative studies) that are better suited to novel research areas and ambiguous constructs. Measures are needed to estimate the prevalence of traumatic experiences and related symptoms in ASD, to detect hypothesized predictors of risk, to track complex traumas and their influence on youth outcomes and to identify youth with chronic trauma-related symptoms who are in need of intervention. There is, moreover, an urgent need to identify outcome measures that are adequately sensitive, specific, reliable and valid to demonstrate treatment benefit in ASD. Accordingly, to pave the way for this research, initial tools must be versatile (i.e. applicable to multiple research disciplines and clinical practice), valid and sensitive enough to evaluate the benefit of future trauma-focused psychotherapeutic or pharmacological trials.

Effective investigation of trauma in ASD will benefit from longitudinal research designs, equipped to delineate risk factors and the influence of traumatic stress on the development trajectory of youth with ASD overtime. Further, this research will benefit form the attention and collaboration of multiple scientific disciplines (e.g. public health, psychology, social work, pediatrics) as well as the engagement of community advocates and representatives, from parents to clinical practitioners and affected individuals. Community involvement will be important to ensure the ethical and caring development of effective research instruments and programs.

Conclusion

Research is needed to advance scientific understanding of trauma in youth with ASD and to prevent and treat associated suffering. At present, there are more questions than answers regarding the occurrence and ramifications of traumatic events in individuals with ASD. The goal of this article is to increase awareness of this important issue and to encourage researchers and practitioners from multiple disciplines to contribute their perspectives, knowledge and skill sets to the advancement and direction of this research area. Fortunately, there has been much progress in the development of approaches to reduce the occurrence and impact of traumatic events (Berkowitz et al. 2011; Kramer and Landolt 2011; Smith et al. 2013)—there is no reason why this work should not be extended to individuals with ASD. Finally, this research should be informed by individuals with ASD, their families and supporters. If done well, such research may help these individuals better understand and cope with trauma in their lives.

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