Enhancing Flexibility: A Biosocial Model for Resilience to Adversity in Youth With Autism

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Abstract

Flexibility is often associated with resilience from adversity. Youth with autism spectrum disorder (ASD) are at risk of stress and trauma yet have inherent difficulties with flexibility, including rigid behaviors, routines, “insistence on sameness,” and lack of social reciprocity. This review highlights literature of physiological and psychological processes related to inflexibility in ASD and proposes a heuristic model to understand mechanisms of resilience in the aftermath of adversity. This article presents the Biosocial Model for Resilience, which posits that interventions that target changes in central, autonomic, and endocrine dysregulation may in turn enhance processes of psychological flexibility (i.e., executive cognitive, emotional, and interpersonal regulation) that increase the likelihood of resilient adjustment in response to stressful experiences. This model of resilience is optimistic in positing that, in addition to critical programs on the prevention of social adversity, future research on flexibility can inform intervention programs that target this specific mechanism to minimize harmful aftereffects in youngsters with ASD.

Keywords

psychiatry, behavioral sciences, intellectual and developmental disabilities, special education, education, social sciences, counseling psychology, applied psychology, psychology, cognitive-behavioral therapy, psychotherapy, clinical psychology, abnormal psychology, experimental psychology

Flexibility is associated with resilience, but what if an individual has inherent difficulties with flexibility? Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by a range of symptoms in two core areas as presented in the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; American Psychiatric Association, 2013): deficits in communication and reciprocal social interactions and excesses in repetitive and restricted behaviors (RRBs). Strang et al. (2017) identified five factors related to flexibility: routines/rituals, transitions/change, special interests, social flexibility, and generativity. Behavioral and cognitive inflexibility are reflected in the first three factors and include RRBs, such as rigid behaviors, interests, routines, thoughts or preoccupations, and a need for sameness. These aspects of inflexibility can lead to co-occurring psychiatric challenges, such as anxiety, depression, and disruptive behaviors (Factor et al., 2016; Gotham et al., 2013; Stratis & Lecavalier, 2013). Difficulties with social communication and interactions in ASD map onto the social flexibility factor and primarily refer to compromised social reciprocity, which is the ability to engage in emotionally appropriate turn-taking in social interactions (Constantino et al., 2000). This deficit reflects inflexibility in coordinating and modifying responses (e.g., gaze, facial expressions, and verbalizations) to another person appropriately for a successful interaction as well as in adapting to social situations such as sharing toys or losing a game to maintain peer relationships. As such, psychological inflexibility can have widespread effects on emotional, cognitive, behavioral, and interpersonal functioning that can interfere with resilience to stressors.

We focus this review specifically on youth (i.e., younger than 18 years old) with ASD, although the proposed model may be applicable to other ages as well as in other diagnoses where flexibility is compromised. The current emphasis on children and adolescents follows multiple studies pointing to high rates of psychiatric co-occurrences in youth with ASD, including anxiety, depression, attention-deficit/hyperactivity disorder, and disruptive behavior disorders, making this an important time period to target for intervention. For example,
in a population-based study, Simonoff et al. (2008) found that 71% of children with ASD had at least one other psychiatric condition, 41% had two or more, and 24% had three or more. The burden becomes even greater for clinic-referred youth with ASD, where 95% of the sample had three or more co-occurring psychiatric conditions, and 74% had five or more (Joshi et al., 2010). Moreover, it has become increasingly recognized that stress, trauma, and social adversity, in general, are more prevalent in children and adolescents with ASD (Kerns et al., 2015). Taken together, this work highlights the need for effective ways to intervene and promote healthy adaptation or resilience in this vulnerable group of youth.

Similar to other definitions in the literature (e.g., Luthar, 2015; Luthar et al., 2000; Padesky & Mooney, 2012), we define resilience here as successful adaptation after experiencing significant adversity. Tugade and Fredrickson (2004), for example, define resilience as the ability to “bounce back” from a difficult situation, whether that be a loss, hardship, or other emotional context. Furthermore, they note that resilience has been likened to “elasticity,” similar to the idea of flexibility we use herein, which can be associated with both physical and behavioral changes in how one acts and reacts to situations. In our proposed model, resilience in youth with ASD is reflected in avoidance of psychopathology and achievement of life satisfaction, positive well-being, competent functioning, and quality of life after experiencing obstacles or stressors. Although multiple individual, family, and community factors contribute to resilience (Luthar, 2015; Tugade & Fredrickson, 2004), psychological flexibility can be viewed as one set of individual-level processes for enhancing resilience. Indeed, Kashdan and Rottenberg (2010) posit that psychological flexibility is a “cornerstone of health.” They define psychological flexibility as various dynamic processes to adapt to situational demands, shift mindsets, and modify behaviors as needed to be consistent with one’s values and to maintain competent personal or social functioning. They also note that, in a world of fluctuating and competing demands, desires, and values, the ability to modulate responses to context is of the utmost importance to navigate life adaptively. Therefore, flexibility is a process, rather than a trait, which enhances the ability to cope with and adapt to stressors. Resilience reflects the attainment of positive outcomes, despite exposure to adversity, that is mediated by flexible responding.

Although significant emphasis has been placed on identifying deficits and challenges associated with ASD needed for diagnosis and treatment planning, focusing on approaches that promote resilience may provide additional avenues through which to intervene. Previous work has noted the dearth of research on resilience in ASD, which, to date, has focused primarily on identifying the “opposite” of risk factors (El-Sabbagh, 2020; Szatmari, 2018). These authors suggest that the field should instead focus on skills needed to decrease the impact of risk factors and specifically target these protective mechanisms. In this narrative literature review, we will present (a) research on inherent physiological inflexibility processes that contribute to psychological inflexibility in ASD; (b) effects of extrinsic stress and trauma in this population that can exacerbate such processes; and (c) a model of resilience that we hope will be empirically tested in future research. Specifically, the proposed model of resilience in the aftermath of adversity focuses on targeting physiological and psychological processes to facilitate the underlying protective mechanism of flexibility in ASD (Figure 2). This model directly contrasts most research that has focused only on risk factors and poor outcomes. Resilience through flexibility provides a specific lens through which to view ASD that may provide more tools to strengthen and empower this population. The purpose of this narrative literature review is to survey recent literature on the theme of flexibility or inflexibility in autistic youth to build upon prior work and offer a conceptual model of resilience through enhancing flexibility, based on a biosocial theoretical framework.

Method

Consistent with components of a narrative literature review (Grant & Booth, 2009), a noncomprehensive literature search was completed in Psych Info, PubMed, and Google Scholar, revolving around specific themes: autism, trauma, and contributors to flexibility/inflexibility and resilience. The search focused on articles published between 1999 and 2019 to stay relatively current and excluded those published in languages other than English. We emphasized studies of children and adolescents, although adult studies were occasionally included to demonstrate a given concept if a youth population was not available or results were not clear in youth. As such, we specify whether studies included youth or adults when reporting study findings to clarify the sample population. Thematic keywords used in our search included terms such as, “autism,” “autism spectrum disorder,” “trauma,” “stress,” “inflexibility,” “restricted repetitive behaviors,” “rigidity,” “perseveration,” “rumination,” “flexibility,” “resilience,” “central nervous system,” “neurobiological,” “autonomic nervous system,” “endocrine,” “HPA,” “heart rate variability,” “cardiac vagal control,” “cortisol,” “executive cognitive functions,” “emotion regulation,” “anxiety,” “depression,” “aggression,” “PTSD,” “posttraumatic stress,” “cognitive behavioral,” “exercise,” “relaxation,” “biofeedback,” “transcranial,” and “mindfulness.” Articles were manually reviewed, and their reference list was also searched for additional relevant articles. Duplicates and personal opinion articles were excluded.

Results

Biosocial Theoretical Framework

Before understanding resilience, we must understand what makes youth with ASD a vulnerable or at-risk population. As
illustrated in Figure 1, and consistent with transactional models of development, the interplay of biological and social risk factors creates a profile of biosocial vulnerability that can disrupt typical development and lead to maladjustment in the face of childhood adversity (Scarpa, 2015). As applied to ASD, this biosocial theoretical framework assumes that maladjustment arises when psychological mechanisms (i.e., affective, cognitive, behavioral, and interpersonal processes) are disrupted by changes in central, autonomic, and endocrine functioning that in turn lead to physiological dysregulation. In other words, the physiological processes lead to psychological processes that have downstream effects on adjustment. Moreover, extrinsic factors related to adverse social context can moderate influences on the child at any level of the model, ultimately derailing the physiological and psychological processes, which can increase psychopathology. These same biosocial vulnerability processes can be applied to inflexible responding frequently seen in ASD such that both physiological and related psychological factors contribute to inflexibility and subsequent maladjustment.

**Physiological contributors to inflexibility in ASD.** Research on neurobiological, autonomic, and endocrine functioning in ASD supports the notion of physiological processes that may lead to rigidity in the face of various environmental challenges. This section will describe research suggesting neurobiological, autonomic, and endocrine contributors to inflexibility in ASD. Although neurotransmitters, such as dopamine, acetylcholine, and gamma-Aminobutyric acid, have been implicated in the production and modulation of RRBs, particularly in animal models, they will not be included in this review. Interested readers in the effects of neurotransmitters are referred to Péter et al. (2017).

**Neurobiological contributors.** Brain-imaging research contributes to our growing understanding of the neurobiology of inflexibility in ASD. Prior research highlights three main brain networks as fundamental to facilitating flexible behavior: the frontal–parietal central executive network, the default mode network, and the salience network (Sridharan et al., 2008; Uddin et al., 2015). The frontoparietal executive network appears crucial for manipulating information and for making decisions; the default mode network is implicated in social cognition and cognitions about oneself, both of which are integral to being flexible in daily interactions; and the salience network is a key network in selecting relevant stimuli that help direct flexible behavior as well as in processes related to affect and control. These three networks must work together to facilitate optimal flexibility. However, research demonstrates functional hyperconnectivity within each of these regions in individuals with ASD (Uddin et al., 2013). This hyperconnectivity within each network may result in these networks operating in relative “isolation” during tasks; that is, individuals with ASD may exhibit relative hypoconnectivity between these brain networks, resulting in less behavioral flexibility.
One effective connectivity study using the three aforementioned networks explored brain-state differentiation between children with ASD and typically developing (TD) age-matched and IQ-matched controls (Uddin et al., 2015) while they completed arithmetic, social, and oddball attention tasks. They found that a computer algorithm could better classify whether a brain scan was taken during resting state or during a task-induced state in TD controls than in those with ASD, demonstrating less brain-state differentiation in ASD. These results offer support of a broader “neurophysiological inflexibility” in the brains of children with ASD that may underlie their cognitive and behavioral inflexibilities, as the actual neural connectivity, and thus recruitment of brain regions needed for different functions seems to be less modulated or controlled when shifting in and out of laboratory task demands.

In addition, corticostriatal circuitry, which is consistently found to be altered in ASD, appears to play a prominent role in processing and integrating across emotions, cognitions, and motor domains to allow for flexible responding. For example, Abbott et al. (2018) found a greater imbalance in corticostriatal intrinsic functional connectivity in children and adolescents with ASD than in TD controls during resting-state scans. Furthermore, within ASD participants, individuals with more RRBs showed greater connectivity imbalance such that limbic intrinsic functional connectivity was relatively increased while frontoparietal and circuit intrinsic functional connectivity was reduced. These findings map onto key behaviors in individuals with ASD. For example, executive functions (e.g., flexibility and inhibition), supported by the frontoparietal circuit, are often impaired in individuals with ASD; thus, we might expect functional connectivity of the frontoparietal circuit to be reduced in these individuals. In addition, the hypoconnectivity of the motor striatal seed with the rest of the brain may be related to the fact that these individuals often demonstrate repetitive motor movements, rather than novel and flexible movements that would require greater functional connectivity between the motor striatal seed and the rest of the brain.

**Autonomic contributors.** Other research suggests that dysregulation of the central-autonomic network leads to poor cardiac vagal control (CVC), which subserves flexible autonomic responding to situations that call for rapid body mobilization (Appelhans & Luecken, 2006). Multiple studies have found high baseline heart rate (HR) and low baseline parasympathetically mediated HR variability (HRV) in youth with ASD (Scarpa, 2015), reflecting low CVC. It has been suggested that this signature of hyperarousal in the autonomic nervous system may reflect chronic mobilization of a threat response (Patriquin et al., 2019).

In general, low CVC is linked to poor attention shifting, emotion dysregulation, and behavioral inflexibility (Kashdan & Rottenberg, 2010). In a recent review of autonomic functioning in ASD, Patriquin and colleagues (2019) demonstrated a positive association between CVC and both cognitive and social functioning. In addition, in a study of school-age children with ASD, researchers found a significant correlation of baseline respiratory sinus arrhythmia (RSA), a common measure of CVC, with social deficits and anxiety such that lower RSA corresponded to higher anxiety symptoms and greater social challenges (Neuhaus et al., 2014).

A growing body of literature also demonstrates a link between CVC and behavioral inflexibility in ASD. In a recent review, Condy et al. (2019) found some support of a link between baseline RSA and RRB severity such that lower CVC was associated with higher behavioral inflexibility. Another study found that reduced baseline RSA was a significant predictor of RRB severity in children with and without ASD, above and beyond IQ alone (Condy et al., 2017). The relationship between autonomic functioning and behavioral inflexibility appears early in development, as one longitudinal study demonstrated that RSA that was consistently low over the first several years of life in TD children predicted ASD symptomology and behavioral challenges at age 4 (Patriquin et al., 2014). In a more recent study, Sheinkopf et al. (2019) showed that infants who later displayed ASD, compared to TD controls, exhibited a slower linear increase in RSA from 0 to 72 months, with slowed growth most evident at 18 months.

**Endocrine contributors.** Cortisol, a stress hormone, allows researchers to examine differences in hypothalamic–pituitary–adrenal (HPA) axis activity and explore the influence of acute and chronic stress. Stress, especially when severe and chronic, has been shown to negatively affect cognitive functioning and flexibility (Lupien et al., 1999). Researchers suggest that individuals with ASD are more vulnerable to stress as a result of challenges in coping with change, sensory aversions, and unpleasant events (Ogawa et al., 2017). A review by Taylor and Corbett (2014) shows support for dysregulation of the circadian pattern of cortisol in ASD, specifically in samples with significant impairment in functioning who previously met criteria for autistic disorder.

In addition, differences in HPA stress responsivity were noted across several studies, suggesting hyper-responsiveness to unpleasant stresses or benign social conditions and hypo-responsiveness to social evaluation situations. For example, Spratt and colleagues (2012) found that children with ASD exhibited a higher increase in cortisol after a blood draw as well as a prolonged elevation in cortisol compared to TD children. On the contrary, studies examining the response to social evaluative stressors using the Trier Social Stress Test for Children (TSST; Buske-Kirschbaum et al., 1997) have shown a blunted cortisol response in individuals with ASD (Corbett et al., 2012, 2019; Levine et al., 2012). In other words, children with ASD showed an atypical anticipatory response to a social evaluative paradigm, which in one study was explained by poorer ability to perceive neutral
facial expressions during the TSST in children with ASD compared with TD controls (Corbett et al., 2019).

Despite variability in findings related to behavioral outcomes, heightened cortisol has also been linked to increased sensory sensitivity (Corbett et al., 2009) in school-age children and higher frequency of RRBs in children and adolescents (Lydon et al., 2015) with ASD. As such, HPA hyperreactivity may be related to behavioral inflexibility, while hyporeactivity may be related to social inflexibility.

**Psychological contributors to inflexibility in ASD.** Psychological processes, such as impairments in executive functioning and emotion regulation, can present challenges in youth with ASD that directly impair functioning (Mazefsky et al., 2013; Wallace et al., 2016). As reviewed subsequently, these difficulties contribute to psychological inflexibility, which often manifests as perseverative thinking, rumination, repetitive behaviors, and lack of social reciprocity.

Regarding executive functioning, individuals with ASD often demonstrate impairments in skills such as attention shifting, planning, response inhibition, and working memory—integral skills for flexible cognitive control (see Wallace et al., 2016 for a review). Ozonoff et al. (2004) referred to the difficulty in ASD with switching the focus of attention, or set shifting, that can lead to persistent use of unhelpful strategies rather than trying new coping strategies. They also suggest that this impairment in shifting can lead to perseveration on negative thoughts and behaviors (e.g., hostile attribution biases and gaze avoidance) to the exclusion of other thoughts or behaviors that may be more adaptive, which ultimately negatively impacts social behaviors. It is also possible that perseverative thoughts could increase the likelihood of rumination, which has been found to be related to insistence on sameness and to moderate ASD severity and depression in adolescents/adults with ASD (Gotham et al., 2014).

Regarding emotion regulation, youth with ASD have been found to use higher rates of maladaptive coping strategies (e.g., suppression) and lower rates of adaptive coping strategies (e.g., cognitive reappraisal) compared to TD peers (Samson et al., 2015). Mazefsky et al. (2013) and White et al. (2014) also reviewed empirical research on social–cognitive (including executive functions), physiological, and neural mechanisms that underlie emotion regulation impairments in ASD, providing further support for the notion of inherent ASD qualities that put individuals with ASD uniquely at risk for social and emotional maladjustment.

**Trauma and Negative Life Events in Children With ASD**

Although physiological factors form the backdrop of inherent processes that contribute to psychological inflexibility in ASD, it is important to recognize that adverse social contexts, such as exposure to trauma and victimization, can exacerbate an already vulnerable system. Children with ASD are more likely to experience maltreatment, bullying, severe accidents, self-injurious behavior, and hospitalizations, as well as involvement with child protective services, than their TD peers (Adams et al., 2014; Kerns et al., 2015). Mehter and Mukaddes (2011) also investigated trauma in individuals with ASD (aged 6–18 years). Approximately 26% of participants reported a history of trauma (i.e., accidents/violence, sexual abuse, and physical abuse) and 17% met the criteria for a posttraumatic stress disorder (PTSD) diagnosis.

Trauma and negative stressful life events can increase mood disturbance, negative arousal, flashbacks, avoidance, and emotional distress. These events, especially when present during childhood, may lead to the manifestation of mental illness and adverse physical outcomes or health problems (Brewin et al., 2000), including long-lasting effects of PTSD, depression, anxiety disorders, and aggression. As discussed earlier, these diagnoses often co-occur with ASD.

Trauma and stress can also exacerbate RRBs. In the general population, both children and adults frequently report the occurrence of stressful life events prior to the onset of rigid, repetitive cognitions and behaviors such as obsessive-compulsive disorder (OCD) symptoms, perseverative thinking, rumination, and lack of social engagement (Gothen et al., 2004). Individuals with diagnoses such as OCD, where inflexible thinking patterns are central, also indicate higher rates of trauma when compared with non-OCD controls (Lochner et al., 2002). Similarly, stress may prompt RRBs (e.g., head banging, complex body movements, and hand or finger mannerisms) in children with ASD, in that children with ASD may use RRBs as a way to calm themselves or to communicate their emotions or needs (Bishop et al., 2007). In addition, because of RRBs, (i.e., sensory interests, rigidity, and perseveration), it is often difficult for children with ASD to cope with unexpected deviations in routines and transitions between activities. This can then magnify difficulties with emotion regulation and result in tantrums and disruptive behaviors (Mazefsky et al., 2013). This stress may cause more delays in executive functioning skills of planning and flexibility, regression in adaptive or communicative behaviors, and a stronger presence of challenging behaviors (Hoover, 2015; Pine, 2003). As such, consistent with the Biosocial Vulnerability Model in Figure 1, inherent ASD qualities may intensify the negative impact of stressors compared with the general population, thereby increasing the likelihood of maladjustment.

Trauma can also lead to physiological dysregulation, which contributes to increased inflexibility, especially in children with ASD. Increased arousal (e.g., reflected in high HR, low HRV, and changes in HPA reactivity) is common following trauma, as internal or external stressors can cause HPA axis dysregulation, elevations in the secretion of cortisol, and other brain changes (Margolin & Gordis, 2000; Nader & Fletcher, 2014; Taylor & Corbett, 2014). Children's response to traumatic stress is moderated by abnormal HPA...
Children with ASD display high cortisol levels in response to threatening stimuli (e.g., stress and sensory sensitivities) and high salivary cortisol levels when anticipating exposure to a nonevaluative stressful stimulus (Spratt et al., 2012). This response contributes to difficulties in cognitive functioning, emotion and behavior regulation, and social attachment (Kerns et al., 2015). As noted earlier, there is also evidence that the general pattern of daily cortisol secretion is disrupted in some individuals with ASD (Sivaratnam et al., 2015; Taylor & Corbett, 2014). The delayed response of the HPA axis inhibits cortisol secretion following negative stress, and this provides evidence that children with ASD experience frequent and longer lasting periods of stress than children without ASD, both psychologically and physically (Spratt et al., 2012). This hyperarousal of the HPA axis occurs in response to any novel experience or social situation, which leads to severe levels of stress and anxiety, regardless of whether the stressor is emotional or nonemotional. These ongoing negative effects on mental and physical health can predispose children to internalizing symptoms later on in adulthood, such as depression and anxiety (Bremner et al., 2007).

It is important to note that the effect of trauma on an individual also depends on multiple characteristics of the trauma itself (i.e., the nature of the trauma, age, and length of time since the trauma) as well as individual factors such as emotions, controllability of stress, comorbidities, and attachment style (Gerson & Rappaport, 2012). Children with ASD are more often exposed to bullying, teasing, and peer rejection, and are likely to be more sensitive to these experiences compared with non-autistic children. In addition, trauma experiences in ASD can be accompanied by emotional regulation deficits, high startle responses, and hyperarousal (e.g., difficulty concentrating, easily irritated, and more anger and anxiety), which can further amplify the likelihood of experiencing trauma and negative stress (Kerns et al., 2015; White et al., 2014). The way that trauma manifests in those with ASD can vary on an individual level and sometimes intensify the already impairing symptoms and traits of ASD, including communication differences or RRBs.

A Positive Approach: Heuristic of the Biosocial Model for Resilience to Adversity in Youth With ASD

As noted in the review earlier, prior findings suggest that children with ASD show the potential for poorer physiological adaptation to social context through physiological dysregulation (e.g., high HR, low HR variability, neural hyperconnectivity, and endocrine changes), which could lead to psychological inflexibility, particularly related to compromised executive cognitive functions, emotion regulation, and social reciprocity. In other words, if the child is exposed to stressors, the stressors may exacerbate an already vulnerable disposition toward more rigid responses. Although it is important to acknowledge the adaptive function of some of these rigid responses, such as the use of routines and rituals to establish predictability and reduce anxiety, we suggest that the ability to use these and other strategies flexibly will be more helpful to promote resilience in the long run.

Resilience after adversity can occur if flexible responding is enhanced, leading to a new heuristic model: Biosocial Model for Resilience to Adversity in Youth with ASD (Figure 2). Enhancing skills that target flexibility (e.g., attentional control, emotional regulation, and social processes) would be advantageous in ASD, where inflexibility is a hallmark symptom. According to our model, flexibility can be addressed through physiological and psychological flexibility tools to increase the likelihood of resilience.

Emerging treatments that target flexibility in children with ASD are promising and span several modalities across physiological (e.g., physical exercise) and psychological (e.g., cognitive-behavior therapy [CBT]) tools, although most studies have methodological weaknesses and have not included children who have cognitive or language impairments (Wallace et al., 2016). The interventions described subsequently are meant to serve as exemplars for future research on methods to improve flexibility in ASD, which may ultimately support resilient adaptation after stress or trauma.

Creating resilience through changes in physiological processes. Regarding physiological processes, physical exercise and relaxation techniques (e.g., breathing) may directly enhance autonomic flexibility via reductions in the physiological stress response (i.e., reduced HR, increased HR variability, and reduced HPA reactivity). In a systematic review, for example, Lang et al. (2010) found that physical exercise improved stereotypic behaviors, aggression, and elopement in youth and adults with ASD. Similarly, Rosenblatt and colleagues (2011) conducted a pilot study and found that relaxation-based yoga reduced problem behaviors in 5- to 12-year-old children with ASD.

In addition, biofeedback shows promise in targeting numerous psychiatric disorders, and researchers often use this approach to target different physiological parameters (e.g., HRV and electroencephalogram [EEG]). Within children with ASD, several studies have used EEG biofeedback and shown improvements in social interaction (Jarusiewicz, 2002), social communication, and executive function (Kouijzer et al., 2010). One study utilized a randomized control design and showed that EEG feedback resulted in significant improvements in cognitive flexibility that were maintained 6 months later (Kouijzer et al., 2013). Despite these promising findings, researchers conducting a systematic review of biofeedback studies
suggest approaching this research with caution, given the variability in methodologies utilized across studies (Schoenberg & David, 2014).

Although speculative, our heuristic model might lead researchers to explore how novel technologies thought to improve frontal functioning can be applied to ASD. The model predicts that frontal enhancement leads to downstream improvements in executive cognitive control and emotion regulation that impact behavior. Results of a systematic review and meta-analysis of 23 reports by Barahona-Corrêa et al. (2018), for example, indicated that repetitive transcranial magnetic stimulation (rTMS) in those with ASD produced significant moderate effects on RRBs, social behaviors, and some executive function tasks. Another systematic review of six transcranial direct current stimulation (tDCS) treatment studies similarly found improvements in behavioral and cognitive symptoms of ASD (Fernandes et al., 2017). In both of these reviews, the majority of studies used child/adolescent participants with IQ more than 80 but varied widely in many other methodological respects, such as blinding to treatment condition, the inclusion of follow-up, and characteristics of the treatment itself (e.g., schedules and parameters). The authors cautioned that the evidence is quite preliminary, and more rigorous research is needed before any conclusions about the benefits of using rTMS or tDCS to treat ASD can be made.

Creating resilience through changes in psychological processes. Flexibility can also be built behaviorally or in psychological contexts. Findings involving clinical populations other than ASD (e.g., social anxiety disorder) suggest that greater flexibility early in treatment is associated with less distress and impairment during later sessions (Dalrymple & Herbert, 2007). Similarly, greater flexibility in individuals with borderline personality disorder was associated with lower attrition, faster reduction in depressive symptoms over the course of treatment, and better outcomes (Berking et al., 2009; Rüssel et al., 2008). In fact, some aspect of flexibility is at the core of a number of treatments even if not explicitly stated as a goal; for example, behavioral activation, cognitive therapy, and interpersonal psychotherapy all focus on questioning thoughts and being flexible in thinking patterns. Therefore, making flexibility a more explicit treatment target could lead to greater improvements in the context of intervention. Specific flexibility tools can include a range of strategies (e.g., altering thinking patterns, emotion regulation strategies, mindfulness, acceptance, increasing positive activities, social skills, etc.) that impact cognitive, social, and behavioral control.
Multiple studies have shown benefits of CBT (e.g., cognitive reappraisal and thought substitution) and social skills training for youth with ASD to address their functioning in cognitive, affective, and interpersonal domains (e.g., Dekker et al., 2019; see Scarpa, White, & Attwood, 2013 for a review), although generalization to everyday functioning remains limited and requires further study (Jonsson et al., 2016). While recognizing its limitations it is possible that CBT can be used to target flexibility, particularly if it addresses the underlying executive function, emotion regulation, and social cognition and reciprocity difficulties. For example, Unstuck and On Target! (UoT; Cannon et al., 2011) directly targets flexibility, planning, and organization. In an RCT, results demonstrated significantly greater improvements for UoT versus a social skills curriculum in executive functions measured with multiple modalities (e.g., classroom observation and parent and teacher report) for children with ASD, although both interventions showed social skill improvements (Kenworthy et al., 2014). Targeting executive function, which can enhance emotion regulation, is a specific strategy that can bolster cognitive tools to allow for flexibility across situations.

Although not developed specifically for individuals with ASD, Padesky and Mooney (2012) describe a four-step program that modifies traditional CBT by helping clients identify existing strengths used to develop a personal model of resilience for day-to-day stressors. Applying and testing this sort of constructive approach with respect to youth with ASD can shift the field to focus on enhancing strengths and on giving these individuals tools to cope with stress and live a full life.

Another intervention that directly targets emotion reactivity and regulation is the Stress and Anger Management Program (STAMP), which adapts CBT for younger children with ASD (4–7 years; preschool/kindergarten developmental level) and adds an active parent-training component (Scarpa, Wells, & Attwood, 2013). This program is a developmental modification of the Exploring Feelings CBT program (Attwood, 2004) that was developed for older children with ASD between the ages of 9 and 13 years (Sofronoff et al., 2005, 2007). Within these interventions, children are taught to improve their flexible responding by using physical, relaxation, cognitive, and social tools to aid in their self-regulation of emotion, thereby targeting both the physiological and the psychological processes often difficult for children with ASD. Although research on STAMP has not directly addressed resilience to adversity, randomized controlled trials (RCT) studies have shown fewer and shorter emotional outbursts and lower negativity/lability scores after treatment (Factor et al., 2019; Scarpa & Reyes, 2011). Future studies could examine trauma, flexibility, and resilience in the context of the STAMP intervention.

Finally, recent work also shows promise for mindfulness training (e.g., acceptance and present awareness) in decreasing ruminative thinking, preoccupations, and social deficits in adolescents with ASD (de Bruin et al., 2015). Similarly, a review of mindfulness-based interventions for youth (targeting either child alone or both child and parent simultaneously) shows increases in quality of life, self-regulation, social motivation, and decreases in irritability and aggression (Semple, 2019). Research is needed to adapt such interventions for youth with ASD and co-occurring language or intellectual impairments.

**Conclusion**

In this narrative literature review, research is presented on the inherent physiological inflexibility processes that contribute to psychological inflexibility in ASD, with a focus on central, autonomic, and endocrine functioning. In general, the research indicates that brain connectivity, cardiac vagal control, and HPA-axis reactivity may be implicated in executive function and emotion regulation difficulties. This review also highlights research indicating heightened risk for stress and trauma in youth with ASD that can exacerbate such biosocial processes. Finally, a model for resilience is presented, based on a biosocial theoretical framework, which can be empirically tested in future research. The Biosocial Model for Resilience posits that intervention that targets changes in central, autonomic, and endocrine dysregulation, may, in turn, enhance processes of psychological flexibility (i.e., executive cognitive, emotional, and interpersonal regulation) that increase the likelihood of resilient adjustment in response to stressful experiences.

Increasing flexibility in youth with ASD can help build resilience to navigate and mitigate difficulties that result from adversity and the inherent nature of ASD to experience events more intensely. Although we acknowledge the powerful role of others (i.e., parents, peers, and community) in shaping flexibility and promoting resilience throughout development, by teaching youth that they have the tools within themselves to create this flexibility, they can embrace their own power to manage difficult situations and to navigate life successfully and meaningfully despite traumatic or stressful life experiences. The current model is proposed as a heuristic to stimulate further thinking and research on this topic. Although initial work is promising, rigorous methodologies and application across the full spectrum of functioning in ASD are critically needed, and this review did not include related topics, such as the role of neurotransmitters or treatment with medication. Furthermore, this review referred primarily to stressors and trauma that are considered adverse and are usually interpersonal in nature, such as victimization or bullying. However, this model could just as easily be applied to other stressful life events and kinds of trauma, which could be considered and tested in future research in youth with ASD. Limitations notwithstanding, research on this model can shift the field to focus on strengths and provide a context
in which youngsters with ASD can flourish by enhancing their flexibility in the face of challenge.

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