



# The association between self-injurious behaviors and autism spectrum disorders

## Citation

Minshawi, Noha F, Sarah Hurwitz, Jill C Fodstad, Sara Biebl, Danielle H Morriss, and Christopher J McDougale. 2014. "The association between self-injurious behaviors and autism spectrum disorders." *Psychology Research and Behavior Management* 7 (1): 125-136. doi:10.2147/PRBM.S44635. <http://dx.doi.org/10.2147/PRBM.S44635>.

## Published Version

doi:10.2147/PRBM.S44635

## Permanent link

<http://nrs.harvard.edu/urn-3:HUL.InstRepos:12152964>

## Terms of Use

This article was downloaded from Harvard University's DASH repository, and is made available under the terms and conditions applicable to Other Posted Material, as set forth at <http://nrs.harvard.edu/urn-3:HUL.InstRepos:dash.current.terms-of-use#LAA>

## Share Your Story

The Harvard community has made this article openly available.  
Please share how this access benefits you. [Submit a story](#).

[Accessibility](#)

# The association between self-injurious behaviors and autism spectrum disorders

Noha F Minshawi<sup>1</sup>

Sarah Hurwitz<sup>2</sup>

Jill C Fodstad<sup>1</sup>

Sara Biebl<sup>3</sup>

Danielle H Morriss<sup>4</sup>

Christopher J McDougle<sup>5</sup>

<sup>1</sup>Department of Psychiatry, Indiana University School of Medicine, Christian Sarkine Autism Treatment Center, James Whitcomb Riley Hospital for Children at Indiana University Health, Indianapolis, IN, USA; <sup>2</sup>School of Education, Indiana University, Bloomington, IN, USA; <sup>3</sup>Child and Adolescent Behavioral Health, Sanford Health, Fargo, ND, USA; <sup>4</sup>Medical College of South Carolina, Charleston, SC, USA; <sup>5</sup>Departments of Psychiatry and Pediatrics, Lurie Center for Autism, Massachusetts General Hospital and MassGeneral Hospital for Children, Harvard Medical School, Boston, MA, USA

Correspondence: Noha F Minshawi  
Indiana University School of Medicine,  
Department of Psychiatry, Christian  
Sarkine Autism Treatment Center, James  
Whitcomb Riley Hospital for Children  
at Indiana University Health,  
705 Barnhill Drive, ROC 4300,  
Indianapolis, IN 46202, USA  
Tel +1 317 944 8162  
Fax +1 317 948 0609  
Email nminshaw@iupui.edu

**Abstract:** A key area of concern in children with autism spectrum disorders (ASDs) are self-injurious behaviors (SIBs). These are behaviors that an individual engages in that may cause physical harm, such as head banging, or self-biting. SIBs are more common in children with ASD than those who are typically developing or have other neurodevelopmental disabilities. Therefore, it is important that clinicians who work with children with ASD have a solid understanding of SIB. The purpose of this paper is to review the research on the epidemiology of SIB in children with ASD, factors that predict the presence of SIB in this population, and the empirically supported behavioral treatments available.

**Keywords:** self-injury, autism spectrum disorders, applied behavior analysis

## Introduction

Autism Spectrum Disorders (ASDs) have received an increasing amount of attention from researchers, clinicians, the media, and the general population over the past several decades. ASD is characterized by clinically significant deficits in social-communication skills, including poor eye contact, difficulty maintaining conversations, and lack of developmentally-appropriate peer relationships, as well as the presence of restricted or repetitive patterns of behavior such as stereotyped behaviors, hypo- or hypersensitivities, and unusual interests.<sup>1</sup> The onset of ASD symptoms typically begins in early childhood and continues across the lifespan. With the increased interest in ASD, researchers have begun to focus on investigating the etiology of this disorder in an effort to identify effective treatments for core and concomitant symptoms.<sup>2,3</sup> One such area that has received considerable focus is problem behaviors (also referred to as challenging or aberrant behaviors in the literature). Problem behaviors include those behaviors that interfere with an individual's ability to function and often have the potential to cause harm or damage, such as physical aggression, verbal aggression, property destruction, tantrums, and self-injurious behaviors (SIBs), which are the focus of this paper. The purpose of this paper is to present the reader with an overview of SIB in children with ASD, as well as the behavioral assessments and interventions that are commonly used to address these behaviors. Literature was reviewed from multiple databases (eg, PsycINFO, PubMed, Ovid), although the information presented is intended to provide the reader with a broad overview of the literature and not a comprehensive compilation of all data currently available.

## SIB defined and incidence in ASD

SIB refers to a class of behaviors which the individual inflicts upon his/herself that have the potential to result in physical injury, more specifically tissue damage. Examples of SIB may include head banging, self-cutting, self-choking, self-biting, self-scratching, hair pulling, hand mouthing, and many others.<sup>4</sup> In extremely severe cases, SIB can cause irreversible injury or death if the behavior is not stopped.<sup>5,6</sup> For those with ASD, SIB tends to be classified as “stereotyped SIB” as opposed to the “impulsive SIB” that is habitual in nature and generally observed in individuals with a serious psychiatric illness (eg, self-mutilation) or typically developing adolescents and adults (eg, self-cutting).<sup>7</sup> It should be noted that although SIB in those with ASD, intellectual disability (ID), or other developmental disabilities (DD) is commonly described as a highly repetitive behavior (occurring at frequencies up to dozens of instances per minute);<sup>4,8</sup> the behavior can be episodic insofar as it either occurs under highly specific stimulus contexts, or in bursts after long periods without problematic behavior.<sup>9</sup> Since the primary focus of this paper is the discussion of SIB in those diagnosed with ASD, only those behaviors classified under the stereotyped SIB subtype will be covered.

There is more literature describing SIB in persons with ASDs than any other problem behavior (eg, physical aggression, tantrums, verbal aggression) which are not considered core symptoms of the disorder. There are a few reasons for why SIB is not considered a core symptom of ASD despite its high incidence. To begin with, while SIB is quite common in individuals with ASD, it is not endemic only to this population; however, those with ASD appear to be at an increased risk for engaging in SIB over and beyond that of other populations. Researchers looking at lifetime prevalence in those with ASD suggest that approximately 50% engage in some form of SIB, even if just at one specific period of their life span.<sup>10,11</sup> Point prevalence estimates indicate that SIB affects upwards of 25% of persons with ASD when surveyed at a distinct time point.<sup>10,12,13</sup> These epidemiological estimates place ASD sufferers as one of the most “at risk” groups despite SIB not being a diagnostic criterion, or there being a genetic marker for the behavior (eg, Lesch-Nyhan syndrome). Individuals with ASD, regardless of whether they have a concomitant diagnosis of ID or not, are noted to engage in SIB at rates substantially higher than those with ID alone. Furthermore, those with ASD are at a higher risk for developing SIB when compared to individuals who have language or speech impairment, visual or auditory impairments, those with other non-genetic medical conditions

(eg, seizures/epilepsy, headaches, ear/sinus infections, etc), or their typically developing peers.<sup>11,14,15</sup>

Second, SIB is associated with a wide range of negative consequences for the individual that compromise their quality of life. The most common forms of SIB in those with ASD are self-biting, self-scratching, skin picking or pinching, self-punching, and head banging; less common but still occurring types of SIB in persons with ASD include eye pressing or gouging, pulling one’s own hair, teeth, or fingernails, dislocation of joints (eg, fingers, periorbital area, mandible), pica, and knee-to-head hitting.<sup>5</sup> Furthermore, the act of engaging in SIB carries significant health risks, including lacerations, fractures, recurrent infections, physical malformations, detached retinas/blindness, and in extreme cases death. Negative consequences for engaging in SIB extend beyond their immediate physical impact and may include restricted educational and vocational opportunities, increased social isolation, limited access to community-based activities, costly medical and residential care, and of course restrictive treatment practices (eg, protective equipment, physical holds, seclusion/time-out, loss of personal property). Other problem behaviors are also noted to coexist, meaning that a person who engages in one act of SIB is more likely to engage in aggressive behavior, disruptive/destructive behavior, or other forms of self-injury.<sup>16–18</sup>

The third reason for the increased research on this topic is that SIB in those with ASD and other developmental disabilities, is considered to be a pervasive and chronic problem. The general long-term course of SIB suggests that the behavior first manifests in childhood and progresses into adolescence with a corresponding increase in prevalence and persistence well into adulthood.<sup>19</sup> Taylor et al<sup>20</sup> found that in a cohort study of 49 adults diagnosed with ID, many with comorbid ASD and SIB, 84% continued to exhibit SIB 20 years later (ie, as part of a longitudinal follow-up study on SIB persistence), with no significant changes in topography (ie, type of SIB) or severity. With continued interest in early intervention, researchers have recently begun to investigate early forms of SIB and other problem behaviors in very young children identified as being at high-risk for developing ASD. Fodstad et al<sup>21</sup> found that in a sample of children with ASD, approximately 18.3% (some as young as 12 months of age) were engaging in SIBs, including eye poking, self-hitting, and head banging. Thus, it appears that even very early in life, behaviors which may be of lesser severity have the potential to cause self-harm and do occur.<sup>22,23</sup> This proclivity for SIB at an early age in high-risk ASD groups has also been reported to be significantly greater than in same-aged peers with general developmental

delays<sup>21</sup> and typically developing peers.<sup>24</sup> Ultimately, regardless of when SIB emerges in the life of a person with ASD, the presence of the behavior predicts poorer long-term outcomes for the person and invested stakeholders.<sup>5,16,18,19</sup>

## Predictors of SIB

Current literature dictates that the etiological origin of SIB in the ASD population is unlikely to involve a simple determinant. That is, there appears to be multiple and often co-occurring processes involved in the emergence, presence, and maintenance of SIB. Likewise, there also appear to be certain risk factors, both personal and environmental, that place the child with ASD at an increased risk for developing chronic SIB. The identification of such factors is of extreme importance if preventative measures or early intervention targets are to be appropriately ascertained. Variables which have been investigated as potentially increasing the likelihood of SIB include severity of ASD symptomology, diagnosis and severity of ID, sex, status of adaptive functioning, and presence of concomitant psychopathology.

The increased prevalence of SIB in those with ASD is reported to also be moderated by the severity of core ASD deficits. McClintock et al<sup>25</sup> found that in adults with ASD, as the severity of autistic symptomatology increased, the risk for more frequent and more severe SIB also increased. Those with more severe ASD symptoms are also reported to be more likely to engage in other forms of, and a greater number of problem behaviors.<sup>11,26</sup> Along a similar line, children who exhibit non-threatening stereotypy at an early age (ie, prior to age 3 years) may also be more likely to develop severe and chronic forms of SIB.<sup>10,14,27</sup> One recent study of 943 children (ages 4–18 years) with intellectual and developmental delays showed that a high frequency of repetitive stereotypic behavior was a risk factor for later severity of SIB and the presence of other challenging behaviors.<sup>28</sup>

In general, the prevalence of problem behaviors is positively correlated with a diagnosis of ID and degree of intellectual impairment, with approximately 25% of those with a diagnosis of ID having SIB.<sup>5</sup> Furthermore, the presence and severity of SIB has also been noted to increase for those with more severe intellectual impairment in both adults<sup>29</sup> and children.<sup>17,30</sup> In a sample of adults with varying levels of intellectual impairment, Borthwick-Duffy<sup>31</sup> found that in a population of adults with ID: 7% with mild ID, 14% with moderate ID, 22% with severe ID, and 33% with profound ID, exhibited one or more topographies of challenging behavior, including SIB. Furthermore, Holden and

Gitlesen<sup>29</sup> noted that in adults, SIB was more common among those with profound and severe ID.

Impairments in areas of adaptive functioning, including communication, socialization, and the physical ability to independently complete self-care tasks, have been associated with SIB.<sup>11,25</sup> Lack of verbal communication, deficits in receptive or expressive communication,<sup>25,28,31,32</sup> greater social skills deficits,<sup>26</sup> motor impairments,<sup>32</sup> and sleep disturbances<sup>33</sup> have all been associated with increased risk for SIB. For example, Emerson et al<sup>34</sup> found that in a large sample of adults with ID there was a moderate association between SIB and more restricted mobility, fewer self-care skills, and/or poorer general communication. Chiang<sup>35</sup> also noted that speech impairment resulted in individuals engaging in SIB and other problem behaviors to express their needs. The author concluded that those with lower verbal skills were more likely to engage in problem behavior. Similarly, Murphy et al<sup>36</sup> found that in adults and adolescents with ID and/or ASD, poorer expressive language and social interaction skills were associated with the development of SIB and other problem behavior.

There is no debate that the association between ASD and other problem behavior has been established. However, researchers suggest that problem behaviors may also be reflective of comorbid psychiatric disorders for a proportion of individuals with ID, as well as those with ASD. That is, within these two populations there appears to be a significant association between the presence of problem behaviors and symptoms of comorbid psychopathology.<sup>34,37,38</sup> Moss et al<sup>39</sup> found that adults (18 to 60 years old) with more severe problem behaviors were more likely to have a comorbid psychiatric diagnosis than those who did not engage in severe behavior. For those who engaged in SIB, anxiety disorders were identified as being the most prevalent comorbid diagnosis. Despite findings that suggest a strong association between psychopathology and challenging behavior, there are other researchers who have found no association between the two.<sup>40,41</sup> Therefore, it appears that the nature of the relationship between problem behaviors and psychiatric comorbidities is unclear, and may be due to debate on how to best assess, categorize, and intervene upon psychiatric disorders in this population.

Much like comorbid psychiatric disorders, other variables are often associated with an increased risk for SIB in those with ASD. Sex is one such variable; some researchers have indicated that males are more likely to engage in any problem behavior,<sup>34</sup> whereas others have stated there is no such relationship, especially when SIB was assessed separately

from other types of problem behaviors.<sup>11,17</sup> Likewise, socioeconomic status and the presence of seizures in those with an ASD have also been implicated, although the results have been mixed in large scale studies.<sup>11,17,25,29,30</sup>

This paper focuses on the behavioral assessment and treatment of SIB in children with ASD. It is important to note that there are several other theories of SIB and associated treatments that have been well studied, in particular the biomedical approaches that treat SIB with atypical antipsychotic drugs to reduce the incidence of SIB.<sup>42</sup> The biomedical approach is a valuable one, particularly in combination with a behavioral component.<sup>43</sup> In addition, there are genetic theories suggesting that ASD symptomology can be attributed to disruptions in particular genes, such as the *Shank3* gene, which cause neurodevelopmental and neurobehavioral deficits among affected individuals.<sup>44</sup> These theories inform our understanding of SIB and help to explain why it is so prevalent among people with ASD. Both the biomedical and genetic theories are large and expand beyond the purview of this article. Instead, the emphasis of this paper is behavioral, including how to use a functional behavior assessment (FBA) to determine if there is a behavioral cause maintaining the SIB and a description of some of the behavior-based intervention techniques that can be employed to diminish SIB.

## Behavioral assessment of SIB

The behavioral theory of SIB suggests that these are learned behaviors that provide the individual with some kind of reinforcement.<sup>4</sup> The reinforcement can be external, coming from the individual's environment; or internal, from their own body. Sometimes SIB can serve a social-communicative function<sup>45</sup> which results in a change to the individual's environment. For example, SIB may result in a reduction in demands placed on an individual, providing them with a desired item, or getting attention from other people. Thus, positive or negative reinforcement can maintain the SIB over time, making the behaviors resistant to change unless the environmental factors are addressed. SIB is motivated by different reinforcement sources for different individuals,<sup>46</sup> so appropriate assessments are necessary to identify what factors are reinforcing each person's SIB.

## Indirect assessment of SIB

Given its high prevalence and the associated negative consequences, most referrals for treatment in those with ASD are initially made based on the presence of problem behaviors.<sup>47</sup> Therefore, the need for empirically validated measures to assess for challenging behaviors in individuals with ASD

is imperative. Several parent or caregiver administered instruments currently exist which assess for challenging behaviors in the general population and those with ASD, ID, and other DDs. Examples of measures assess the frequency and/or severity (generally using a Likert-type scale of "not a problem" to a "severe problem") of a variety of challenging behaviors (ie, not just SIB) include the Aberrant Behavior Checklist,<sup>48</sup> Behavior Problems Inventory-01,<sup>49</sup> Children's Scale of Hostility and Aggression: Reactive/Proactive,<sup>50</sup> Developmental Behavior Checklist,<sup>51</sup> and Nisonger Child Behavior Rating Form.<sup>52</sup> Similarly, there are a few measures which specifically address the range of behavioral concerns exclusively in those with ASD including the PDD Behavior Inventory,<sup>53</sup> Autism Spectrum Disorder – Behavior Problems for Adults,<sup>54</sup> Autism Spectrum Disorders – Behavior Problems for Children,<sup>55</sup> and the Baby and Infant Screen for Children with aUtism Traits (BISCUIT)-Part 3.<sup>56</sup> Outcomes of these measures generally reflect a score on a behavioral subdomain (eg, self-injury, stereotypy, aggression), which are then used to determine an overall score when compared to data from a normative sample. These measures have been validated as being a quick and efficient measure of broad domains of challenging behavior and have been determined to be useful for multiple purposes including evaluating pharmacologic interventions, determining occurrence of specific topographies of challenging behavior, and brief progress monitoring. However, indirect measures are limited in their scope with respect to assessing the severity of the behavior injury and health risks of engaging in the specific action, as well as quantifying numerically behavioral change due to an intervention (ie, relies on subjective informant report).<sup>5</sup>

At this time, there appears to be only one measure that takes a more impact-based, observational approach to assessing SIB in those with ID and DDs, including ASD and that is the Self-Injury Trauma (SIT) scale.<sup>57</sup> The SIT scale attempts to classify and quantify the damage which results from an act of SIB – assessors indicate the location of the SIB, how many acts of the SIB topography occurred, the severity of the wound(s), and the type of injury (eg, redness, bruising, skin breakage/lacerations, fractures, contusions, etc). After individual SIB injury locations are scored, overall summative scores are provided based upon the number of SIB topographies (on a 5-point scale), severity index (on a 5-point scale), and overall risk estimate (on a 3-point scale). Outcomes are summed to then yield a severity index score. While the SIT scale has high face validity and does show promise in the area of tracking outcomes of interventions, even the developers caution its use

as a “stand alone” method of assessment and progress monitoring.<sup>57</sup> Other drawbacks of the SIT scale include: it is fairly time-consuming, the inability to utilize with other destructive behavior (eg, aggression) that may occur in combination with SIB, and the questionable utility of the risk estimates produced by the measure when compared to outcomes from a less time-consuming or formal evaluation.<sup>58</sup>

As the focus on SIB appears to be well-warranted, identifying appropriate assessment strategies should not take a homogenous approach nor should assessors/clinicians rely on one source of information.<sup>27,32</sup> A brief list of the most well-research measures are provided previously in this section; a more thorough discussion of these and other measures is beyond the scope of this discussion and readers should look elsewhere.<sup>5</sup> However, based upon the topography, frequency, and severity of the individual’s SIB an individualized approach appears to be the best. Prior to the implementation of any intervention for SIB, an appropriate evaluation of SIB should include a combination of a thorough interview with the individual and/or caregivers, indirect assessments, behavioral observation, pre-treatment objective data collection (eg, behavior logs, scatterplots, event or duration recording), a medical evaluation, and a FBA. Being able to identify and thoroughly assess the occurrence and impact of a person’s SIB on their, and others’ quality of life, as well as identifying those specific situations or events which trigger and contribute to the persistence of the individual’s problem behavior is currently the accepted method to increase more person-centered treatment planning and progress monitoring in lieu of more reactive, punitive procedures.<sup>5,18,23,24,27</sup>

## Functional behavior assessment

An FBA is an integral assessment methodology for developing behavioral interventions that maintain their effectiveness over time.<sup>59</sup> An FBA is built on the premise that behaviors serve a communicative function for an individual. The “function” of a behavior refers to the specific reinforcing outcome of the behavior.<sup>60</sup> In functional assessment, information is gathered about the antecedents, behaviors, and consequences surrounding a specific behavior in order to hypothesize the function of that behavior for the individual.<sup>60,61</sup> Once the antecedents and consequences maintaining SIB have been identified through an FBA, the function(s) of the behavior(s) can be hypothesized. Evidence suggests that the common functions of behavior are: social attention, access to tangible rewards, escape or avoidance of activities or situations, and internal stimulation.<sup>8,62</sup>

## Behavioral treatments of SIB

With the function as the basis for the behavioral understanding of SIB, formulation of a behavioral intervention can begin. Behavioral interventions for problem behaviors, such as SIB, typically consist of several key components: antecedent manipulations, reinforcement-based, extinction-based, and punishment-based strategies. These interventions are typically used in combination to develop a comprehensive treatment plan that addresses the environmental factors that may trigger SIB to occur (ie, antecedent manipulations), increase the presence of more appropriate behaviors (ie, reinforcement-based strategies), and decrease the likelihood that the individual will continue to engage in SIB (ie, extinction- and punishment-based strategies).

## Antecedent-based intervention strategies

Based on the patterns noted in the environmental events that serve as antecedents or precursors to SIB, antecedent interventions can be implemented to alter the environment ahead of the problem behavior in order to reduce the likelihood that the behavior will occur again in the future. A wide variety of antecedent interventions have been shown to be effective in altering the contingencies maintaining SIB in individuals with ASD. These strategies can and should be as unique as the individual circumstances surrounding a child’s problem behaviors.

One common category of antecedent intervention is changing a child’s schedule to avoid, minimize or rearrange challenging parts of the day.<sup>63,64</sup> Schedules, either written or pictorial, can also be introduced in order to reduce the stress or anxiety brought about by transitions<sup>65</sup> or to help explain the components of a task or routine.<sup>66</sup> Manipulation of sleep schedules has also been shown to decrease problem behaviors in children with autism. Examples include the inclusion of a nap after a night of reduced sleep<sup>67</sup> that had been related to high rates of SIB or the use of a faded bedtime routine to decrease the number of night-time awakenings and associated SIB.<sup>68</sup> By arranging schedules and routines, one may be able to avoid or neutralize the effects of specific environmental or internal antecedent events.

Another category of antecedent intervention is the adaptation of demands that may be precursors to SIB. One of the primary functions of problem behaviors and SIB in children with autism is “escape from demands”.<sup>4</sup> Some children may use SIB to avoid or delay compliance with demands such as academic tasks, social interactions, or completion of daily adaptive behaviors (eg, toileting, dressing, bathing). In these circumstances, SIB is maintained by the negative

reinforcement the child receives when he or she is given a break from demands or when demands are withdrawn or lessened contingent on the child engaging in SIB.<sup>69</sup> Studies have shown that changing the way a demand is delivered may result in reduced rates of SIB.<sup>70,71</sup> Interspersing simple, high compliance demands amongst more difficult, lower compliance demands has been demonstrated to reduce rates of SIB and physical aggression.<sup>71</sup> In another example of manipulation of demands, the effects of discrete-trial training (DTT), a method of instruction shown to be effective with children with ASD,<sup>72-74</sup> was compared to embedded instruction<sup>75</sup> in regards to rates of escape-maintained SIB. DTT resulted in higher rates of SIB and lower rates of correct responding, demonstrating that SIB can be reduced based on the manner in which demands are presented.<sup>70</sup>

## Reinforcement-based intervention strategies

Reinforcement is the application or removal of stimuli that results in an increase in behavior over time. As related to SIB, reinforcement-based strategies are utilized to increase more desirable behaviors, and therefore, decrease the frequency, duration, or severity of SIB. Reinforcement-based interventions are used when a problem behavior is maintained by social consequences (ie, attention, tangible, or escape-maintained behaviors).<sup>76</sup> Reinforcement strategies are considered to be the least intrusive form of behavioral intervention for SIB because they do not entail the use of a punishment procedure.<sup>77</sup> There are several reinforcement schedules that have been shown to create this behavioral change in children with SIB, including noncontingent reinforcement and differential reinforcement.

Noncontingent reinforcement (NCR) involves the presentation of the reinforcing consequence for the problem behavior on a time-based and response-independent schedule.<sup>78</sup> NCR has been an effective component in the treatment of a number of problem behaviors.<sup>79</sup> The reinforcing stimulus delivered in NCR and other reinforcement strategies discussed here, can either be the same reinforcer that maintains the SIB (which is preferable) or another preferred stimuli (such as an edible or other tangible one). In the case of the former, if SIB is found to be maintained by social attention, then the reinforcer stimulus provided would be positive social attention from adults or peers. If the behavior is maintained by negative reinforcement, as is the case in escape-maintained behavior, then the reinforcer stimulus provided would be escape (ie, break) from demands. Noncontingent negative reinforcement may be composed of providing breaks from demands to an individual

with SIB on a fixed schedule so that breaks are no longer provided contingent on SIB.<sup>80</sup> This strategy has been proven to be a useful treatment component primarily due to its effects of abolishing, or abating, the effectiveness of the reinforcing stimulus due to the individual obtaining the reinforcer (ie, escape, social attention, or a tangible), irrespective of them having to engage in a problem behavior. Thus, NCR decreases the individual's motivation to engage in behaviors maintained by that functional-class of problem behaviors.<sup>81</sup>

A criticism of NCR is that reinforcement is given regardless of the individual engaging in more socially appropriate behavior that is functionally-equivalent to the problem behavior (eg, asking for a "break" from work).<sup>82,83</sup> This means that a more appropriate alternative behavior is not being taught. Another criticism of NCR is that it may adventitiously reinforce behaviors that coincide with the presentation of the reinforcement, which may be the behavior targeted for decrease or some other undesirable behavior. As a result, differential reinforcement schedules are often preferred. Differential reinforcement involves the application of positive or negative reinforcement contingent on "other behaviors" (ie, differential reinforcement of other behaviors [DRO]) or "alternative behaviors" (ie, differential reinforcement of alternative behaviors [DRA]). In these differential reinforcement systems (as well as other variations not discussed here), reinforcement is not provided when SIB occurs, but instead is provided based on the presence of a different behavior.

DRO is based on the principle that if a behavior besides the targeted problem behavior can result in reinforcement, then the individual will begin to use the reinforced behavior more frequently and the problem behavior will decrease. In DRO, any "other" behavior besides SIB is reinforced on a predetermined time schedule. In the case of an individual with SIB, reinforcement would be delivered if the individual did not engage in SIB throughout the time interval. DRO has been shown to be effective at reducing SIB.<sup>77,84-86</sup> These positive results may be improved in cases where the reinforcer maintaining SIB is appropriately identified, reinforcers selected are able to compete with the reinforcement maintaining SIB, and when a variety of reinforcers are utilized.<sup>85</sup>

DRA schedules focus on the use of reinforcement to teach a new, "alternative" behavior or skill that can serve to replace SIB in obtaining reinforcement. Through combined use of reinforcement and extinction (covered in "Extinction-based intervention strategies") the child learns over time that reinforcement will be received for engaging in a predetermined and taught alternative behavior and not SIB. DRA schedules are frequently combined with functional communication training

(FCT) as a means of teaching a new communication response. A primary component of FCT is that the new skill taught must serve the same function as the problem behavior for the child. For example, this may entail teaching a child to ask for a “break” to replace SIB maintained by escape from demands, or using a picture exchange system to request “attention” or “help” to replace attention-maintained problem behaviors. FCT has been shown to decrease rates of SIB and other problem behaviors in a number of well-designed studies.<sup>87–92</sup>

## Extinction-based intervention strategies

Extinction-based interventions are frequently used to treat SIB. During extinction procedures, the reinforcing consequence that was previously maintaining the SIB is stopped, thereby removing the motivation for the problem behavior. For example, in a case of SIB maintained by social attention, planned ignoring can be employed. In planned ignoring, the attention from others in the environment that had previously been maintaining the problem behavior is no longer provided contingent upon the behavior. Essentially, SIB is ignored by the people in the child’s environment. Eliminating reinforcement (in the form of ignoring) results in a decrease in SIB over time.<sup>69,93–95</sup> This form of extinction can be taught to parents, teachers, and other caregivers and can be performed across a number of settings and situations in which SIB may occur.

For SIB maintained by escape from demands, escape extinction is the appropriate extinction technique to employ. Escape extinction entails the continued presentation of demands, despite the presence of SIB. If the problem behavior no longer results in reinforcement (ie, being able to avoid or escape demands) then the SIB should decrease over time, thereby increasing compliance with demands.<sup>66,69,96–99</sup> In some cases, specific prompting methods are employed to ensure compliance with demands. For example, a most-to-least prompting hierarchy<sup>78</sup> and demand fading<sup>100</sup> have been utilized to assist with escape extinction.

SIB that is maintained by automatic reinforcement presents unique challenges.<sup>101</sup> This is because the behavior itself results in reinforcement to the individual, as opposed to reinforcement coming from an external agent that may be easier to control. In the case of SIB maintained by automatic reinforcement, intervention involves blocking the sensory experience that results from the SIB. This sensory extinction is typically conducted through the use of protective equipment, such as helmets, gloves, or arm restraints. Protective equipment is often used in cases of severe SIB in order to reduce the likelihood of bodily injury.<sup>102</sup> However, protective equipment may also serve to reduce the sensory stimulation

experienced during and after an episode of SIB and thereby serves as an extinction mechanism. Studies have shown that SIB will decrease with the use of protective equipment.<sup>102–104</sup> It is important to keep in mind that the physical restraint used should inhibit movement as minimally as possible while avoiding SIB.<sup>105</sup> Whenever manual restraints are used, plans should always be made at the onset of treatment for how the use of the restraint will be faded over time.<sup>106</sup> Another effective option for the treatment of automatically-maintained SIB is the use of a competing sensory stimulus that matches the sensory experience of SIB (eg, use of a hand massager to mimic the effects of hand mouthing or biting).<sup>101</sup> By providing noncontingent access to these stimuli the motivation to obtain reinforcement through SIB may be decreased.<sup>101</sup>

Extinction is believed by some to be a critical component to any behavioral intervention.<sup>107–109</sup> Drawbacks of using extinction, however, include the potential for extinction bursts, aggression, and emotional behavior.<sup>110</sup> An extinction burst is an increase in the frequency or severity of SIB when the extinction intervention is initiated. Initially, extinction bursts were thought to be a common occurrence.<sup>97,99,111</sup> However, it is now understood that extinction bursts may be less likely when extinction is not the only behavioral intervention being used,<sup>110</sup> and when the number of demands presented during an escape extinction program are increased gradually.<sup>99</sup>

## Punishment-based intervention strategies

One of the more controversial issues in the field of behavior modification in general is the use of punishment-based treatment strategies, also referred to as “aversives”, “response reduction procedures”, or “behavioral decelerants”. Punishment is the application or removal of stimuli in order to decrease the likelihood that a particular behavior will occur again in the future. Punishment-based strategies are often selected for use in situations where the reinforcing stimuli maintaining a problem behavior either cannot be clearly identified or when these variables cannot be controlled.<sup>112</sup> Punishment-based strategies have a long history of use in the treatment of SIB. However, as the focus has shifted toward the use of positive, less intrusive interventions for behavior problems, the current research on this area has decreased.<sup>113,114</sup> Some of the most commonly studied punishments are: physical restraint, “response reduction” procedures (eg, time-out, facial screens), and the application of aversive stimuli (eg, water misting, aversive odors, brief contingent electric shock).

Physical restraint is divided into two main types: manual and mechanical.<sup>115</sup> Manual restraint involves the application



of physical pressure or physical contact by other people, whereas mechanical restraint is achieved through the use of material or equipment.<sup>115</sup> Manual restraint is more common, with nearly 50% to 60% of children and adults with ID and problem behaviors experiencing manual restraint.<sup>116</sup> Physical restraint should be considered a last-resort form of behavioral intervention due to the restrictive nature of this intervention and the potential for injury or harm<sup>117</sup> and should only be used as part of a structured behavior intervention plan.<sup>106</sup>

Several “response reduction” procedures have been studied by researchers due to the increased social acceptability of their use and established efficacy. Examples of these procedures include time-out from positive reinforcement (ie, time-out) and brief facial screens. Time-out procedures, which can include removal of the individual from attention and reinforcement into another reinforcement-free space and/or removal of a highly preferred stimuli, has a long history of demonstrated efficacy in behavior modification. For example, punishment in the form of time-out has been shown to enhance the efficacy of other interventions, such as functional communication training.<sup>107,108</sup> Another example of a “response reduction” procedure with some efficacy is facial screening. During a facial screen, a piece of fabric is tied over the eyes (resulting in loss of vision) for a brief period of time (eg, 10 seconds) contingent on the individual engaging in SIB.<sup>118</sup>

Another category of punishment is the application of negative stimuli contingent on the occurrence of the targeted problem behavior. Several such stimuli that have been studied include water misting, aversive odors, and most controversial, the application of contingent electric shock. In each of these cases, the aversive stimulus is applied immediately following the presence of SIB. This may entail spraying the individual’s face with a fine mist of water from a spray bottle<sup>119–121</sup> or the presentation of an aversive odor such as ammonia or citric acid.<sup>122–124</sup> At the most extreme end of this category is the contingent application of electric shock. In these situations, a brief electrical current is delivered immediately after the individual engages in SIB. One should note that this is distinctly different than electroconvulsive shock therapy (ECT). Brief, contingent electric shock is considered by many to be the most aversive of all punishment procedures.<sup>125</sup> However, its efficacy has been demonstrated in the literature, albeit over 30 years ago.<sup>126,127</sup> With the number of effective, less intrusive interventions available (eg, DRO, extinction), the use of aversive interventions has justifiably declined over time.<sup>128</sup>

A wide variety of behavioral interventions with good empirical support exist from which one can design a comprehensive intervention package. The current trend in the literature is

to use the least restrictive intervention necessary to produce behavior change. This means that if a positive reinforcement schedule is equally effective as an aversive procedure, then the reinforcement schedule should be utilized. Regardless of the specific strategy chosen, careful attention should be given to determination of the function of the behavior in order to be able to create a behavioral intervention package that will address the function of the behavior and the environmental or internal mechanisms that maintain the behavior.

## Conclusion

Children with ASD demonstrate SIB at high rates. The etiology of SIB can be behavioral, which is the focus of this paper, or may be linked to biomedical or genetic causes. These behaviors can be physically dangerous for the individual who is head-banging, self-hitting, biting themselves, or pressing on their eyes; and SIB is very concerning for their caregivers who want to keep these children safe. In order to implement a behavioral treatment for SIB, an FBA should be performed to help determine the environmental and/or internal factors that are maintaining the behaviors. This information is then used to inform behavioral interventions in order to preempt the causes or replace the unwanted behaviors with ones that are more acceptable. Examples of commonly used behavioral interventions include removing the antecedent that had been prompting the behavior, reinforcing a more appropriate behavior via positive attention, or extinguishing the SIB by deliberately ignoring it. SIB that is maintained by automatic reinforcement (internally reinforced because it feels good to the person with ASD) is the most difficult type of SIB to change but even this can be often be helped by using differential reinforcement and replacing the inappropriate behavior with a behavior that may provide a similar sensory experience, amongst other interventions. The problem of SIB in ASD is common and can require immediate intervention in order to avoid injury. Fortunately there are several intervention methods that can reduce or eliminate the SIB and refocus the child’s behavior in a more positive manner.

## Disclosure

The authors have no conflicts of interest in this work.

## References

1. APA. *Diagnostic and Statistical Manual of Mental Disorders: Fifth Edition*. Washington, DC: American Psychiatric Publishing; 2013.
2. Kopp S, Beckung E, Gillberg C. Developmental coordination disorder and other motor control problems in girls with autism spectrum disorder and/or attention-deficit/hyperactivity disorder. *Research in Developmental Disabilities*. 2010;31(2):350–361.

3. Peters-Scheffer N, Didden R, Mulders M, Korzilius H. Low intensity behavioral treatment supplementing preschool services for young children with autism spectrum disorders and severe to mild intellectual disability. *Research in Developmental Disabilities*. 2010;31(6):1678–1684.
4. Iwata BA, Pace GM, Dorsey MF, Zarcone JR. The functions of self-injurious behavior: An experimental-epidemiological analysis. *Journal of Applied Behavior Analysis*. 1994;27(2):215–240.
5. Rojahn J, Schroeder SR, Hoch TA. *Self-Injurious Behavior in Intellectual Disabilities*. New York: Elsevier; 2008.
6. Schroeder SR, Mulick JA, Rojahn J. The definition, taxonomy, epidemiology, and ecology of self-injurious behavior. *Journal of Autism and Developmental Disorders*. 1980;10(4):417–432.
7. Yates TM. The developmental psychopathology of self-injurious behavior: Compensatory regulation in posttraumatic adaptation. *Clinical Psychology Review*. 2004;24(1):35–74.
8. Iwata BA, Dorsey MF, Slifer KJ, Bauman KE. Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis*. 1994;27(2):197–209.
9. O'Reilly MF. Functional analysis of episodic self-injury correlated with recurrent otitis media. *Journal of Applied Behavior Analysis*. 1997;30(1):165–167.
10. Bodfish JW, Symons FJ, Parker DE, Lewis MH. Varieties of repetitive behavior in autism: Comparisons to mental retardation. *Journal of Autism and Developmental Disorders*. 2000;30(3):237–243.
11. Baghdadli A, Pascal C, Grisi S, Aussilloux C. Risk factors for self-injurious behaviours among 222 young children with autistic disorders. *Journal of Intellectual Disability Research*. 2003;47(8):622–627.
12. Matson JL, Fodstad JC, Rivet TT. The relationship of social skills and problem behaviors in adults with intellectual disability and autism or PDD-NOS. *Research in Autism Spectrum Disorders*. 2009;3(1):258–268.
13. Rojahn J, Wilkins J, Matson JL, Boisjoli J. A Comparison of Adults with Intellectual Disabilities with and without ASD on Parallel Measures of Challenging Behaviour: The Behavior Problems Inventory-01 (BPI-01) and Autism Spectrum Disorders-Behavior Problems for Intellectually Disabled Adults (ASD-BPA). *Journal of Applied Research in Intellectual Disabilities*. 2010;23:179–185.
14. Berkson G, Tupa M. Early development of stereotyped and self-injurious behaviors. *Journal of Early Intervention*. 2000;23(1):1–19.
15. Dominick KC, Davis NO, Lainhart J, Tager-Flusberg H, Folstein S. Atypical behaviors in children with autism and children with a history of language impairment. *Research in Developmental Disabilities*. 2007;28(2):145–162.
16. Nottestad JA, Linaker OM. Self-injurious behaviour before and after deinstitutionalization. *J Intellect Disabil Res*. Apr 2001; 45(Pt 2):121–129.
17. Murphy O, Healy O, Leader G. Risk factors for challenging behaviors among 157 children with autism spectrum disorder in Ireland. *Research in Autism Spectrum Disorders*. 2009;3(2):474–482.
18. Totsika V, Toogood S, Hastings RP, Lewis S. Persistence of challenging behaviours in adults with intellectual disability over a period of 11 years. *Journal of Intellectual Disability Research*. 2008;52(5):446–457.
19. Oliver C, Murphy GH, Corbett JA. Self-injurious behaviour in people with mental handicap: A total population study. *Journal of Mental Deficiency Research*. 1987;31(2):147–162.
20. Taylor L, Oliver C, Murphy G. The chronicity of self-injurious behaviour: A long-term follow-up of a total population study. *Journal of Applied Research in Intellectual Disabilities*. 2011;24(2):105–117.
21. Fodstad JC, Rojahn J, Matson JL. The emergence of challenging behaviors in at-risk toddlers with and without autism spectrum disorder: A cross-sectional study. *Journal of Developmental and Physical Disabilities*. 2012;24(3):217–234.
22. Berkson G, Tupa M, Sherman L. Early development of stereotyped and self-injurious behaviors: I. incidence. *American Journal on Mental Retardation*. 2001;106(6):539–547.
23. Schroeder SR, Rojahn J, An X, Mayo-Ortega L, Oyama-Ganiko R, LeBlanc J. The parental concerns questionnaire: A brief screening instrument for potentially severe behavior problems in infants and toddlers at-risk for developmental delays. *Journal of Developmental and Physical Disabilities*. 2013.
24. Cunningham AB, Schreibman L. Stereotypy in autism: The importance of function. *Research in Autism Spectrum Disorders*. 2008;2(3):469–479.
25. McClintock K, Hall S, Oliver C. Risk markers associated with challenging behaviours in people with intellectual disabilities: A meta-analytic study. *Journal of Intellectual Disability Research*. 2003;47(6):405–416.
26. Matson JL, Wilkins J, Macken J. The relationship of challenging behaviors to severity and symptoms of autism spectrum disorders. *Journal of Mental Health Research in Intellectual Disabilities*. 2009;2(1):29–44.
27. Schroeder SR, Tessel RE, Loupe PS, Stodgell CJ. Severe behavior problems among people with developmental disabilities. In: MacLean WE Jr editor. *Ellis' Handbook of Mental Deficiency, Psychological Theory and Research*. 3rd ed. Mahwah, NJ US: Lawrence Erlbaum Associates Publishers; 1997:439–464.
28. Oliver C, Petty J, Ruddick L, Bacarese-Hamilton M. The association between repetitive, self-injurious and aggressive behavior in children with severe intellectual disability. *Journal of Autism and Developmental Disorders*. 2012;42(6):910–919.
29. Holden B, Gitlesen JP. A total population study of challenging behaviour in the county of Hedmark, Norway: Prevalence, and risk markers. *Research in Developmental Disabilities*. 2006;27(4):456–465.
30. McTiernan A, Leader G, Healy O, Mannion A. Analysis of risk factors and early predictors of challenging behavior for children with autism spectrum disorder. *Research in Autism Spectrum Disorders*. 2011;5(3):1215–1222.
31. Borthwick-Duffy SA. Prevalence of destructive behaviors: A study of aggression, self-injury, and property destruction. In: Thompson T, Gray DB, editors. *Destructive Behavior in Developmental Disabilities: Diagnosis and Treatment*. Thousand Oaks, CA US: Sage Publications, Inc.; 1994:3–23.
32. Emerson E, Kiernan C, Alborz A, et al. Predicting the persistence of severe self-injurious behavior. *Research in Developmental Disabilities*. 2001;22(1):67–75.
33. Symons FJ, Davis ML, Thompson T. Self-injurious behavior and sleep disturbance in adults with developmental disabilities. *Research in Developmental Disabilities*. 2000;21(2):115–123.
34. Emerson E, Kiernan C, Alborz A, et al. The prevalence of challenging behaviors: A total population study. *Research in Developmental Disabilities*. 2001;22(1):77–93.
35. Chiang H-M. Expressive communication of children with autism: The use of challenging behavior. *Journal of Intellectual Disability Research*. 2008;52:966–972.
36. Murphy GH, Beadle-Brown J, Wing L, Gould J, Shah A, Holmes N. Chronicity of Challenging Behaviours in People with Severe Intellectual Disabilities and/or Autism: A Total Population Sample. *Journal of Autism and Developmental Disorders*. 2005;35(4):405–418.
37. Hemmings CP, Gravestock S, Pickard M, Bouras N. Psychiatric symptoms and problem behaviours in people with intellectual disabilities. *Journal of Intellectual Disability Research*. 2006;50(4):269–276.
38. Sturmey P, Laud RB, Cooper CL, Matson JL, Fodstad JC. Mania and behavioral equivalents: A preliminary study. *Research in Developmental Disabilities*. 2010;31(5):1008–1014.
39. Moss S, Emerson E, Kiernan C, Turner S, Hatton C, Alborz A. Psychiatric symptoms in adults with learning disability and challenging behaviour. *The British Journal of Psychiatry*. 2000;177:452–456.
40. Holden B, Gitlesen JP. Prevalence of psychiatric symptoms in adults with mental retardation and challenging behaviour. *Research in Developmental Disabilities*. 2003;24(5):323–332.

41. Rojahn J, Borthwick-Duffy SA, Jacobson JW. The association between psychiatric diagnoses and severe behavior problems in mental retardation. *Annals of Clinical Psychiatry*. 1993;5(3):163–170.
42. Politte LC, McDougle CJ. Atypical antipsychotics in the treatment of children and adolescents with pervasive developmental disorders. *Psychopharmacology*. April 4, 2013.
43. Aman MG, Arnold LE, Lecavalier L, et al. 'Risperidone and parent training in pervasive developmental disorders:' Dr Aman et al reply. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2010;49(4):407–408.
44. Peca J, Feliciano C, Ting JT, et al. Shank3 mutant mice display autistic-like behaviours and striatal dysfunction. *Nature*. April 28, 2011;472(7344):437–442.
45. Schroeder SR, Oster-Granite ML, Berkson G, et al. Self-injurious behavior: Gene–brain–behavior relationships. *Mental Retardation and Developmental Disabilities Research Reviews*. 2001;7(1):3–12.
46. Iwata BA, Pace GM, Dorsey MF, et al. The functions of self-injurious behavior: an experimental-epidemiological analysis. *J Appl Behav Anal*. Summer 1994;27(2):215–240.
47. Gurney JG, McPheeters ML, Davis MM. Parental report of health conditions and health care use among children with and without autism: National Survey of Children's Health. *Archives of Pediatrics and Adolescent Medicine*. Aug 2006;160(8):825–830.
48. Aman MG, Singh NN, Stewart AW, Field CJ. The aberrant behavior checklist: A behavior rating scale for the assessment of treatment effects. *American Journal of Mental Deficiency*. 1985;89(5):485–491.
49. Rojahn J, Matson JL, Lott D, Esbensen AJ, Smalls Y. The Behavior Problems Inventory: an instrument for the assessment of self-injury, stereotyped behavior, and aggression/destruction in individuals with developmental disabilities. *Journal of Autism and Developmental Disorders*. 2001;31(6):577–588.
50. Farmer CA, Aman MG. Development of the Children's Scale of Hostility and Aggression: Reactive/Proactive (C-SHARP). *Research in Developmental Disabilities*. 2009;30(6):1155–1167.
51. Einfeld SL, Tonge BJ. The Developmental Behavior Checklist: The development and validation of an instrument to assess behavioral and emotional disturbance in children and adolescents with mental retardation. *Journal of Autism and Developmental Disorders*. 1995;25(2):81–104.
52. Aman MG, Tassé MJ, Rojahn J, Hammer D. The Nisonger CBRF: A child behavior rating form for children with developmental disabilities. *Research in Developmental Disabilities*. 1996;17(1):41–57.
53. Cohen IL, Schmidt-Lackner S, Romanczyk R, Sudhalter V. The PDD Behavior Inventory: A rating scale for assessing response to intervention in children with pervasive developmental disorder. *Journal of Autism and Developmental Disorders*. 2003;33(1):31–45.
54. Matson JL, Rivet TT. A validity study of the Autism Spectrum Disorders – Behavior Problems for Adults (ASD-BPA) scale. *Journal of Developmental and Physical Disabilities*. 2007;19(6):557–564.
55. Matson JL, Gonzalez ML, Rivet TT. Reliability of the Autism Spectrum Disorder-Behavior Problems for Children (ASD-BPC). *Research in Autism Spectrum Disorders*. 2008;2(4):696–706.
56. Matson JL, Wilkins J, Sevin JA, Knight C, Boisjoli JA, Sharp B. Reliability and item content of the baby and infant screen for children with autism traits (BISCUIT): Parts 1–3. *Research in Autism Spectrum Disorders*. 2009;3(2):336–344.
57. Iwata BA, Pace GM, Kissel RC, Nau PA, Farber JM. The Self-Injury Trauma (SIT) Scale: A method for quantifying surface tissue damage caused by self-injurious behavior. *Journal of Applied Behavior Analysis*. 1990;23(1):99–110.
58. Fisher WW, Rodriguez NM, Luczynski KC, Kelley ME. The Use of Protective Equipment in the Management of Severe Behavior Disorders. *Handbook of Crisis Intervention and Developmental Disabilities*. New York: Springer; 2013:87–105.
59. Kern L, Gallagher P, Starosta K, Hickman W, George M. Longitudinal outcomes of functional behavioral assessment-based intervention. *J Posit Behav Interv*. Spr 2006;8(2):67–78.
60. Jennett H, Hagopian LP, Beaulieu L. Analysis of heart rate and self-injury with and without restraint in an individual with autism. *Research in Autism Spectrum Disorders*. 2011;5(3):1110–1118.
61. Gresham F, Watson TS, Skinner CH. Functional behavioral assessment: Principles, procedures, and future directions. *School Psychology Review*. 2001;30(2):156–172.
62. Carr EG, LeBlanc LA, editors. *Functional Analysis of Problem Behavior*. Hoboken: John Wiley & Sons; 2003. Donahue W, Fishers JE, Hayes SC, editors. Cognitive behavior therapy: Applying empirically supported techniques in your practice.
63. Mesibov GB, Browder DM, Kirkland C. Using individualized schedules as a component of positive behavioral support for students with developmental disabilities. *Journal of Positive Behavior Interventions*. 2002;4(2):73–79.
64. Clarke S, Dunlap G, Vaughn B. Family-centered, assessment-based intervention to improve behavior during an early morning routine. *Journal of Positive Behavior Interventions*. 1999;1(4):235–241.
65. Dooley P, Wilczenski FL, Torem C. Using an activity schedule to smooth school transitions. *Journal of Positive Behavior Interventions*. 2001;3(1):57–61.
66. Lalli JS, Casey S, Goh H, Merlino J. Treatment of escape-maintained aberrant behavior with escape extinction and predictable routines. *Journal of Applied Behavior Analysis*. 1994;27(4):705–714.
67. Horner RH, Day HM, Day JR. Using neutralizing routines to reduce problem behaviors. *Journal of Applied Behavior Analysis*. 1997;30(4):601–614.
68. DeLeon IG, Fisher WW, Marhefka J-M. Decreasing Self-Injurious Behavior Associated with Awakening in a Child with Autism and Developmental Delays. *Behavioral Interventions*. 2004;19(2):111–119.
69. Iwata BA, Pace GM, Kalsher MJ, Cowdery GE. Experimental analysis and extinction of self-injurious escape behavior. *Journal of Applied Behavior Analysis*. 1990;23(1):11–27.
70. Sigafos J, O'Reilly M, Ma CH, Edrisinha C, Cannella H, Lancioni GE. Effects of embedded instruction versus discrete-trial training on self-injury, correct responding, and mood in a child with autism. *Journal of Intellectual and Developmental Disability*. 2006;31(4):196–203.
71. Horner RH, Day HM, Sprague JR, O'Brien M. Interspersed requests: A nonaversive procedure for reducing aggression and self-injury during instruction. *Journal of Applied Behavior Analysis*. 1991;24(2):265–278.
72. Lovaas OI. Behavioral treatment and normal educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology*. Feb 1987;55(1):3–9.
73. Smith T, Eikeseth S, Klevstrand M, Lovaas OI. Intensive Behavioral Treatment for Preschoolers with Severe Mental Retardation and Pervasive Developmental Disorder. *American Journal on Mental Retardation*. Nov 1997;102(3):238–249.
74. Smith T, Lovaas OI. Intensive and Early Behavioral Intervention with Autism: The UCLA Young Autism Project. *Infants and Young Children*. Jan 1998;10(3):67–78.
75. Johnson JW, McDonnell J, Holzwarth VN, Hunter K. The Efficacy of Embedded Instruction for Students with Developmental Disabilities Enrolled in General Education Classes. *Journal of Positive Behavior Interventions*. 2004;6(4):214–227.
76. Lindberg JS, Iwata BA, Roscoe EM, Worsdell AS, Hanley GP. Treatment efficacy of noncontingent reinforcement during brief and extended application. *Journal of Applied Behavior Analysis*. 2003;36(1):1–19.
77. Cowdery GE, Iwata BA, Pace GM. Effects and side effects of DRO as treatment for self-injurious behavior. *Journal of Applied Behavior Analysis*. 1990;23(4):497–506.
78. Cooper JOH, Heron TE, Heward WL. *Applied Behavior Analysis*. 2nd ed. Upper Saddle River: Pearson; 2007.
79. Carr JE, Kellum KK, Chong IM. The reductive effects of noncontingent reinforcement fixed-time versus variable-time schedules. *J Appl Behav Anal*. Winter 2001;34(4):505–509.

80. Vollmer TR, Marcus BA, Ringdahl JE. Noncontingent escape as treatment for self-injurious behavior maintained by negative reinforcement. *Journal of Applied Behavior Analysis*. 1995;28(1):15–26.
81. Laraway S, Snyckerski S, Michael J, Poling A. Motivating operations and terms to describe them: Some further refinements. *Journal of Applied Behavior Analysis*. 2003;36(3):407–414.
82. Goh H-L, Iwata BA, DeLeon IG. Competition between noncontingent and contingent reinforcement schedules during response acquisition. *Journal of Applied Behavior Analysis*. 2000;33(2):195–205.
83. Carr JE, Coriaty S, Wilder DA, et al. A Review of “Noncontingent” Reinforcement as Treatment for the Aberrant Behavior of Individuals with Developmental Disabilities. *Research in Developmental Disabilities*. Sep–Oct 2000;21(5):377–391.
84. Tiger JH, Fisher WW, Boussein KJ. Therapist- and self-monitored DRO contingencies as a treatment for the self-injurious skin picking of a young man with Asperger syndrome. *Journal of Applied Behavior Analysis*. 2009;42(2):315–319.
85. Mazaleski JL, Iwata BA, Vollmer TR, Zarcone JR. Analysis of the reinforcement and extinction components in DRO contingencies with self-injury. *Journal of Applied Behavior Analysis*. 1993;26(2):143–156.
86. Vollmer TR. *The Role of Noncontingent Attention in the Treatment of Self-Injurious Behavior Maintained by Positive Reinforcement*. US, ProQuest Information and Learning; 1993.
87. Carr EG, Durand VM. Reducing behavior problems through functional communication training. *J Appl Behav Anal*. Summer 1985;18(2):111–126.
88. Durand VM, Carr EG. Functional communication training to reduce challenging behavior: maintenance and application in new settings. *J Appl Behav Anal*. Summer 1991;24(2):251–264.
89. Braithwaite KL, Richdale AL. Functional communication training to replace challenging behaviors across two behavioral outcomes. *Behavioral Interventions*. 2000;15(1):21–36.
90. Durand VM, Carr EG. An analysis of maintenance following functional communication training. *J Appl Behav Anal*. Winter 1992;25(4):777–794.
91. Durand VM, Merges E. Functional communication training: A contemporary behavior analytic intervention for problem behaviors. *Focus on Autism and Other Developmental Disabilities*. 2001;16(2):110–119, 136.
92. Casey SD, Merial CL. The use of functional communication training without additional treatment procedures in an inclusive school setting. *Behavioral Disorders*. 2006;32(1):46–54.
93. Foxx RM. *Decreasing Behaviors of Severely Retarded and Autistic Person*. Champaign: Research Press; 1982.
94. Rose V, Sloop W, Baker P. Elimination of chronic self-injurious behavior by withdrawal of staff attention. *Psychological Reports*. 1980;46(1):327–330.
95. Magee SK, Ellis J. Extinction Effects during the Assessment of Multiple Problem Behaviors. *Journal of Applied Behavior Analysis*. Fall 2000;33(3):313–316.
96. Blindert HD, Hartridge CL, Gwadry FG. Controlling self-injurious escape behaviors. *Behavioral Interventions*. 1995;10(3):173–179.
97. Goh H-L, Iwata BA. Behavioral persistence and variability during extinction of self-injury maintained by escape. *Journal of Applied Behavior Analysis*. 1994;27(1):173–174.
98. Neidert PL, Iwata BA, Dozier CL. Treatment of Multiply Controlled Problem Behavior With Procedural Variations of Differential Reinforcement. *Exceptionality*. 2005;13(1):45–53.
99. Zarcone JR, Iwata BA, Vollmer TR, Jagtiani S. Extinction of self-injurious escape behavior with and without instructional fading. *Journal of Applied Behavior Analysis*. 1993;26(3):353–360.
100. Piazza CC, Moes DR, Fisher WW. Differential reinforcement of alternative behavior and demand fading in the treating fading in the treatment of escape-maintained destructive behavior. *Journal of Applied Behavior Analysis*. 1996;29(4):569–572.
101. Piazza CC, Adelinis JD, Hanley GP, Goh H-L, Delia MD. An evaluation of the effects of matched stimuli on behaviors maintained by automatic reinforcement. *Journal of Applied Behavior Analysis*. 2000;33(1):13–27.
102. Borrero JC, Vollmer TR, Wright CS, Lerman DC, Kelley ME. Further evaluation of the role of protective equipment in the functional analysis of self-injurious behavior. *Journal of Applied Behavior Analysis*. 2002;35(1):69–72.
103. Moore JW, Fisher WW, Pennington A. Systematic application and removal of protective equipment in the assessment of multiple topographies of self-injury. *Journal of Applied Behavior Analysis*. 2004;37(1):73–77.
104. Le DD, Smith RG. Functional analysis of self-injury with and without protective equipment. *Journal of Developmental and Physical Disabilities*. 2002;14(3):277–290.
105. Wallace MD, Iwata BA, Zhou L, Goff GA. Rapid assessment of the effects of restraint on self-injury and adaptive behavior. *Journal of Applied Behavior Analysis*. 1999;32(4):525–528.
106. Jones E, Allen D, Moore K, Phillips B, Lowe K. Restraint and self-injury in people with intellectual disabilities: A review. *Journal of Intellectual Disabilities*. 2007;11(1):105–118.
107. Wacker DP, Steege MW, Northup J, et al. A component analysis of functional communication training across three topographies of severe behavior problems. *Journal of Applied Behavior Analysis*. 1990;23(4):417–429.
108. Hagopian LP, Fisher WW, Sullivan MT, Acquisto J, LeBlanc LA. Effectiveness of functional communication training with and without extinction and punishment: A summary of 21 inpatient cases. *Journal of Applied Behavior Analysis*. 1998;31(2):211–235.
109. Fisher WW, Piazza CC, Cataldo MF, Harrell R. Functional communication training with and without extinction and punishment. *Journal of Applied Behavior Analysis*. 1993;26(1):23–36.
110. Lerman DC, Iwata BA, Wallace MD. Side effects of extinction: Prevalence of bursting and aggression during the treatment of self-injurious behavior. *Journal of Applied Behavior Analysis*. 1999;32(1):1–8.
111. Pace GM, Iwata BA, Cowdery GE, Andree PJ. Stimulus (instructional) fading during extinction of self-injurious escape behavior. *Journal of Applied Behavior Analysis*. 1993;26(2):205–212.
112. Lerman DC, Iwata BA, Shore BA, DeLeon IG. Effects of intermittent punishment on self-injurious behavior: An evaluation of schedule thinning. *Journal of Applied Behavior Analysis*. 1997;30(2):187–201.
113. Cannella HI, O’Reilly MF, Lancioni GE. Treatment of hand mouthing in individuals with severe to profound developmental disabilities: A review of the literature. *Research in Developmental Disabilities*. 2006;27(5):529–544.
114. Mancil GR. Functional Communication Training: A Review of the Literature Related to Children with Autism. *Education and Training in Developmental Disabilities*. 2006;41(3):213–224.
115. Hawkins S, Allen D, Jenkins R. The Use of Physical Interventions with People with Intellectual Disabilities and Challenging Behaviour – The Experiences of Service Users and Staff Members. *Journal of Applied Research in Intellectual Disabilities*. 2005;18(1):19–34.
116. Emerson E. The prevalence of use of reactive management strategies in community-based services in the UK. In: Allen D, editor. *Ethical Approaches to Physical Interventions: Responding to Challenging Behaviour in People with Intellectual Disabilities*. Kidderminster: BILD Publications; 2002:15–28.
117. Matson JL, Boisjoli JA. Restraint procedures and challenging behaviours in intellectual disability: An analysis of causative factors. *Journal of Applied Research in Intellectual Disabilities*. 2009;22(2):111–117.
118. Singh NN, Watson JE, Winton AS. Treating self-injury: Water mist spray versus facial screening or forced arm exercise. *Journal of Applied Behavior Analysis*. 1986;19(4):403–410.

119. Dorsey MF, Iwata BA, Ong P, McSween TE. Treatment of self-injurious behavior using a water mist: Initial response suppression and generalization. *Journal of Applied Behavior Analysis*. 1980;13(2): 343–353.
120. Fehr A, Beckwith BE. Water misting: Treating self-injurious behavior in a multiply handicapped, visually impaired child. *Journal of Visual Impairment and Blindness*. 1989;83(5):245–248.
121. Arntzen E, Werner B. Water mist punishment for two classes of problem behavior. *Scandinavian Journal of Behaviour Therapy*. 1999;28(2):88–93.
122. Tanner BA, Zeiler M. Punishment of self-injurious behavior using aromatic ammonia as the aversive stimulus. *Journal of Applied Behavior Analysis*. 1975;8(1):53–57.
123. Baumeister AA, Baumeister AA. Suppression of repetitive self-injurious behavior by contingent inhalation of aromatic ammonia. *Journal of Autism and Childhood Schizophrenia*. 1978;8(1):71–77.
124. Mayhew G, Harris FC. Decreasing self-injurious behavior: Punishment with citric acid and reinforcement of alternative behavior. *Behavior Modification*. 1979;3(3):322–336.
125. Salvy S-J, Mulick JA, Butter E, Bartlett RK, Linscheid TR. Contingent Electric Shock (SIBIS) and a Conditioned Punisher Eliminate Severe Head Banging in a Preschool Child. *Behavioral Interventions*. 2004;19(2):59–72.
126. Duker PC. Use of aversive shock therapy on a retarded girl with self destructive behaviors. *Zeitschrift für Klinische Psychologie*. 1975;4(1): 38–47.
127. Tate BG, Baroff GS. Aversive Control of Self-Injurious Behavior in A Psychotic Boy. In: Stedman JM, Patton WF, Walton KF, editors. *Clinical Studies in Behavior Therapy with Children, Adolescents and Their Families*. Springfield, IL US: Charles C Thomas Publisher; 1973:352–360.
128. Matson JL, LoVullo SV. A review of behavioral treatments for self-injurious behaviors of persons with autism spectrum disorders. *Behavior Modification*. 2008;32(1):61–76.

## Psychology Research and Behavior Management

Dovepress

### Publish your work in this journal

Psychology Research and Behavior Management is an international, peer-reviewed, open access journal focusing on the science of psychology and its application in behavior management to develop improved outcomes in the clinical, educational, sports and business arenas. Specific topics covered include: Neuroscience, memory & decision making; Behavior

modification & management; Clinical applications; Business & sports performance management; Social and developmental studies; Animal studies. The manuscript management system is completely online and includes a quick and fair peer-review system. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <http://www.dovepress.com/psychology-research-and-behavior-management-journal>