

# Self-injurious Behavior among Individuals with Intellectual and Developmental Disabilities

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## Abstract

Self-injurious behavior (SIB) is a broad term describing a behavior that causes (or potentially produces) physical harm to oneself. This behavior is described in individuals intellectual and developmental disabilities, including those with autism. SIB is a severe clinical condition that produces serious medical consequences and limits life opportunities for the persons and those who care for them. Research confirms that applied behavior analysis based approaches designed to identify controlling variables of SIB, can lead to effective interventions. Current knowledge indicates that across individuals, SIB varies along a continuum of relative environmental-biological influence. Additional research is needed to identify how medication can be used in concert with behavioral treatment, and to better understand the biological variables that are associated with the occurrence and maintenance of SIB.

**Keywords:** Self-injurious behavior; Developmental disabilities; Physical harm; Psychopathology

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## Introduction

Self-injurious behavior (SIB) is a broad term describing a behavior that causes (or potentially produces) physical harm to oneself [1-3]. These behaviors including head banging, head hitting and other behaviors that can cause physical trauma. SIB in the population with intellectual and developmental disabilities (ID) is likely distinct from self-mutilation and related behavior occurring in typically developing individuals with other psychopathology. It was first described in literature by Hall [4], but its contemporary scientific analysis can be said to have been initiated in 1965 when Lovaas, et al. [5] introduced experimental manipulation of environmental conditions for the assessment of SIB.

## Phenomenology and Prevalence of SIB

Many individuals with intellectual and developmental disabilities suffer from SIB, as well as other types of behavioral dysfunction that can result in injury to self or others. SIB is often described in individuals with severe or profound intellectual disabilities, in those with autism, and in persons diagnosed with a variety of genetic disorders [6-8]. The most common forms of SIB reported in the literature include head banging, head hitting, and self-

biting [9]; these are reported in approximately 40% of all cases. Other common forms of SIB among individuals with intellectual and developmental disabilities are punching/slapping body, pinches/scratches skin, eye poking. Other type of challenging behavior also pose risk of injury to the individual, but are often not classified as SIB: pica (eats inedible objects); polydipsia; self-induced vomiting; bruxism (teeth grinding); trichotillomania (pulls out hair); aerophagia (swallowing air). SIB sometimes co-occurs with self-restraint, a behavior that is incompatible with SIB that can be highly debilitating also interfere with functioning. Self-restraint includes wrapping body parts in one's clothing, continuously holding objects, and using other people to restrict movements [10].

SIB can directly produce a variety of injuries including contusions, lacerations, infections, concussion, loss of vision secondary to retinal detachment, and permanent disfigurement related to scarring and loss of tissue from self-biting and skin scratching [11,12]. In addition to the injuries SIB produces, it also can lead

to the use of excessive medication and restraint, placement in restrictive settings [13,14], and excessive health care costs [15,16]. SIB can lead to hospitalization, it can impede typical learning process in the acquisition of basic abilities for communication and interaction, for educational, vocational, and community activities. SIB and other problem behavior is also source of great of stress for families, and incurs high costs to society for treatment and placement [17,18]. If untreated or if the treatment is not effective, SIB usually persists or worsen [6,19,20].

Estimates of the prevalence of SIB vary widely. Early studies suggested that SIB occurs in approximately between 7–12% of all people with ID (range: 3% to 30%; [8,21-25]). Recent estimates of the prevalence of SIB in those with autism suggest it occurs in average in 27.7% of individuals [26]. Higher rates are reported in genetic syndromes [27]: SIB is a hallmark of Lesch-Nyhan Syndrome [28], 94.8% in Smith–Magenis Syndrome [18], 73.9% in Cri du Chat Syndrome [18], 55.3% in Cornelia de Lange syndrome [18], 64% in Lowe Syndrome [18,27], 73% in Prader–Willi Syndrome [18], 54.8% in Fragile-X Syndrome [18], and 45% in Angelman Syndrome [18,27]. Indeed, SIB has been cited as part of a behavioral phenotype of individuals diagnosed with a variety of genetic syndromes. Notwithstanding these data, environmental variables and learning history appear more related to SIB than does a diagnosis.

## Risk Factors and Potential Causes

**Table 1** presents a list of potential risk factors usually associated with SIB. Findings related to risk factors should be interpreted with caution, however, as they are based on correlational studies of individuals who already have SIB. It is also difficult to isolate the contribution of certain variables, because many are related. For example, individuals with more severe intellectual impairment also tend to have greater adaptive behavior deficits. Hence, it is not possible to determine whether impairments in functioning (e.g. communication or social skills domains), are unique risk factors for SIB.

There is no doubt on the fact that SIB has multiple etiologies. It is important to distinguish between the factors that lead to the emergence of SIB (causes) from those that result in its persistence (maintenance). In the context of impairments associated with ID, SIB may emerge as either a frustrative response or a self-stimulatory response, which then comes into contact with reinforcing contingencies that strengthen it. Because SIB itself distresses parents and caregivers, they sometimes seek to calm or console the individual, remove the stimulus that occasioned the behavior, or interrupt SIB. These reactions may inadvertently reinforce SIB through operant learning processes, increasing its future probability and establishing a maladaptive behavioral repertoire that persists. Ultimately, SIB is the product of interactions stemming from deficits secondary to the developmental disability and experiences that occasion and reinforce SIB through operant learning processes [6,29,30]. Although the processes that lead to the emergence of SIB are not fully known in general, nor can they be identified in any a given case, the variables that currently maintain SIB through reinforcement can be identified through functional behavioral assessment in the majority of cases.

These methods can precisely identify the antecedent events that occasion SIB, the consequences that reinforce it; and thus determine its “reinforcing function”.

## Classification of SIB

SIB itself is a multifaceted, heterogeneous phenomenon varying in its form, frequency and pattern of occurrence, reinforcing function, co-occurrence with other problem behaviors, and resistance to treatment [31]. Classification for the purpose structuring research and informing treatment of SIB ideally involves identify its controlling variables, which likely include organic/somatic factors, psychiatric conditions, psychosocial/environmental factors, and behavioral history [32-34]. Unfortunately, research largely involves either psychiatric diagnosis, or functional behavioral assessment, and rarely the two together. We will focus on these two major taxonomies for the classification of SIB and related issues in this discussion: (a) psychiatric diagnosis, that describes SIB, and other psychiatric conditions or may co-occur with it; and (b) functional behavioral classification, which categorizes SIB in terms of its reinforcing function (i.e., its controlling antecedents and consequences).

### Psychiatric diagnosis

There is general consensus that individuals with ID are at increased probability of receiving a psychiatric diagnosis [35-40]. However, data on the prevalence of mood, anxiety, and psychotic disorders are still not clear because of problems in methodology of the studies (i.e. validity issues), and features of the studied populations [41]. The application of psychiatric diagnostic classification systems originally designed for typically developing individuals to individuals with IDD has frequently been criticized and should be done with caution [34]. The communication deficits that often preclude self-report, and of the restricted behavioral repertoires that make difficult to ascertain the extent to which impairments in functioning are due to developmental/intellectual disabilities versus a psychiatric condition [35,37,42]. In subjects with SIB, the comorbid diagnosis may be related to and contribute to SIB, or it may be independent of it.

With regard to SIB, the diagnosis of Stereotypic Movement Disorder with Self-Injury according to DSM-5 and ICD (307.3; F98.4) is included in the Neurodevelopmental Disorders. This diagnosis simply describes the behavior, but does not inform treatment selection as there are no approved medications for SIB. Unfortunately, the sole diagnosis describes SIB as a single diagnostic entity, but fails to recognize decades of behavioral research indicting SIB has a variety of types in terms of the operant reinforcing function [43] – which has important implications for both treatment selection and research [31]. The psychiatric diagnoses that are most relevant to clinical care for individuals suffer from SIB, are diagnoses of co-occurring conditions, including mood instability, irritability, hyperactivity, and other dimensions of functioning that can be targeted with medication [44].

### Functional behavioral assessment and classification

Functional behavior assessment (FBA) identifies environmental events that influence the individual responses, and it is the leading

**Table 1** Potential risk factors usually associated with SIB.

Risk factor	Core issues	Main references
Intellectual and adaptive functioning	<ul style="list-style-type: none"> <li>SIB is more prevalent among individuals with severe ID, and lower level of adaptive behavior functioning.</li> <li>Relevant areas of related impairment are:                             <ol style="list-style-type: none"> <li>communication functioning (e.g., verbal behavior abilities);</li> <li>self-care (e.g., eating, toileting, washing, dressing);</li> <li>gross motor;</li> <li>social skills</li> </ol> </li> </ul>	Schroeder, Tessel, Loupe, Stodgell, 1997; Emerson et al., 2001; Baghdadli et al., 2003; Richards, Oliver, Nelson, & Moss, 2012; Richards et al., 2012 Duerden, Oatley, et al., 2012
Comorbid conditions	<ul style="list-style-type: none"> <li>Autism;</li> <li>Sensory impairments;</li> <li>Ritualistic/Repetitive behaviors;</li> <li>Psychopathology (e.g., anxiety and mood disorders - especially instability depression, environmental deprivation; mood, irritability, hyperactivity);</li> <li>Vision or hearing impairment;</li> <li>Seizure disorders;</li> <li>Undiagnosed medical condition</li> </ul>	Gunsett, Mulick, Fernald, & Martin, 1989; Baghdadli, Pascal, Grisi, & Aussilloux, 2003; McClintock, Hall, & Oliver, 2003 Holden & Gitlesen, 2006; Lowe et al., 2007; Matson & LoVullo, 2008; Duerden et al. 2012a; Duerden et al. 2012b
Genetic Syndromes	<ul style="list-style-type: none"> <li>Smith Magenis Syndrome, Cornelia de Lange Syndrome, Smith-Lemli-Opitz Syndrome: SIB as a characteristic of the behavioral phenotype;</li> <li>Prader-Willi syndrome: increased prevalence of skin picking;</li> <li>Lesch-Nyhan: SIB is part of the behavioral phenotype of this disorder;</li> <li>Cri du Chat Syndrome;</li> <li>Lowe Syndrome;</li> <li>Fragile-X Syndrome;</li> <li>Angelman Syndrome;</li> <li>Down Syndrome</li> </ul>	Winchel & Stanley, 1991; Symons, Butler, Sanders, Feurer, & Thompson, 1999; Arron et al., 2011
Environment	<ul style="list-style-type: none"> <li>More prevalent among people living in institutional settings;</li> <li>This could be a secondary effect of other variables often related with severity of ID limitations and to the difficult to estimate among community samples</li> </ul>	Emerson et al., 2001; Lowe et al., 2007
Age	<ul style="list-style-type: none"> <li>SIB often emerges between 2 and 3 years of age;</li> <li>More frequent and severe in childhood and adolescence;</li> <li>Severity can decrease over the course of adulthood</li> <li>Typical events occurring in aging individuals with ID may increase the rising of SIB</li> </ul>	Schroeder et al., 1997; Emerson et al., 2001; Davies and Oliver, 2013; Glaesser and Perkins, 2013
Life events, learning history	<ul style="list-style-type: none"> <li>Moving to a different residence;</li> <li>Change of direct support staff;</li> <li>Change of roommate;</li> <li>Trauma (physical assault; sexual abuse);</li> <li>Separation (or loss) from a significant person (e.g. close friend or family member)</li> </ul>	Owen et al., 2004

approach to assessment of all challenging behaviors, including SIB [45]. Treatments are subsequently based on the information obtained via FBA, and are focused on the modification of the contingencies postulated as directly responsible for behavioral maintenance [43]. There is a large amount of data to support the use FBA as the first step in SIB treatment [20,46,47]. FBA for SIB includes a variety of procedures (e.g., interviews, rating scales, experimental functional analysis) used to identify the operant reinforcing function for the individual (i.e., its controlling antecedents and consequences) of SIB.

Despite its common misinterpretation, a “functional analysis” is a highly rigorous methodology that involves systematically exposing the individual to controlled conditions, where the antecedent

and consequent events are manipulated while changes in SIB are recorded. Those conditions examined in the functional analysis represent analogs to real-world situations the individual is likely to routinely encounter. This approach is used to empirically test hypotheses about the controlling variables of SIB. For example, in order to determine if problem behavior is maintained by escape from academic demands (a common reinforcing function of SIB), an academic “work” environment is simulated wherein academic demands are presented and then briefly terminated contingent upon SIB. Other conditions commonly examined in a functional analysis include those designed to examine whether SIB is maintained by attention, access to tangibles (e.g. toys), or whether it occurs independent of social-mediated reinforcement.

With repeated observation and analysis of behavioral data, this rigorous data-based method can produce objective and reliable conclusions about the environmental variables controlling problem behavior – and thus inform treatment selection and design.

SIB can be functionally categorized within one of two broad categories, socially-mediated and non-socially mediated (also known as “automatic” reinforcement). Within each of these broad categories are subtypes presented in **Table 2** [31], categorized across dimensions (i.e., reinforcing function), co-occurrence with other problem behaviors, and response to treatment.

The direct examination of how the functional classes of SIB differ provides knowledge that improves the understanding of SIB, and supports clinicians to develop more effective behavioral and pharmacological interventions. Available data suggest clearly that the majority of cases of SIB (approximately two thirds) it is under greater control by environmental variables that are socially mediated. The most common reinforcing functions of SIB include access to attention, access to preferred items, and escape from demands. Because these reinforcers can be precisely identified and controlled during therapy sessions, interventions can involve withholding these reinforcers when SIB occurs, delivering them contingent upon appropriate behavior, or making them freely available to decrease motivation to engage in SIB.

Automatic reinforced SIB (ASIB) is instead often assumed to be under greater relative control by biological variables, and therefore it is the most challenging type of SIB because the variables that occasion and maintain it are not well known. Recent research has recently delineated subtypes of ASIB [48,49], with clear characteristics related to environmental and biological factors (e.g., higher rates of SIB in conditions with minimal external stimulation in Subtype-1; scarce variability of SIB in all environmental conditions in Subtype-2; and SIB higher when self-restraint is not allowed in Subtype-3). Subtype 1 has positive response to treatment (as Socially maintained SIB), whilst Subtype 2 is the most severe and treatment resistant type of SIB.

With respect of the SIB occurring in presence of self-restraint (the hallmark of Subtype-3 ASIB), a recent study [50], presents preliminary support for a developmental model of self-injury and self-restraint in which painful health conditions and compromised behavioral control influence the presence and trajectory of self-injury in autism spectrum disorder.

## Behavioral Treatment of SIB

An extensive body of literature over the past four decades has established the effectiveness of Applied Behavior Analysis approach for problem behavior (including SIB) in individuals with IDD, autism, and related disorders [9,43,42,51,52,53]. Various meta-analyses [54-57] also indicate that treatments based on operant principles of learning were more effective than alternative treatments (e.g. psychotherapy, sensory integration therapy) in reducing problem behavior (including SIB) in this population. A recent systematic search [58], confirms these earlier conclusions. Sigafos concluded that Applied Behavior Analysis-based treatments (i.e. Functional

communication training, Noncontingent reinforcement, Function-based extinction, Differential reinforcement schedules, Punishment, Contingent restraint/protective equipment), is effective for a range of conditions; whereas other treatments (Cognitive Behavior Therapy; Auditory Integration Training; Sensory Integrative Therapy; Weighted Vests; Gentle Teaching; Electroconvulsive Therapy; Snoezelen Rooms; Transcutaneous Electric Nerve Stimulation; Exercise; Room Management) have limited support or are confirmed to be ineffective. Many scientific, governmental, and professional organizations (e.g., the National Institutes of Health [13]; the American Association on Intellectual and Developmental Disabilities [33]; the American Academy of Pediatrics [59]; and the National Collaborating Centre for Mental Health – UK [60]) have characterized ABA-based procedures as empirically-supported and as representing best practice for individuals with autism and developmental disabilities.

There is considerable evidence to support the value of a prior functional assessment of SIB. Information from a prior functional assessment may enable clinicians to select treatments that are matched to the operant function of the person’s SIB. Different forms of indirect assessment tools are used in combination with direct strategies and descriptive analysis. Some of the most used indirect assessment interview is: The Functional Assessment Interview (FAI) [61], the Questions About Behavioral Function (QABF) [62] and the Motivational Assessment Scale (MAS) [63]. Brief questionnaires like the Behavior Problems Inventory-Short Form for individuals with intellectual disabilities could be useful to screen and monitor challenging behaviors (including SIB), prior in-depth analysis [8].

Functional classification of SIB is critical to guiding the design of behavioral treatments. These rely on the function of SIB so much that they are often referred to as “function-based” interventions. Fundamentally, function-based behavioral treatments use of operant conditioning procedures relying on reinforcement to establish and maintain alternative adaptive behavior such as communication, social and leisure skills. Function-based interventions also involve engineering the environment to build tolerance to or sometimes minimize exposure to events that are likely to occasion SIB; and when possible they involve “extinction” which is the withholding of reinforcement for SIB. ABA-based approaches that combine a number of specific procedures are confirmed to be consistently effective in the treatment of SIB among individuals with ID. **Table 3** presents the main features of the effective treatment programs components for SIB. Treatment usually involve various procedures (**Table 3**), and are described as packages.

Most studies examining the effectiveness of behavioral interventions for SIB have been conducted using single-subject research design [64]; typically with two to four participants per study. These designs are perfectly suited for evaluating the effects of highly individualized treatments. The approach to treatment involves applying the least restrictive interventions first, then adding additional treatment components as dictated by the individual’s response to treatment. The structure of the experimental design permits rigorous analysis of the effects of the intervention, and demonstration of control via the use of

**Table 2** SIB classified using functional behavioral assessment.

SIB Types	Features and Sub-Types	Main references
Socially-Mediated SIB	<ul style="list-style-type: none"> <li>• SIB controlled by antecedents and consequences that are mediated by other individuals (such as parents, and other care providers) when their interactions may set the occasion for SIB to occur and when they respond to SIB in a manner that reinforces it;</li> <li>• Approximately 60-70% of SIB are socially-mediated;</li> <li>• Social variables:               <ol style="list-style-type: none"> <li>1. access to attention;</li> <li>2. escape (from demands);</li> <li>3. tangibles (preferred items);</li> <li>4. many other.</li> </ol> </li> </ul>	Beavers, Iwata, & Lerman, 2013; Hanley, Iwata, & McCord, 2003; Iwata, Dorsey, Slifer, Bauman, & Richman, 1982; Hagopian & Frank-Crawford, in press
Non-Socially Mediated SIB	<ul style="list-style-type: none"> <li>• “Automatic” reinforced SIB (ASIB): controlled by variables independent of social interaction (the behavior itself produces reinforcement by biological processes);</li> <li>• Hypothesized maintaining processes:               <ol style="list-style-type: none"> <li>1. Biological “reinforcement” (e.g., release of endogenous opioids, and pain attenuation);</li> <li>2. Elicited response (i.e., an unconditioned frustrative response, or established via Pavlovian conditioning);</li> </ol> </li> <li>• Approximately 25% of SIB are automatically-reinforced;</li> <li>• ASIB Subtypes:               <ol style="list-style-type: none"> <li>1. Subtype-1: SIB decreases as a function of external stimulation (SIB is lower in the “play” condition of experimental FA - high environmental stimulation - and higher in the “alone” condition – low external stimulation); it is responsive to treatment using reinforcement alone; Subtype-1 is a Predictive Behavioral Marker for response to treatment (Positive Predictive Value = 82.6. Highly differentiated responding of ASIB in the functional analysis exceeding 63.7% has been identified as the optimal cutoff (ROC AUC = 0.87, <math>p &lt; 0.0001</math>, with the Positive Predictive Value = 85.5); hypothesized to be maintained by peripheral sensory stimulation;</li> <li>2. Subtype-2: SIB occurs irrespective of external stimulation (SIB occurs in all conditions of experimental FA); it is highly unresponsive to treatment using reinforcement alone; hypothesized to be secondary to sensory motor dysfunction, or central nervous system endogenous reinforcement;</li> <li>3. Subtype-3: SIB occurs in presence of Self-Restraint (SIB may be low when Self-Restraint is allowed, and high when Self-Restraint is blocked); hypothesized to be reinforced by one biological mechanism, yet SIB produces aversive consequences by another, which negatively reinforces self-restraint</li> </ol> </li> </ul>	LeBlanc, Patel, & Carr, 2000; Cataldo & Harris, 1982 Furniss & Biswas, 2012; Hagopian & Frank-Crawford, in press; Hagopian, Rooker, Zarcone, 2015; Hagopian, Rooker, Zarcone, Bonner, & Arevalo, 2017; Hagopian et al., 2015; 2017; Hagopian, Rooker, & Yenokyan, in press

brief treatment withdrawals and replications. These analyses rely on direct observation of behavior, precisely defined operational definitions for each targeted response, computerized data collection, calculation of inter-observer agreement coefficients to ensure reliable and accurate data collection, and other controls to ensure experimental rigor. The validity of findings from studies employing single-subject designs that comprises the body of literature has been supported by larger-n studies that reveal similar outcomes. Studies examining functional analysis outcomes by Iwata et al. [65] and Hagopian et al. [66] reporting on 154 and 176 consecutively encountered cases, respectively found the relative prevalence of functional classes of problem behavior to be comparable to that reported in the literature. Larger scale studies on functional communication training ( $n=21;n=58$  [66,67]); noncontingent reinforcement ([68], $n=27$ ); automatically reinforced SIB [48,49] produced findings comparable that reported across smaller scale studies in body of literature as a whole.

### Integrating behavioral treatment with medication

Although the integration of behavioral and pharmacological approaches is regarded as best clinical practice, direct scientific evidence supporting the efficacy of this approach is quite limited because studies examining the effects of medication and behavioral treatments are typically conducted separately. Functional and psychiatric classification systems and their respective treatment modalities represent different and seemingly competing approaches, but there is recognition that these approaches can be combined in a complementary fashion [69-73]. The Neurobehavioral Model [69,73] suggests a more complete account of SIB requires consideration of environmental and biological variables. Behavioral analytic interventions are highly effective for addressing SIB related to histories of reinforcement and skills deficits, but there is little evidence to indicate that behavioral treatment can address co-occurring mood disorders or hyperactivity in individuals with IDD. In those cases, pharmacologic interventions are needed, though they will not

**Table 3** Effective treatment programs for SIB.

Treatment procedure		Features	Main references
Applied Behavior Analysis (broad category including the below ones)		<ul style="list-style-type: none"> <li>The use of functional assessment to identify the operant function of SIB;</li> <li>Function-based treatments are conceptually related to, and derived from, more basic principles of learning theory</li> </ul>	Baer, Wolf, & Risley, 1987
Functional assessment		<ul style="list-style-type: none"> <li>The use of one or more procedures (e.g., experimental-functional analysis, descriptive analysis, interviews, and rating scales) to identify the operant function of SIB</li> <li>Functional assessment is not a treatment but an assessment approach used to select function-based treatments;</li> <li>Experimental-functional analysis procedure are highly effective in identifying the operant function of SIB among individuals with ID;</li> <li>ABA or function-based approaches are often combined into multicomponent treatment packages (e.g., functional communication plus extinction).</li> </ul>	Beavers et al., 2013; Iwata et al., 1982
Antecedents interventions: The modification of discriminative stimuli, motivating operations, and setting events found to be functionally related to the self-injury	1. Noncontingent reinforcement	<ul style="list-style-type: none"> <li>Involves the delivery of the reinforcer responsible for behavioral maintenance on a fixed-time response-independent schedule</li> </ul>	Mace, & Lalli, 1991; Hagopian, Crockett, Stone, Deleon, & Bowman, 2000
	2. Manipulation of motivating operation	<ul style="list-style-type: none"> <li>Involves the manipulation of motivating operations (establishing, abolishing)</li> </ul>	Van Houten, 1993; Horner et al., 1997
	3. High probability instructional sequence	<ul style="list-style-type: none"> <li>Involves the delivery of 3– 5 instructions to which compliance is very likely prior to giving an instruction to which compliance is unlikely</li> </ul>	Zarcone et al., 1994
	4. Response blocking	<ul style="list-style-type: none"> <li>Prevent from engaging in interfering behaviors</li> </ul>	MacDonald et al., 2002
	5. Restraint and protective equipment and Fading use of protective equipment	<ul style="list-style-type: none"> <li>Various types of restraint and protective equipment applied to prevent and suppress SIB and faded out progressively;</li> <li>If used noncontingently are generally considered a antecedent intervention;</li> <li>If used contingently are generally considered a consequences intervention</li> </ul>	Hanley, Piazza, Keeney, Blakeley-Smith, & Worsdell, 1998
Consequence Interventions: involve delivery/removal of punishers, reinforcers	1. Functional Communication Training (FCT)	<ul style="list-style-type: none"> <li>Teaches appropriate forms of communication enabling the individual to access the same reinforcers that maintain SIB;</li> <li>An appropriate and functionally equivalent communication response is selected for instruction</li> </ul>	Durand, 1990; Hagopian, Fisher, Sullivan, Acquistio, and LeBlanc, 1998
	2. Differential reinforcement schedules	<ul style="list-style-type: none"> <li>Differential reinforcement schedules aim to reduce SIB either by reinforcing the absence of SIB, which is through differential reinforcement of other behavior (DRO), or by reinforcing an alternative or incompatible behavior, which is through differential reinforcement of alternative behavior (DRA) or differential reinforcement of incompatible behavior (DRI)</li> </ul>	Foxx, 1982
	3. Punishment	<ul style="list-style-type: none"> <li>Punishment procedures aim to reduce SIB by either removal of reinforcement (i.e., time-out, response cost) or delivery of aversive stimulation (e.g., water mist to the face, mild electric shock, aromatic ammonia) contingent upon SIB</li> </ul>	Hoch, Dzyak, & Burkhalter, 2016
	4. Extinction	<ul style="list-style-type: none"> <li>the consequences that maintain SIB no longer occur during or immediately following SIB</li> </ul>	Goh & Iwata, 1994; Iwata, Pace, Cowdery, & Miltenberger, 1994

alter social and environmental factors that occasion or reinforce SIB nor will they establish new skills. As has been noted, informed integration of the behavioral treatments and medication has the potential capitalize on the strengths and offset the limitations of each approach [69].

## Conclusions

SIB is a severe clinical condition that produces serious medical consequences and greatly impairs functioning. SIB is the product of interactions stemming from deficits secondary developmental disabilities and experiences that occasion and reinforce SIB through operant learning processes. Although the processes that lead to the emergence of SIB are not fully known, the variables that presently maintain SIB through reinforcement processes can be identified through functional behavioral assessment in the majority of cases. The operant reinforcing function of SIB appears to be its most important dimension, and research confirms that applied behavior analysis based approaches designed to identify the controlling variables of SIB can lead to effective behavioral interventions.

## Future Directions for Research

SIB is a highly heterogeneous and multidimensional phenomenon. Functional analysis using standardized methods shows that SIB varies along a continuum of relative environmental-biological

influence across individuals. In some cases, SIB is under clear and direct control of environmental variables (socially-maintained SIB), whilst in other cases, SIB occurs independent of social variables (ASIB) but varies also in terms of its sensitivity to changes in the environment (i.e., Subtype-1 v Subtype 2 ASIB). Unfortunately, most pharmacological treatment studies of SIB and studies examining the biological bases of SIB fail to consider the function of SIB. It is imperative that future research on SIB experimentally control for and directly examine the known functional classes of SIB. Future pharmacological studies could systematically explore if the various functional classes of SIB have differential response to specific drug treatment [31]. With recent findings identifying the most severe and treatment resistant type of SIB (Subtype-2 ASIB) that appears largely if wholly under control of biological variables, its analysis should yield scientific benefit, and ultimately the development of more effective treatments.

## Author Notes

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