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DELINEATING SUBTYPES OF SELF-INJURIOUS BEHAVIOR MAINTAINED BY AUTOMATIC REINFORCEMENT

Louis P. Hagopian, **Griffin W. Rooker**, and **Jennifer R. Zarcone**
The Kennedy Krieger Institute, Johns Hopkins University School of Medicine

Abstract

Self-injurious behavior (SIB) is maintained by automatic reinforcement in roughly 25% of cases. Automatically reinforced SIB typically has been considered a single functional category, and is less understood than socially reinforced SIB. Subtyping automatically reinforced SIB into functional categories has the potential to guide the development of more targeted interventions and increase our understanding of its biological underpinnings. The current study involved an analysis of 39 individuals with automatically reinforced SIB and a comparison group of 13 individuals with socially reinforced SIB. Automatically reinforced SIB was categorized into 3 subtypes based on patterns of responding in the functional analysis and the presence of self-restraint. These response features were selected as the basis for subtyping on the premise that they could reflect functional properties of SIB unique to each subtype. Analysis of treatment data revealed important differences across subtypes and provides preliminary support to warrant additional research on this proposed subtyping model.

Keywords

functional analysis; self-injurious behavior; automatic reinforcement

Self-injurious behavior (SIB) has been defined as "behavior which produces physical injury to the individual's own body" (Tate & Baroff, 1966). Although the interactions of biological and environmental variables that lead to the emergence of SIB are not fully understood (Richman & Lindauer, 2005), empirical research has produced a wealth of findings regarding the environmental factors that occasion and maintain SIB. Reviews of the published literature on functional analysis (FA) of SIB (Beavers, Iwata, & Lerman, 2013; Hanley, Iwata, & McCord, 2003), and a large-scale study of 152 individuals with SIB conducted by Iwata et al. (1994) indicate that SIB is maintained by social consequences in most cases (e.g., by escape from instructional demands, attention, and preferred items). In approximately 20% to 25% of cases, SIB occurs independent of social consequences. In these cases, the term *automatic reinforcement* (Vaughan & Michael, 1982) is used to describe this functional class of behavior because it is assumed that the behavior itself produces its own reinforcement (through unspecified processes, such as sensory stimulation). It is also possible that automatically reinforced SIB may not be maintained by

Address correspondence to Louis P. Hagopian, Neurobehavioral Unit, Kennedy Krieger Institute, 707 N. Broadway, Baltimore, Maryland 21205 (hagopian@kennedykrieger.org).

reinforcement in all cases but could be elicited or schedule induced (Vollmer, 1994). By its nature, automatically reinforced SIB poses unique treatment challenges because the maintaining reinforcer cannot be directly identified, nor is it directly controllable by the clinician in most cases (LeBlanc, Patel, & Carr, 2000; Vollmer, 1994).

The understanding of the nature of automatically reinforced SIB has advanced little over the past few decades, but there have been advances in the realm of assessment and treatment of SIB and other behaviors maintained by automatic reinforcement. Findings from studies that have addressed other behaviors commonly maintained by automatic reinforcement (e.g., pica and non-self-injurious stereotypy) have informed treatment of automatically reinforced SIB (e.g., Goh et al., 1995; Piazza et al., 1998; Piazza, Roane, Keeney, Boney, & Abt, 2002). In some studies, analyses were conducted to identify the particular source of stimulation produced by the behavior itself, and the findings were further validated through the demonstration of effective treatment outcomes. For example,Goh et al. (1995) conducted an analysis designed to identify the specific reinforcing properties of hand mouthing and found that hand stimulation was the primary reinforcer for all 10 participants. Similar types of analyses have been used to identify the type of oral stimulation that maintained pica (Piazza et al., 1998; Piazza, Hanley, & Fisher, 1996) and other automatically reinforced problem behavior (Fisher, Lindauer, Alterson, & Thompson, 1998; Piazza, Adelinis, Hanley, Goh, & Delia, 2000). Although these studies illustrate methods for isolating the source of reinforcement for non-self-injurious behavior, the sources of reinforcement that maintain automatically reinforced SIB have yet to be identified.

Progress in treating automatically reinforced SIB has advanced through the development of methods to identify empirically the preferred toys or other activities that are associated with reduced SIB, presumably because they produce reinforcement that competes with reinforcement produced by SIB (Shore, Iwata, DeLeon, Kahng, & Smith, 1997). Other intervention components used to treat automatically reinforced SIB include differential reinforcement of adaptive behavior such as toy engagement (e.g., Lindberg, Iwata, & Kahng, 1999; Vollmer, Marcus, & LeBlanc, 1994), response interruption (e.g., Sprague, Holland, & Thomas, 1997), protective equipment for sensory extinction (e.g., Moore, Fisher, & Pennington, 2004; Roscoe, Iwata, & Goh, 1998), punishment (e.g., Lerman, Iwata, Shore, & DeLeon, 1997), and restraint devices (e.g., Wallace, Iwata, Zhou, & Goff, 1999; Zhou, Goff, & Iwata, 2000).

Automatically reinforced SIB is typically assumed to be maintained by positive reinforcement (possibly sensory stimulation); however, it has been suggested that automatically reinforced SIB can also be maintained by negative reinforcement when the behavior attenuates some aversive stimulation such as pain or discomfort (Vollmer, 1994). Although automatic negative reinforcement is sometimes hypothesized as maintaining SIB when there is a known medical condition associated with discomfort (Iwata et al., 1994; Kuhn, Hagopian, & Terlonge, 2008), our review of the literature did not identify any studies that provide a conclusive empirical demonstration of SIB maintained by automatic negative reinforcement. In their large-scale epidemiological analysis, Iwata et al. (1994) hypothesized that of the 39 cases identified that had automatically reinforced SIB, only two might have SIB maintained by automatic negative reinforcement. This was based on the observation that the two cases had allergic dermatological conditions and engaged in skin scratching. Likewise Kuhn et al. (2008) suspected that skin scratching was maintained by automatic negative reinforcement in a child with sensory neuropathy who verbally reported that self-injurious scratching was due to itching. Although those few cases are intriguing, it should be noted that painful medical conditions can increase SIB that is socially maintained, possibly by establishing certain stimuli as aversive (e.g., noise; O'Reilly, 1997). In light of the fact that there are only a few reported cases in which automatically reinforced SIB was hypothesized to be maintained by negative reinforcement, this remains more a theoretical possibility than an established empirical phenomenon.

Because automatically reinforced SIB occurs independently of social contingencies, it has been suggested that its maintaining variables are more biological in nature than those of socially reinforced SIB (Mace & Mauk, 1995). There is a body of research on the "biological bases" of SIB that has examined how SIB correlates with brain morphology (Duerden et al., 2014), skin nerve fibers (Symons et al., 2008), pain sensitivity (Symons, Harper, Shinde, Clary, & Bodfish, 2010), and biological or neurochemical mechanisms (see Symons & Thompson, 1997 for a review). Unfortunately, this body of research does not inform us about automatically reinforced SIB as a class distinct from socially reinforced SIB, because the majority of those studies neither reported on the function of SIB nor listed any exclusion criteria that would allow one to hypothesize the operant functions of participants' SIB. Thus, the participants in these studies likely included a mixture of individuals with socially reinforced and automatically reinforced SIB. Other than a few notable exceptions (e.g., Garcia & Smith, 1999; Mace, Blum, Sierp, Delaney, & Mauk, 2001; Valdovinos, Ellringer, & Alexander, 2007; Zarcone et al., 2004), the majority of studies that have evaluated the effects of medication on SIB also fail to report on the function of SIB. The probable inclusion of participants with both socially and automatically reinforced SIB in most studies that have investigated biological variables that may influence SIB results in a high level of heterogeneity that may obscure potentially important findings within these investigations. More germane to the current investigation, the extant literature on biological mechanisms in SIB, as a whole, provides little information relevant to understanding automatically reinforced SIB.

In their large-scale epidemiological analysis describing FA outcomes with 152 individuals with SIB, Iwata et al. (1994) noted two outcomes indicative of automatic reinforcement during a multielement FA. First, the rates of SIB are inversely related to the level of stimulation present in each condition of the FA. That is, SIB is highest or occurs exclusively in the alone (or no interaction[1]) condition and is lowest in the play condition, in which toys and attention are available. The other pattern that indicates automatic reinforcement is when SIB occurs across all conditions of the functional analysis. Hagopian et al. (1997) described those same two patterns as indicative of automatic reinforcement in their guidelines for interpretation of multielement FAs (see also Roane, Fisher, Kelley, Lomas Mevers, & Bouxsein, 2013). There is general consensus among leading FA researchers that either of

[1]The terms *alone condition* or *alone sessions* will be used to refer to both alone and no-interaction conditions and sessions in the context of general discussion. However, when we refer to a particular study, the specific condition used will be noted.

these patterns of responding in the context of a multielement FA are indicative of automatic reinforcement (LeBlanc et al., 2000; Vollmer, 1994).

Another relevant behavioral feature present in some individuals with automatically reinforced SIB is self-restraint, which refers to behavior that is topographically incompatible with or prevents SIB (e.g., sitting on one's own hands to prevent face slapping; Powell, Bodfish, Parker, Crawford, & Lewis, 1996). Examples of self-restraint include behaviors such as wrapping body parts using clothing or material, sitting on hands, continuously holding onto objects, using others to restrict movements, and seeking out protective equipment or restraint devices (Isley, Kartsonis, McCurley, Weisz, & Roberts, 1991; Oliver, Murphy, Hall, Arron, & Leggett, 2003). Prevalence estimates of self-restraint vary widely across studies, ranging from 9% to 55% of individuals who engage in SIB (Powell et al., 1996). Although self-restraint usually does not produce as much tissue damage as SIB, it can be physically harmful due to loss of circulation, bruising, or swelling of extremities if restraint materials are too tight, and it can greatly interfere with participation in daily activities (Smith, Lerman, & Iwata, 1996). The relation between self-restraint and SIB is not fully understood, although several hypotheses have been proffered (Derby, Fisher, & Piazza, 1996; Fisher & Iwata, 1996; Freeman, Horner, & Reichle, 2002). One explanation is that SIB may produce both reinforcing and aversive consequences, and self-restraint occurs to avoid or escape the aversive consequences SIB produces (see Fisher & Iwata, 1996, for a detailed discussion). When an FA of SIB is conducted, if self-restraint occurs to the exclusion of SIB, it may not be possible to identify the function of SIB. In these cases, blocking self-restraint may be necessary to observe SIB and determine its function (Fisher, Grace, & Murphy, 1996; Lerman, Iwata, Smith, & Vollmer, 1994).

The purpose of the current study was to describe and provide some preliminary data examining a model for subtyping automatically reinforced SIB. An analysis was conducted of 39 consecutive cases of automatically reinforced SIB (i.e., all cases that met inclusion criteria are described regardless of treatment outcomes), and a comparison group of 13 individuals with socially reinforced SIB. Cases with automatically reinforced SIB were classified into one of three subtypes, two of which were based on the two patterns of responding during the FA that are indicative of automatic reinforcement, whereas the third was characterized by the presence of self-restraint. These response features were selected as the basis for subtyping SIB maintained by automatic reinforcement based on the premise that they reflect distinct functional properties of SIB.

METHOD

Participants and Setting

Patients treated between 1997 and 2012 by the inpatient and outpatient neurobehavioral programs at the Kennedy Krieger Institute were eligible for inclusion. All participants displayed highly severe and treatment-resistant SIB that was often not responsive to numerous medication trials or traditional outpatient behavioral interventions. We obtained diagnoses of autism spectrum disorder, level of intellectual disability, or both, from review of official records. We included participants if (a) they displayed SIB that was maintained by automatic reinforcement based on the criteria described in Hagopian et al. (1997); (b) we completed all assessments and treatment analyses using single-subject experimental designs (e.g., reversal, multielement) with at least three series conducted for each test and control condition for multielement designs and at least three series in each phase for reversal designs; and (c) we collected interobserver agreement data using two independent data collectors for at least 25% of sessions. In addition, we also included individuals who engaged in SIB maintained by social reinforcement as a comparison group. This comparison group was composed of the first 13 individuals in our patient database who had received assessment and behavioral treatment from the neurobehavioral inpatient program during the same time period and met the following criteria: (a) The participant underwent an FA and treatment was based on the outcome of the FA; (b) we evaluated the treatment using a single-case design with results that showed a clear demonstration of functional control of SIB; and (c) we collected interobserver agreement data using two independent data collectors for at least 25% of sessions.

Our initial examination of the patient database identified 66 individuals with SIB maintained by automatic reinforcement. However, only 39 of these individuals met the inclusion criteria for participation noted above (age range of 3 to 21 years old; $M = 11.7$). In addition, we identified a comparison group of 13 individuals with SIB maintained by social consequences that met the inclusion criteria (age range of 7 to 21 years old; $M = 13.7$). These individuals' SIB had a variety of social functions: access to attention ($n = 3$), escape from demands ($n = 3$), tangible ($n = 5$), compliance with mands ($n = 1$), and multiply controlled ($n = 1$); none of these individuals had automatically reinforced SIB. See Table 1 for a summary of participant characteristics.

Response Definitions

We defined SIB for each participant individually. For the purpose of the current study, we categorized individual topographies of SIB based on the area of the body that was targeted as follows: (a) *body-directed SIB*, which included behavior that targeted the individual's body not including the head (e.g., punching self in the chest, kicking one leg with the other); (b) *head-directed SIB*, which included behaviors that targeted the individual's head area (e.g., punching self in face, head banging); (c) *mouth-directed SIB*, which included responses that targeted the teeth, lips, or inside of the mouth (e.g., biting lips or biting tongue); and (d) *skin-directed SIB*, which included behaviors that targeted the skin (e.g., scratching, biting other than the lips or inside the mouth, pinching, or picking skin).

We defined *self-restraint* as the participant independently engaging in some form of behavior that restricted movement and was incompatible with his or her SIB (e.g., tucking one's hands into crevices of chairs or under his or her own legs or armpits, crossing legs, holding onto objects, or wrapping clothes around oneself).

Subtype Categorization Rationale and Coding

Rationale—We categorized automatically reinforced SIB into one of three subtypes based on distinct patterns of responding exhibited during the FA along with the presence or absence of self-restraint. We selected these response patterns for subtyping based on the premise that they might reflect the functional properties of automatically reinforced SIB. As noted previously, we identified two patterns of responding considered in the extant literature to be indicative of automatic reinforcement in the context of a multielement FA: (a) one in which levels of SIB are highest in the alone condition and lowest in the play condition; and (b) another in which levels of SIB are high (and sometimes variable) across all conditions. In the former pattern, SIB is sensitive to the level of environmental stimulation provided during an FA (Subtype 1), whereas in the latter, SIB shows little sensitivity to the environmental manipulations implemented during an FA (Subtype 2). These differences in behavioral sensitivity in the context of the FA could stem from differences in the potency or type of reinforcing consequences that SIB produces relative to other reinforcers in the environment. For example, the play condition of an FA typically includes highly preferred toys or leisure materials that are freely available to the participant, and allocation of responding to SIB often indicates a preference for reinforcement automatically produced by SIB over reinforcement produced by interacting with the toys or leisure items.

Finally, the presence of self-restraint was the basis for the third subtype (Subtype 3). Researchers have hypothesized that this response is typically maintained by negative reinforcement, suggesting that SIB produces aversive consequences (e.g., pain) for these individuals. Therefore, for Subtype 3, SIB may produce reinforcing consequences by one mechanism (e.g., positive sensory stimulation) and aversive consequences by another (e.g., pain when the individual’s targeted tissue is bruised and sensitive).

Criteria and coding—All of the FA data sets we reviewed had been identified by the treating behavior analyst as indicating that SIB met criteria for automatic reinforcement. For the current analysis, we trained two independent observers to apply the subtyping criteria described below to each FA and to categorize each FA into one of three subtypes (five randomly selected cases of automatically reinforced SIB were used for training purposes). After training, the remaining cases were scored independently by both observers. Specifically, we trained the observers to calculate a subtype quotient score that represented the degree of difference between SIB in the play and alone conditions. The observers first drew an upper criterion line (UCL) between the second and third highest data points and a lower criterion line (LCL) between the second and third lowest points from the play condition based on the procedure described by Hagopian et al. (1997). Next, the observers subtracted the number of points in the alone condition that were below the LCL from the number of points above the UCL. They then converted this value to a subtype quotient score by dividing it by the number of alone sessions, based on the modifications to the Hagopian et al. visual-inspection criteria for FAs of differing lengths described by Roane et al. (2013). In addition, scorers noted the percentage of play and alone data points that overlapped and the number of alone sessions in which self-restraint occurred in more than 25% of 10-s intervals. Both observers coded 35% of the graphs to evaluate interobserver agreement. An agreement was defined as both raters producing the same subtype quotient score. We calculated interobserver agreement values by dividing the number of agreements by the total number of agreements plus disagreements and converting the result to a percentage. Mean exact agreement on the number of series of alone and play conditions in the FA, the UCL, and the LCL, and the amount of overlap between data points for each participant was 91.7% (range, 80% to 100%), and mean exact agreement on quotient scores was 100% across all

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participants. When disagreements occurred, they were all between scorers on the exact location of the UCL and LCL.

Criteria for Subtype 1—We categorized a case of automatically reinforced SIB as Subtype 1 if the subtype quotient score was greater than or equal to 0.5. This means that the results of the FA displayed clear differentiation between the alone and play conditions, with lower rates of SIB occurring in the play condition. This quotient score is similar to the requirement for differentiation of social conditions described by Roane et al. (2013).

Criteria for Subtype 2—We categorized a case of automatically reinforced SIB as Subtype 2 if (a) the subtype quotient was less than 0.5, (b) more than 30% of the data points were overlapping between the play and alone conditions, or (c) the mean rate of SIB was more than 50 responses per minute in both the play and alone conditions. Thus, to be categorized as Subtype 2, the FA had to indicate that SIB occurred at markedly high levels regardless of the level of stimulation or environmental conditions.

Criteria for Subtype 3—We categorized a case of automatically reinforced SIB as Subtype 3 if (a) self-restraint occurred in at least 25% of 10-s intervals (using partial-interval recording) for at least three series of the alone condition of the FA, and (b) SIB was maintained by automatic reinforcement (which, in some cases, was revealed only after self-restraint was blocked).

Assessment and Treatment

Functional analysis (FA)—The FA was based on the procedures described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) and typically consisted of four to five conditions conducted in a multielement design (alone, attention, demand, tangible, and play). In most cases, each condition lasted 10 min and was conducted in a padded treatment room (3 m by 3 m). In all cases, we assessed at least one form of SIB; in some cases, we also targeted other problem behavior such as aggression and disruption. The alone condition consisted of the participant being placed in a bare treatment room with no toys or task materials. If SIB was deemed to be too severe to allow the participant to be left in a room alone, we implemented a no-interaction condition, and a therapist was in the room to ensure the safety of the participant by blocking some topographies of SIB that had been identified by medical staff. The attention condition consisted of the participant and therapist in a treatment room, with the therapist ignoring the participant. If a targeted response occurred, the therapist provided brief (5 to 10 s) attention to the participant. The demand condition consisted of a therapist issuing demands using a least-to-most prompting sequence. If a targeted response occurred, the therapist terminated demands and removed task materials for 30 s. The tangible condition consisted of the participant and the therapist in a treatment room with a preferred item. The participant had access to the item for 2 min before the beginning of the session. Next, the therapist removed the item but kept it in plain view of the participant. If the participant engaged in the target behavior, the therapist returned the item for 30 s if it was a leisure item or one bite if it was edible. The play condition was used as a control in which the participant had free access to highly preferred leisure items that had been identified from a preference assessment (paired stimulus, multiple stimulus without replacement, or single stimulus) and was provided attention every 30 s.

We mitigated risks to participants and staff through the use of numerous safety measures, including oversight and direct care from medical staff, criteria for response blocking or session termination, session holidays to allow healing if injuries were present, and the use of protective dressings and equipment when clinically indicated.

Competing stimulus assessment (CSA)—We conducted a CSA with a subset of participants. A CSA involves providing free access to test stimuli (preferred activities and materials, e.g., toys), presenting one at a time briefly (e.g., 3 min) and recording both SIB and engagement with the stimulus (Shore et al., 1997). Activities or items associated with lower rates of SIB and higher levels of engagement (relative to rates of SIB during the no-stimulus control condition) are thought to reduce SIB because they provide reinforcement that competes with the reinforcement produced by SIB. CSAs are commonly used to identify stimuli that can be used as a component of treatment for automatically reinforced problem behavior (e.g., Piazza et al., 1996, 1998), and they also provide an objective and systematic way to examine how readily SIB changes (or resists change) as a function of alternative sources of reinforcement (cf. Lionello-DeNolf, Dube, & McIlvane, 2010).

We selected the particular stimuli evaluated during the CSA based on the results of a prior stimulus preference assessment, parental report, staff report, or some combination, suggesting that the individual preferred or interacted frequently with the various toys or leisure materials. The CSA consisted of one control condition (with no competing stimulus present) and multiple test conditions in which one preferred stimulus or activity was presented (across participants, 7 to 21 stimuli were tested). During a test condition, the therapist provided the participant with free access to the test stimulus. The therapist provided no consequences for problem behavior but placed the leisure item in easily accessible areas if it was dropped out of reach. The control condition was identical to the test conditions except that the participant did not have access to toys or leisure items. We presented the test and control conditions in a quasirandom order for a fixed duration (ranging from 3 to 10 min across participants). Trained observers collected data on the frequency of SIB and the occurrence of item interaction. Sessions continued until we observed stable levels of SIB and item interaction (M = 3.1 series; range, 2 to 6). We collected CSA data, as described above, for 15 of the 39 participants with automatically reinforced SIB. We defined a competing stimulus as effective if it produced at least an 80% reduction in SIB across the series relative to the no-stimulus control condition. It was hypothesized that a greater number of effective competing stimuli would be identified for Subtype 1 cases than for Subtypes 2 and 3.

Treatment evaluation—The supervising behavior analyst developed individualized treatments for each participant based on the results of an FA and in accordance with a least restrictive treatment approach while safety was ensured. Treatments were selected and modified based on the effectiveness of treatment. Thus, treatment plans varied on a case-by-case basis and sometimes involved multiple treatment components. Treatments components included reinforcement (contingent, non-contingent, or both) in all cases, and when necessary, response blocking, protective equipment (devices such as wound dressings, gloves, knee pads, and helmets that do not restrict movement), punishment (30-s holds), and arm splints that limited elbow flexion. We ordered these treatment components sequentially in accordance with a least restrictive treatment philosophy (Vollmer et al., 2011); however, in some cases, we applied protective equipment or restraint at the outset because medical staff determined that the participant displayed topographies (e.g., eye gouging) or intensities (e.g., severe face punching) of SIB that posed a clear and imminent health risk. We included only treatment evaluations in which there were a minimum of three baseline and three treatment sessions conducted, a demonstration of experimental control using a single-subject design (e.g., a reversal) occurred, and interobserver agreement had been collected during treatment implementation. Based on these inclusion criteria, treatment outcome data were available for 12 individuals with Subtype 1, 8 individuals with Subtype 2, 4 individuals with Subtype 3, and 13 individuals with SIB maintained by social reinforcement.

We evaluated resistance to treatment by examining the level of intensity of treatment components combined with the percentage reduction in SIB. For example, SIB for which reinforcement as the sole treatment was effective (i.e., reduced it by at least 80% relative to baseline) can be characterized as less resistant to treatment than SIB for which punishment, restraint, or protective equipment was needed to reduce it. Baseline conditions were typically similar to the test condition of the FA (the alone or no-interaction condition) and sometimes included access to toys or restraint materials. We compared this baseline condition to subsequent treatment conditions. We calculated percentage reduction in SIB relative to baseline by determining a mean response rate for both the treatment and baseline phases using the last five points of each condition (or all of the sessions, if the condition was less than five sessions). We then subtracted the mean treatment response rate from the mean baseline rate and divided by the mean baseline rate and converted this quotient to a percentage. We considered treatments with an 80% or greater reduction in SIB to be effective. Examination of whether subtypes differed in terms of their resistance to treatment is relevant to the current model, which proposes that the observed behavioral features that distinguish the three subtypes could reflect the type and potency of consequences produced by automatically reinforced SIB, and thus would affect treatment outcomes. We hypothesized that Subtype 1 (and the comparison group with socially reinforced SIB) would require less intensive interventions (i.e., more cases would be successfully treated using reinforcement as the sole treatment) than Subtypes 2 and 3; we hypothesized that these latter two subtypes would require the use of more intensive interventions such as protective equipment, punishment, restraint devices, or some combination. We also hypothesized that behavioral sensitivity observed during the FA would also be evident during treatment across all groups. Specifically, we hypothesized that the level of differentiation between the play condition and the relevant test condition (e.g., alone for automatically reinforced SIB) would be positively correlated with the percentage reduction of SIB during treatment that involved reinforcement alone.

RESULTS

Subtype classification

Of the individuals with automatically reinforced SIB, 16 (41%) met criteria for Subtype 1, 15 (38.5%) met criteria for Subtype 2, and 8 (20.5%) met criteria for Subtype 3. Participants who met criteria for Subtype 1 had a mean subtype quotient of 0.8 ($SD = 0.2$; range, 0.5 to 1.0) and those who met criteria for Subtype 2 had a mean subtype quotient of 0.0 ($SD = 3.6$; range, −0.9 to 0.5). Two Subtype 2 individuals had a subtype quotient of 0.5 but met the overlap criteria or rate criteria. In addition, a Mann-Whitney test of statistical significance revealed a significant difference between groups on the subtype quotient ($p < .0001$). FA results for each participant are summarized in Table 2 across groups.

Functional analysis results

Figure 1 shows an FA exemplar for each of the three subtypes of automatically reinforced SIB. In the top panel, the FA of an individual with automatically reinforced SIB identified as Subtype 1 is illustrated (Participant 33). In this analysis, SIB was low in the play condition and highest in the ignore condition. The second panel shows the FA results of an individual classified as having Subtype 2 (Participant 12); SIB was high and variable across all conditions with overlapping data points. The third panel depicts the FA results of an individual classified as having Subtype 3 (Participant 38) when self-restraint was blocked. The bottom panel shows the results of the initial FA for Participant 1 when self-restraint was permitted. Self-restraint occurred in most intervals for most sessions, and the function of SIB could not be determined because SIB was not emitted in more than 80% of the sessions. Of the eight participants who had SIB classified as Subtype 3, six (75%) showed patterns of SIB characteristic of Subtype 2 when self-restraint was blocked (Participants 2 and 27 showed response patterns comparable to Subtype 1 when self-restraint was blocked).

Table 2 summarizes the mean rates of SIB in the play and alone conditions (or relevant social test condition for the social comparison group) of the FA, percentage differentiation between the play and test conditions, the mean percentage of intervals with self-restraint, and means of these data for each group. For Subtype 3, Table 2 depicts the mean rate of SIB in the play and alone conditions when self-restraint was blocked as well as the mean percentage of intervals with self-restraint when self-restraint was not blocked. The mean rates of SIB in the alone condition of the FA were highest for Subtype 2 ($M = 11.4$), followed closely by Subtype 3 ($M = 11$) and Subtype 1 ($M = 7.6$). The mean rates of SIB in the play condition of the FA were highest for Subtype 2 ($M = 8.6$) followed closely by Subtype 3 ($M = 7.1$) but relatively low for Subtype 1 ($M = 1.8$) and quite low for socially reinforced SIB ($M = 0.3$). In addition, a nonparametric ANOVA using the Kruskal-Wallis test revealed a significant difference in the rate of SIB in the play condition ($K = 27.7$, $p < .0001$) between groups. A Dunn's multiple-comparison post hoc test identified significant differences in the rate of SIB in the play condition ($p < .05$) between Subtypes 1 and 2, between Subtypes 1 and 3, between Subtype 2 and social, and between Subtype 3 and social but not between Subtype 1 and social or between Subtypes 2 and 3. Average percentage of differentiation between the play and the relevant test condition (e.g., alone) was highest for individuals with Subtype 1 and with socially reinforced SIB. Differences in rate of SIB in the alone condition across automatic subtypes were not significant.

Figure 2 depicts the level of differentiation between the play condition and the relevant test condition across subtypes for each participant (and mean for each group). For individuals with Subtype 1 and those with socially reinforced SIB, differentiation was generally high for most participants (M = 89.1%; range, 62.5% to 100%). For Subtypes 2 and 3, the level of differentiation was lower overall and varied widely across participants. A nonparametric ANOVA Kruskal-Wallis test revealed a significant difference between groups ($K = 32.7$, $p < .0001$). A Dunn's multiple-comparison post hoc test identified significant differences ($p < .05$) in level of differentiation between Subtypes 1 and 2, Subtypes 1 and 3, Subtype 2 and social, and Subtype 3 and social but not between Subtype 1 and social or Subtypes 2 and 3.

Demographic variables

We also examined whether there were differences between groups with regard to age, gender, level of disability, and diagnosis of autism (see Table 1). The ratio of males to females was 4:1 for Subtype 2, whereas it was closer to 2:1 for Subtypes 1 and 3 and for the group with socially reinforced SIB. All the individuals with Subtype 3 (eight of eight) had been diagnosed with an autism spectrum disorder (ASD), whereas the prevalence of ASD in the other groups ranged from 60% to 77%. Individuals with Subtype 3 were more likely to have severe to profound intellectual disability (75%) than individuals in the other groups (Subtype 1: 50%, Subtype 2: 20%, and social: 30.8%). Thus, the most notable finding with regard to these variables was that individuals with Subtype 3 were more likely to have ASD and to be lower functioning than all other groups (socially reinforced and automatically reinforced Subtypes 1 and 2), although the observed difference could have easily been due to chance variation given the small sample sizes for the subtypes.

Topographies of SIB and other problem behavior

We also examined differences in topographies of SIB, the presence of other forms of problem behavior (e.g., aggression), and the presence of other operant functions of problem behavior (see Table 1). Head-directed SIB was the most common topography across all groups. Body-directed SIB occurred the most with individuals with socially reinforced SIB (77% of individuals) but was less common among those with automatically reinforced SIB (M = 23.1%; range, 18.8% to 37.5% of individuals). Individuals with socially reinforced SIB had more topographies of SIB (M = 2.4) than the automatically reinforced SIB group (M = 1.8), whereas automatically reinforced SIB subtypes did not differ substantially on this variable (range, 1.6 to 1.9). More individuals with Subtype 1 (87.5%) had other forms of problem behavior (e.g., aggression and disruption) than individuals with Subtypes 2 and 3 (53.3% and 50%, respectively), and 92.3% of those with socially reinforced SIB engaged in other forms of problem behavior. Also, individuals with Subtype 1 (93.8%) were more likely to have other forms of problem behavior maintained by social contingencies than those with Subtypes 2 and 3 (46.7% and 50%, respectively).

Effects of competing stimuli

CSA data were available for five individuals with Subtype 1, seven with Subtype 2, and five with Subtype 3 automatically reinforced SIB. For all individuals with Subtype 1 (five of five), at least one effective competing stimulus was identified. As hypothesized, an effective competing stimulus was identified in a smaller proportion of individuals with Subtypes 2 and 3 (71.4% and 40%, respectively) than those with Subtype 1. Differences across subtypes were also evident when we examined the number of effective competing stimuli identified relative to the number evaluated. For Subtype 1, we identified an average of 3.6 competing stimuli for each participant of the 8.4 items evaluated; thus, for Subtype 1, 42.9% of tested stimuli effectively competed with reinforcement that maintained SIB. For Subtype 2, only 19.4% of tested stimuli were effective competing stimuli ($M = 2.4$ of 12.4 that were evaluated), and for Subtype 3, 34.7% of tested stimuli were effective competing stimuli ($M =$ 3.4 of 9.8 that were evaluated).

Resistance to treatment

As noted above, not all participants' treatment data met criteria for inclusion, mostly because of the design limitations that are sometimes inherent to treating and managing dangerous behavior. Data summarized in Figure 3 depict how often various treatment components were implemented and how often they resulted in a successful outcome, defined as producing at least an 80% reduction in SIB relative to baseline. We used reinforcement either alone or in combination with the other components (e.g., we never implemented punishment without reinforcement). Figure 3 (top three panels) depicts the treatment results for each of the three subtypes of automatically reinforced SIB, and the results for the participants with socially reinforced SIB (bottom panel; Participants 40 to 52). Comparisons across cases with automatically and socially reinforced SIB are difficult for several reasons, and thus the results should be interpreted with some caution. Most notably, reinforcement is typically used in combination with extinction of socially reinforced SIB, whereas extinction is difficult to define and implement for automatically reinforced SIB; thus, initial treatments for automatically reinforced SIB involve reinforcement alone. Therefore, for the current analysis we compared these "first line" interventions: reinforcement with extinction for the group with socially reinforced SIB and reinforcement alone for the individuals with automatically reinforced SIB.

Reinforcement was effective for most individuals with Subtype 1 (8 of 12) automatically reinforced SIB and with socially reinforced SIB (11 of 13). In contrast, reinforcement was not effective for anyone with Subtype 2 (zero of seven). We did not implement reinforcement alone with individuals with Subtype 3; although all engaged in self-restraint, SIB occurred at levels that necessitated the use of restraint throughout the treatment analysis to prevent further injury. None of the individuals with Subtype 1 or socially reinforced SIB required protective equipment or restraints, and response blocking and punishment were used infrequently. We used restraint most often with individuals with Subtype 3 (and it was effective in three of three cases). Treatments that involved more than two components were needed only for individuals with Subtype 2. As hypothesized, more intensive treatment elements were much more likely to be necessary with individuals with Subtypes 2 and 3 than those with Subtype 1 and socially reinforced SIB.

Figure 4 depicts the relation of the percentage reduction of SIB obtained with first line treatments (reinforcement alone for automatically reinforced SIB and reinforcement with extinction for socially reinforced SIB) and the level of differentiation in the FA between the play and the relevant test conditions. This figure and the correlational analysis illustrate how the level of differentiation in the FA predicted response to reinforcement alone during treatment. As noted, the level of differentiation in the FA provides an index of behavioral sensitivity, or the degree to which SIB varies as a function of changes in environmental conditions. The correlation of $r = 0.61$ (Pearson) was highly statistically significant ($p < .0001$). Data points that refer to individuals also illustrate how the identified groups tend to cluster together (no data on Subtype 3 are presented because none of those participants were treated with reinforcement alone). These findings suggest that SIB maintained by automatic reinforcement may be differentially sensitive to reinforcement during treatment based on subtype classification. Moreover, the findings indicate that in terms of responsiveness to treatment, individuals with Subtype 1 may be more similar to individuals with socially reinforced SIB than to the other subtypes of automatically reinforced SIB. Not surprisingly, SIB that shows increased sensitivity to the environment during the FA (Subtype 1 and those with socially reinforced SIB) is more responsive to reinforcement during treatment.

DISCUSSION

Results of this analysis of 39 consecutive cases of automatically reinforced SIB provide substantial initial support for the proposed model for subtyping automatically reinforced SIB, indicating that it warrants continued study. As we hypothesized, an effective competing stimulus (one that reduces SIB by 80%) could be identified in a higher proportion of individuals with Subtype 1 than those with Subtypes 2 and 3 SIB maintained by automatic reinforcement. Second, results supported our hypotheses regarding resistance to treatment in that reinforcement-based procedures alone often failed and more intensive interventions were required to reduce SIB to clinically acceptable levels for Subtypes 2 and 3. In addition, we found a large correlation between the level of differentiation during the FA and the level of response to reinforcement-based treatment that was statically significant (Cohen, 1988). We also found that individuals with Subtype 1 SIB were more likely to have other forms of problem behavior and other functions than were participants with other subtypes of automatically reinforced SIB. Interestingly, Subtype 1 SIB was more similar to socially reinforced SIB than to Subtypes 2 and 3 in terms of (a) resistance to treatment and (b) the presence of other forms of problem behavior.

We characterized the level of differentiation during the FA between the alone and play conditions as an index of behavioral sensitivity to environmental changes or manipulations, and the results of this investigation supported this characterization. Because behavioral treatments involve changing the environment to establish new learning histories and skills, it is not surprising that behavioral sensitivity evident during the FA would also be evident later in treatment. However, findings related to resistance to treatment should be interpreted with some caution, given that this was a retrospective analysis of clinical data and we did not apply a formal and uniform sequence of treatment components across participants. Despite these limitations, this is the first empirical study to illustrate that automatically reinforced

SIB is often more resistant to treatment than socially reinforced SIB, particularly for Subtypes 2 and 3.

We based the current subtyping model on the premise that the level of differentiated responding between the play and alone conditions and the presence of self-restraint could reflect distinct functional properties of SIB unique to each subtype. We posit that sensitivity of SIB to changes in the environment could reflect differences in the type or potency of reinforcement produced by SIB. As previously noted, it is possible that for individuals in Subtype 1, SIB may produce sensory consequences that reinforce this response when other forms of reinforcing stimuli (i.e., competing stimuli) are unavailable. In contrast, for individuals in Subtype 2, SIB may produce reinforcement of a higher magnitude or quality, against which alternative stimuli will typically not compete effectively. For example, we speculate that it is possible that for individuals in Subtype 2, SIB may produce changes in neurotransmitter activity in ways that function as automatic reinforcement for this response (e.g., release of endogenous opiates; Cataldo & Harris, 1982). Similarly, for Subtype 3 we think that it is worth considering the possibility that SIB persists because it produces reinforcing consequences that are mediated by one biological mechanism and aversive consequences that are mediated by another, which negatively reinforces self-restraint. If one were to apply descriptive terms for each subtype in accord with the premise that their distinct behavioral features reflect unique differences in the type and potency of reinforcement that SIB produces, the terms *sensory, strong sensory*, and *mixed sensory* SIB might be reasonably applied to Subtypes 1, 2, and 3, respectively.

The framework we proposed and evaluated in this investigation for subtyping automatically reinforced SIB is consistent with the approach used to classify socially reinforced SIB (at least conceptually) and in some ways represents a logical extension. There are technological limitations to the functional classification of automatically reinforced SIB that are typically not problematic for categorizing socially reinforced problem behavior. Most notably, it is usually not possible to observe and manipulate the hypothesized reinforcer for automatically reinforced SIB directly, whereas social reinforcers are much more amenable to both observation and experimental manipulation.

One limitation of the current study is that it is retrospective, and we developed our model after most of the participants' assessment and treatment evaluations had been completed. Also, we collected these data as part of the participants' clinical assessment and treatment of their SIB, which may have introduced variability and potential sources of error. For example, FAs targeted multiple behaviors (e.g., aggression and disruption) in some cases. When responses other than SIB produced programmed consequences, it is possible that these consequences competed with the reinforcement available for automatically reinforced SIB, thereby decreasing its occurrence in some conditions. Because of this, we evaluated only the rate in the alone and play conditions in constructing our subtype quotient score. However, information from other conditions (e.g., how well demands displaced SIB) could provide additional relevant information both about subtyping cases of automatically reinforced SIB and the types of treatments that may eventually be effective in treating this behavior.

Another example of how our clinical management of these cases introduced procedural variation was in how we selected the items for the play condition of the FA and the CSA. Although we used similar procedures across participants to select the toys used in the play condition (high-preference items identified via a preference assessment), it is possible that even minor variations in procedures could have affected rates of SIB in the play condition, thereby affecting the subtype quotient score. Nevertheless, we developed a model of automatically reinforced SIB that produced a set of testable hypotheses, and our results supported the model and its predictions. At a minimum, the current results support the need for additional research aimed at further testing the proposed subtyping model using prospective investigative methods.

In addition, future prospective studies on this model might include some methodological refinements. First, it would be useful to include a more precise method for determining the potency of the reinforcement produced by SIB by examining whether subtypes differ in terms of how much individuals will work to access opportunities to engage in or avoid SIB. We hypothesize that individuals with Subtype 2 automatically reinforced SIB (and also perhaps Subtype 1, though less so) would work more to gain opportunities to engage in SIB than would individuals with Subtype 3, who would work more to avoid SIB (e.g., completing more work tasks to gain access to items used for self-restraint).

Second, the effects of response blocking on SIB also could further inform us about the reinforcing potency of SIB. Response blocking, along with the use of protective equipment that may attenuate the sensory consequences of SIB, may be the closest approximation to extinction that is achievable when automatically reinforced SIB is assessed and treated. Often, extinction following a history of more potent reinforcement is associated with higher rates of behavior (Lerman & Iwata, 1996), greater response force (Morris, 1968), and greater persistence of behavior relative to a history of weaker reinforcement (Nevin & Grace, 2000). Thus, we hypothesize that response blocking would increase the rate, force, persistence, and variation of SIB most for Subtype 2, whereas it would be more effective in reducing SIB for Subtypes 1 and 3. We also hypothesize that individuals with Subtype 3 may show increased sensitivity to pain, whereas there may be decreased sensitivity to pain among those with Subtype 2 SIB. We have initiated prospective investigations to test these and other subtype-specific hypotheses that are consistent with our model.

Third, prospective research on our model of automatically reinforced SIB should include objective and protocol-driven procedures for initiating, augmenting, or abandoning interventions. For example, despite the literature that supports the effectiveness of CSAs in the treatment of automatically reinforced problem behavior, CSAs were completed with only 15 of the 39 participants in the current study. Therefore, it is difficult to conclude with certainty that the observed differences in resistance to treatment would have been the same had every participant's reinforcement-based treatment been informed by a CSA. In our ongoing studies on automatically reinforced SIB, we have included clear and objective decision rules for proceeding through the process of selecting the least restrictive intervention that is both safe and effective.

Behavioral research on SIB (most notably functional analysis and function-based treatment) and research that has examined the biological basis of SIB have largely been independent, despite some attempts to bridge these lines of research (Mace & Mauk, 1995). Behavioral research on SIB over the past three decades has advanced knowledge and revolutionized practice. Numerous classes (e.g., social positive) and subclasses (e.g., attention maintained) of social functions have been identified during this time, yet automatically reinforced SIB has remained a single and poorly understood category. It is premature to say whether the development of a model that subtypes automatically reinforced SIB into specific functional categories will have an impact on assessment and treatment practices that approximates the progress that has been made with socially reinforced problem behavior. However, in light of the demonstration in the past three decades of how knowledge of behavioral function can bring about advances in the treatment of socially reinforced problem behavior, there is at least some reason to believe that improving our ability to assess and functionally categorize automatically reinforced SIB may lead to more effective interventions for this recalcitrant problem. For example, the results of the current study suggest that reinforcement-based treatments may need to be augmented (e.g., with response blocking) for automatically reinforced SIB classified as Subtype 2. Nevertheless, the aforementioned limitations of the current study preclude recommendations that would alter the currently recommended practice of proceeding from less to more intensive interventions until prospective research validates these preliminary findings.

The proposed subtyping of automatically reinforced SIB also may have implications for research on the biological bases of SIB as well as pharmacological studies on SIB. As noted above, this body of research has not considered the operant function of SIB. If investigators used the proposed subtypes of automatically reinforced SIB in future studies on the biological basis of SIB, or in future clinical trials of medications, then heterogeneity that may have previously led to mixed findings or nonsignificant effects might be accounted for, thereby reducing error variance and revealing more robust effects. For example, rather than conducting a trial of opioid antagonists across a diverse group of individuals regardless of function of SIB, future studies might classify participants along the lines proposed herein and examine differential responsiveness.

Finally, accurate delineation of both the functional and topographical characteristics of the phenotypes of SIB may facilitate biobehavioral research on these perplexing disorders. We speculate that research on defining the subtypes of SIB could lead to the discovery of the unique biomarkers for each subtype, which in turn might lead to more specific and effective pharmacological interventions. Likewise, the current subtyping model could potentially lead to collaborations between behavior analysts and basic biological researchers to examine other biological variables that may be subtype specific, such as peripheral nerve innervation, arousal, sensory perception of pain, and neurotransmitter systems. Collaborative research of this sort could lead to (a) further refinements of the current subtypes; (b) the identification of additional unique subtypes; and (c) hypothesis-driven research about how various biological mechanisms may be involved in the subtypes of SIB. As noted previously, given that automatically reinforced SIB occurs independent of social variables, it is logically assumed to be under control of biological variables that reside “under the skin.” However, the current results clearly show that automatically reinforced SIB is affected by (and can be subtyped by) the extent to which it responds to systematic environmental manipulations (e.g., during an FA or CSA). Therefore, automatically reinforced SIB represents a logical point of convergence and collaboration for behavior analysts and biological researchers on the biobehavioral relations involved in these complex disorders.

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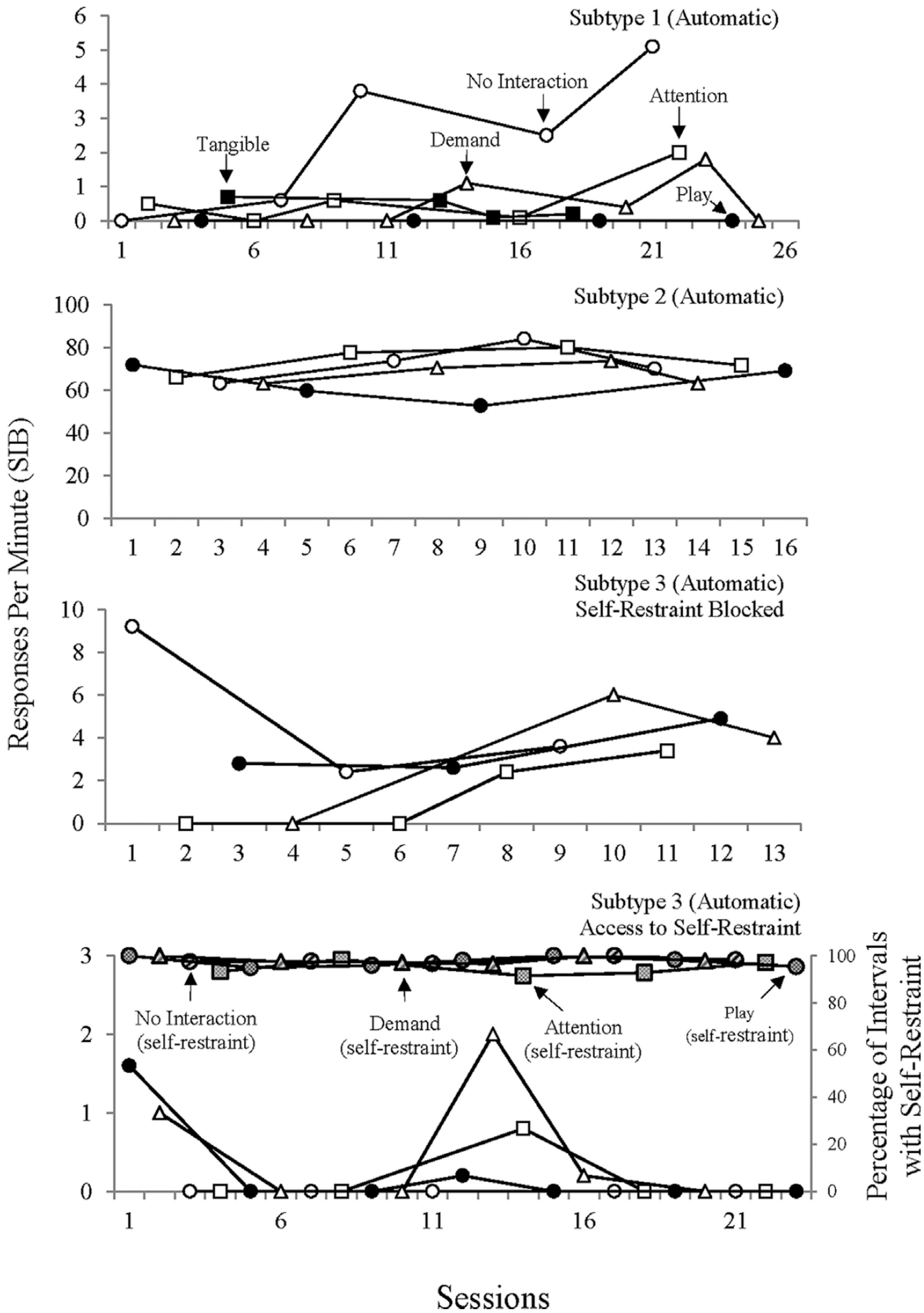

Figure 1.

Functional analysis exemplars for Subtype 1 (Participant 33), Subtype 2 (Participant 12), and Subtype 3 (Participant 38). Responses per minute of SIB are on the left axis, and percentages of intervals with self-restraint are on the right axis for the fourth panel.

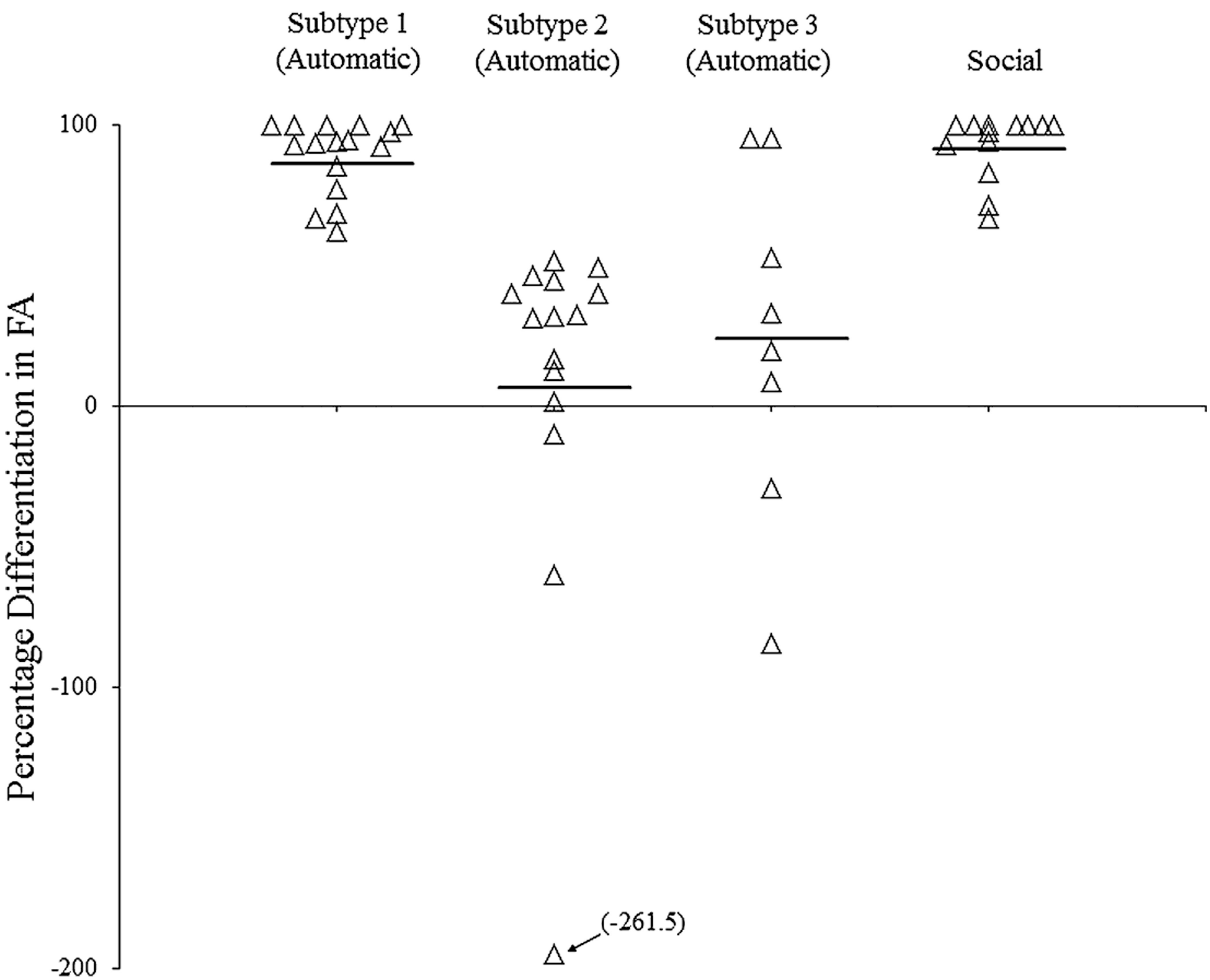

Figure 2.

Percentage of differentiation between play and the relevant test condition in the functional analysis for each individual by group. Mean percentage for each group is indicated by the horizontal bold lines.

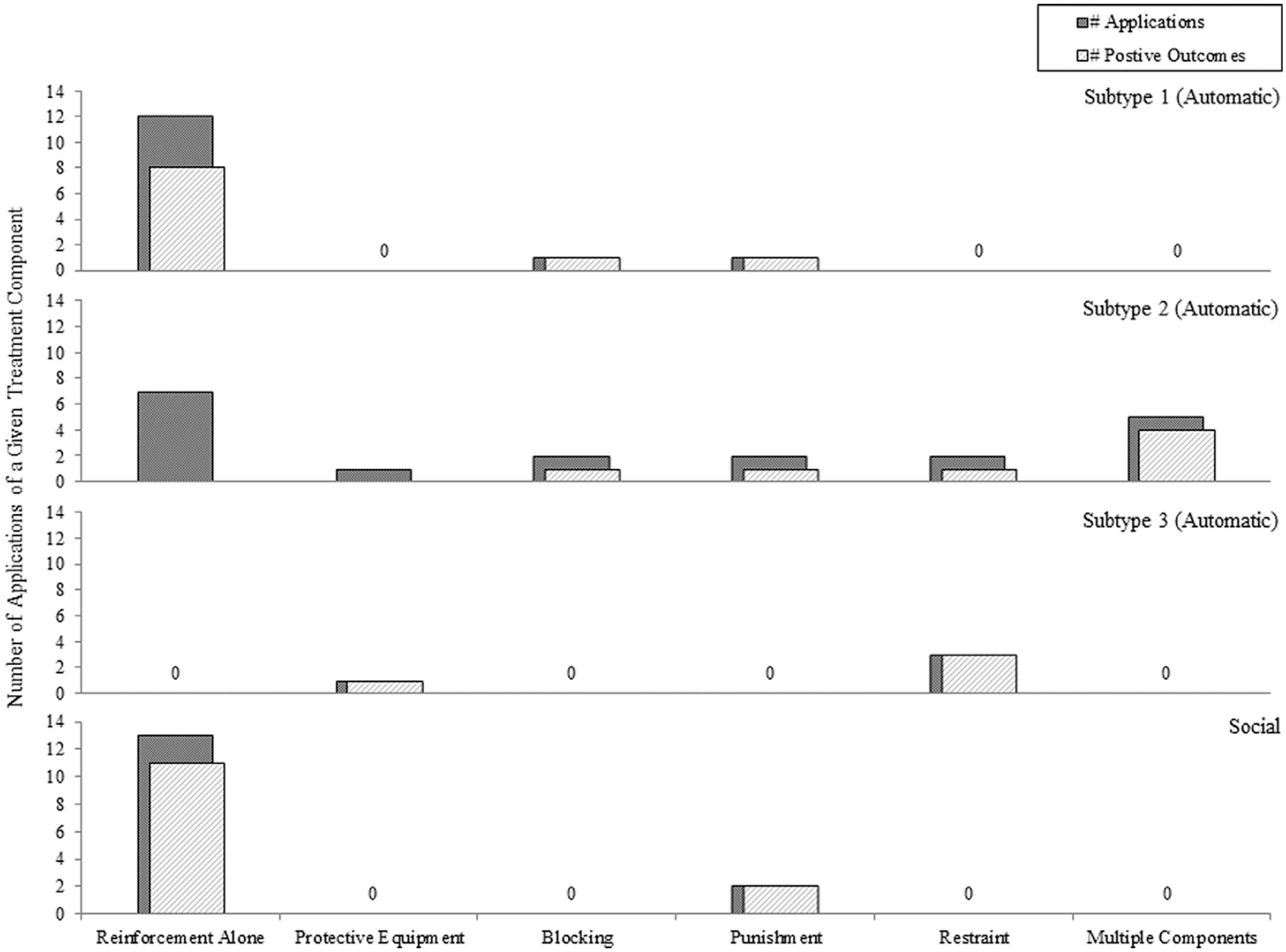

Figure 3.

Number of applications and number of positive outcomes for each type of treatment component by subtype. For this analysis, a positive outcome was defined as an 80% reduction from the initial baseline.

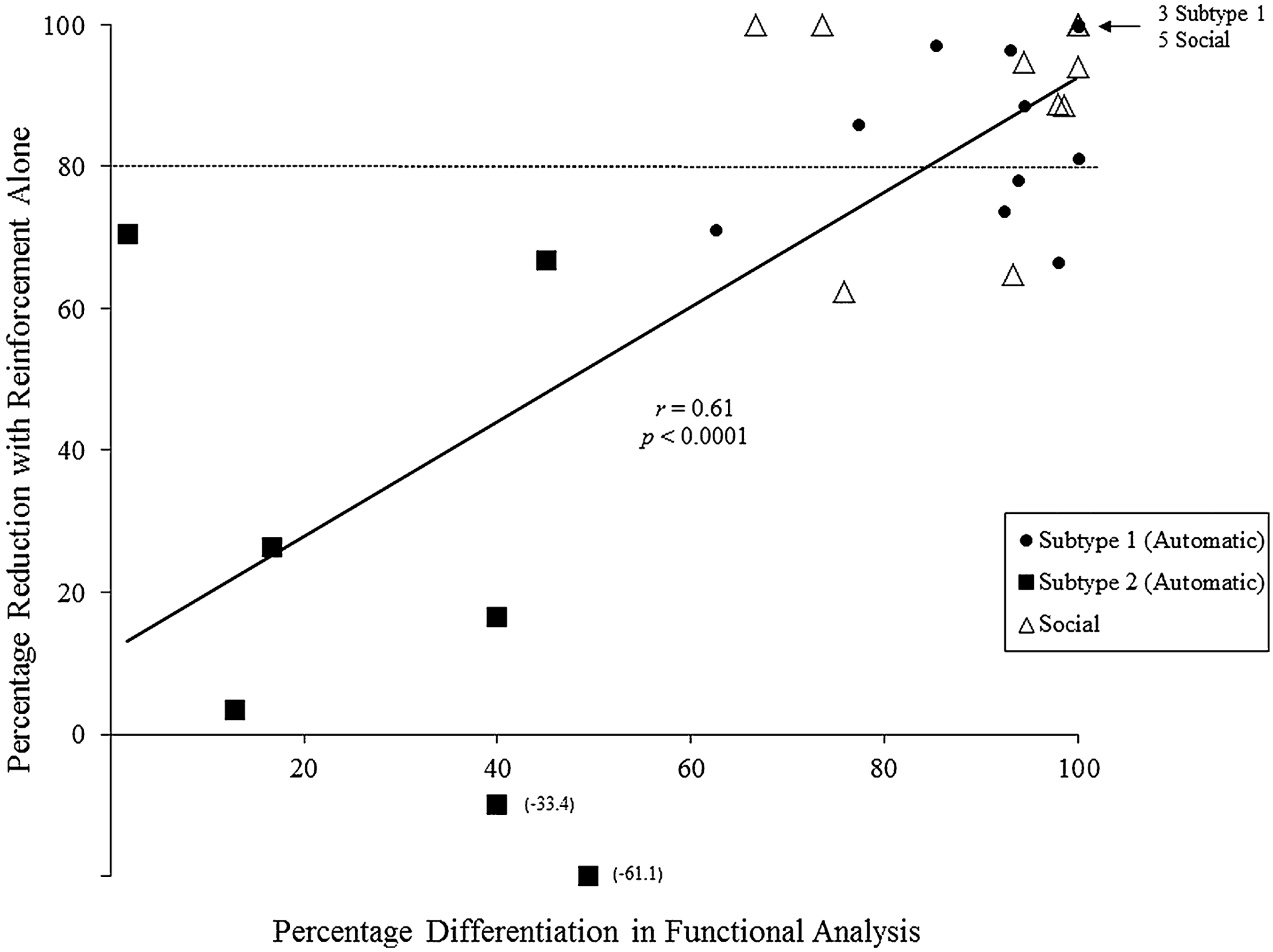

Figure 4.

Relation between differentiation in the functional analysis and percentage reduction of SIB for each subtype with reinforcement during treatment. The trend line represents the linear relation between these two variables, which was statistically significant (Pearson $r = 0.61$; $p < .0001$).

Table 1

Demographic and Behavioral Variables Across Groups

	Total (*N* = 52)		Subtype 1 (*n* = 16)		Subtype 2 (*n* = 15)		Subtype 3 (*n* = 8)		All automatic (*n* = 39)		Social (*n* = 13)	
Variable	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Gender												
Female	15	28.8	5	31.3	3	20	3	37.5	11	28.2	4	30.8
Male	37	71.2	11	68.8	12	80	5	62.5	28	71.8	9	69.2
Age (years)												
3 to 12	25	48.1	9	56.3	8	53.3	3	37.5	20	51.3	5	38.5
13 to 17	21	40.4	5	31.3	6	40	4	50	15	38.5	6	46.2
>18	6	11.5	2	12.5	1	6.7	1	12.5	4	10.3	2	15.4
ASD												
Yes	38	73.1	11	68.8	9	60	8	100	28	71.8	10	76.9
No	14	26.9	5	31.3	6	40	0	0	11	28.2	3	23.1
Level of ID												
Mild	4	7.7	3	18.8	0	0	1	12.5	4	10.3	0	0
Moderate	10	19.2	3	18.8	3	20	0	0	6	15.4	4	30.8
Severe	15	28.8	5	31.3	2	13.3	5	62.5	12	30.8	3	23.1
Profound	6	11.5	3	18.8	1	6.7	1	12.5	5	12.8	1	7.7
Unspecified	10	19.2	1	6.3	5	33.3	0	0	6	15.4	4	30.8
Not reported	7	13.5	1	6.3	4	26.7	1	12.5	6	15.4	1	7.7
SIB topography												
Body directed	19	36.5	3	18.8	3	20	3	37.5	9	23.1	10	76.9
Head directed	49	94.2	15	93.8	14	93.3	7	87.5	36	92.3	13	100
Mouth directed	2	3.8	1	6.3	0	0	0	0	1	2.6	1	7.7
Skin directed	29	55.8	10	62.5	7	46.7	5	62.5	22	56.4	7	53.8
Other problem behavior	38	73.1	14	87.5	8	53.3	4	50	26	66.7	12	92.3
Additional functions[a]	32	61.5	15	93.8	7	46.7	4	50	25	64.1	7	53.8

[a]For problem behavior besides self-injury.

Table 2

Mean Responses per Minute of SIB and Percentage of Intervals with Self-Restraint During the Functional Analysis

Participant and group	Alone or social test condition	Play condition	% intervals with self-restraint	% differentiation between alone (or test) and play
Automatic Subtype 1				
3	1.8	0.1		94.4
5	1.8	0		100
7	1.9	0.1		94.7
9	6.8	1		85.3
11	0.8	0		100
15	1.6	0.1		93.8
16	3.9	0.3		92.3
18	5.3	0		100
21	24.0	8		66.7
22	4.4	1		77.3
30	9.7	0.2		97.9
32	2.4	0.9		62.5
33	2.4	0.0		100
34	51.3	16.2		68.4
35	1.5	0		100
37	1.4	0.1		92.9
Average	7.6	1.8		89.1
Automatic Subtype 2				
6	1.5	2.4		−60
8	6.0	3.3		45.0
12	72.7	63.3		12
13	2.4	2.0		16.7
14	1.3	4.7		−261.5
17	25.5	12.3		51.8
19	6.9	3.5		49.3
20	3.1	2.1		32.3
23	0.5	0.3		40
24	1.0	1.1		−10
25	5.7	3.4		40.4
26	21.6	11.5		46.8
28	4.14	2.8		31.9
29	7.9	5.4		31.6
31	11.4	11.2		1.8
Average	11.4	8.6		4.6
Automatic Subtype 3[a]				
1	32.6	29.8	98.9	8.6

Participant and group	Alone or social test condition	Play condition	% intervals with self-restraint	% differentiation between alone (or test) and play
2	15.9	0.72	78.3	95.5
4	17.7	8.3	83.3	53.1
10	3.1	4	91.7	−29
27	6.8	0.3	100	95.6
36	2.5	2	29.1	20
38	5.1	3.4	97.2	33.3
39	4.4	8.1	98	−84.1
Average	11.0	7.1	84.6	24.7
Social				
40	0.3	0		100
41	6	0.4		93.3
42	1.4	0		100
43	1.4	0		100
44	1.5	0		100
45	9.5	0.2		97.9
46	0.6	0.1		83.3
47	1.4	0.4		71.4
48	0.9	0		100
49	0.3	0		100
50	1.4	0		100
51	6	2		66.7
52	1.8	0.1		94.4
Average	2.5	0.3		92.8

[a]For Automatic Subtype 3, responses per minute of SIB reported are from FA sessions in which self-restraint was blocked; percentages of intervals of self-restraint reported are from the initial FA, when self-restraint was permitted.