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Evaluating the Relationship between the Rate and Temporal Distribution of Self-Injurious Behavior

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Abstract

Self-injurious behavior (SIB) presents unique challenges as researchers have identified that some SIB may be resistant to treatment. The unit of analysis in this research is often the frequency of behavior with relatively little attention devoted to the analysis of inter-response time relations. We assessed whether changes in the rate of SIB were also associated with changes in the temporal distribution of this behavior in the presence and absence of systematically manipulated environmental variables. This study included three participants diagnosed with profound intellectual disabilities who engaged in SIB maintained by both negative and automatic reinforcement. For two of the participants, we used a multiple baseline design across participants to assess the effects of noncontingent access to preferred activities on both the rate and temporal distribution of SIB. For the third participant, we used a reversal design to assess the effects of a change in daily schedule (i.e., attending or not attending work) on the rate and temporal distribution of SIB. For all three participants, antecedent manipulations decreased the rate of SIB; however, operant contingency values (a measure of temporal distribution) did not change in a corresponding fashion. These data suggest that although antecedent manipulations may decrease the overall rate of the behavior, once SIB is emitted, additional instances are likely to occur close together in time.

Keywords

self-injurious behavior; sequential analysis; inter-response time

Self-injurious behavior (SIB) can be defined as repetitive acts directed toward oneself that have the potential to cause direct or indirect physical damage (for comprehensive reviews see Rojahn, Schroeder, & Hoch, 2008; Schroeder, Oster-Granite, & Thompson, 2002). SIB occurs frequently among individuals with intellectual and developmental disabilities (IDD) (Poppes, van der Putten, & Vlaskamp, 2010) and is manifested in a variety of different topographies (Rojahn, 1994). Individual environmental and biological interactions, which are hypothesized to produce and maintain SIB, contribute to the complex nature of this

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behavior (Hagopian & Crawford, 2017). Due to its heterogeneity, identifying effective treatments for SIB may be difficult (Minishawi, Hurwitz, Morriss, & McDougle, 2015).

Nonetheless, function-based behavioral interventions have been effective at reducing the frequency of SIB in many cases (Iwata et al., 1994; Kahng, Iwata, & Lewin, 2002; Matson & LoVullo, 2008). In addition to using frequency as a measure of successful treatment outcomes, measuring other behavioral dimensions of SIB may also help identify the most clinically significant interventions. Specifically, LaVigna and Willis (2005) suggested that in addition to using rate as a measure of treatment outcomes, that episodic severity should also be measured to not only assess changes in behavior over time but also to assess changes in behavior within specific instances. Thus, measuring the temporal distribution of SIB (i.e., how close instances of SIB occur in time) could be used as a measure of episodic severity and used as an outcome measure in treatment evaluations. By measuring rate and temporal distribution (i.e., SIB-SIB contingencies), one can assess how often SIB happens and how close together those instances occur in time. Measuring the inter-response time of SIB using sequential analysis techniques may provide information about the severity of SIB episodes during baseline and intervention conditions (LaVigna & Willis, 2005). For example, if SIB occurred at high frequencies with strong SIB-SIB contingencies within a session, its likely SIB occurred at a high rate and instances occurred close together (high intensity) throughout the entire session. However, if SIB occurred at a low rate with strong SIB-SIB contingencies, that pattern may suggest that SIB occurred infrequently but was of high intensity when it did occur. Lastly, if SIB occurred at a low rate with weak or negative SIB-SIB contingencies, this pattern might suggest that SIB occurred infrequently and in isolated instances (low intensity). Using this type of analysis during baseline and treatment conditions may be helpful in identifying the most effective interventions for SIB (i.e., those that reduce both the frequency and the intensity of the behavior).

The temporal distribution of SIB in the natural environment has been studied in some cases. Descriptive analyses of SIB in institution-like and community settings have revealed that for many individuals with IDD and chronic SIB, instances of SIB are likely to occur together in time (i.e., short inter-response times). Using sequential analysis methodologies, researchers have consistently demonstrated that across different groups of individuals with chronic SIB, a large majority of participants displayed strong sequential associations between instances of SIB (Courtemanche, Lloyd, & Tapp, 2018; Kemp et al., 2008; Marion, Touchette, & Sandman, 2003; Sandman, Touchette, Marion, & Chicz-DeMet, 2008), meaning that one instance of SIB is likely to predict a future instance.

For example, Courtemanche et al. (2018) used sequential analysis methods to estimate the likelihood of one instance of SIB being followed by an additional instance of SIB in adults who lived in community settings. For seven individuals with chronic SIB, the best predictor of an instance of SIB was a previous instance of SIB. When using a more in-depth analysis where researchers evaluated the strength and direction of SIB-SIB contingencies during different environmental contexts (i.e., staff interaction vs. no staff interaction), the strength of the SIB-SIB contingencies varied, with some participants displaying weaker contingencies between instances of SIB during times when staff interaction was present compared to absent. Thus, for some individuals, SIB was more likely to occur together in

time during times without staff interaction and instances of SIB were more likely to occur in isolation when staff interaction was present. These results highlight the potential use of antecedent manipulations to not only reduce the frequency of SIB but also the temporal distribution of this behavior.

Thus far, some studies assessing how the temporal distribution of SIB is affected by different environmental variables have been descriptive (rather than experimental) in nature, where specific environmental variables were free to vary in the natural environment. The purpose of this study was to systematically evaluate how the presence or absence of environmental variables affected both the rate and temporal distribution of SIB. More specifically, for two participants, we evaluated the effects of the presence and absence of preferred items and for a third participant we evaluated the effects of a daily schedule change (i.e., not attending work) on the rate and temporal distribution of SIB. The primary focus of this paper was to assess whether sequential analyses of instances of SIB provide appropriate dependent measures for assessing outcomes for SIB.

Method

Participants and Setting

Prior to beginning the study, all procedures were submitted and reviewed by an institutional review board at the university level and a human rights committee at the organizational level. Parental or legal guardian written consent was obtained for all participants.

Brent was a 28-year-old male diagnosed with autism, a profound intellectual disability, Attention Deficit Hyperactivity Disorder, and a seizure disorder. Brent engaged in a number of different topographies of SIB including head hitting and banging and body hitting. His current residence was a community group home that served one additional individual. All sessions took place in the kitchen and attached garage areas of his home.

Jeremy was a 46-year-old male diagnosed with a profound intellectual disability, a seizure disorder, and an anxiety disorder. Jeremy's SIB included head hitting and banging, body hitting, and self-biting. He engaged in these behaviors in his home and while riding in the group home van. Jeremy lived in a community group home with three additional individuals. For Jeremy, sessions were conducted in his group home living room and on the group home van. While riding in the van, Jeremy sat in the last row by the window of the driver's side of the van.

Tony was a 38-year old male diagnosed with profound intellectual disability and autism. He was prescribed Risperidone (3mg) and Hydroxyzine (50mg). He lived at a state institution in a cottage with seven additional housemates. Weekly observations were conducted on the same day of the week and at approximately the same time of day. Observations took place during a time when Tony was transitioning from home to work, thus data were collected in Tony's home, on the bus that he rode to work, at his place of work, and outside his home and work. Tony's observations were recorded as part of a larger study (Valdovinos et al., 2016).

Prior to participation, both Brent and Jeremy had indirect and descriptive assessments that indicated that their SIB was likely to be multiply maintained by automatic reinforcement and escape from demands. Tony's functional analysis also identified SIB was maintained by escape and automatic reinforcement.

Data Collection and Dependent Variables

Session duration for Brent and Jeremy was 10 min and 60 min for Tony and all observations were video recorded. We used ProCoderDV (Tapp & Walden, 1993) and Noldus' The Observer ® XT software and a continuous and timed-event sampling procedure to code each video for instances of SIB. Four topographies of SIB were coded: head hitting, head banging, body hitting, and self-biting. Head and body hitting were defined as any instance in which the participant used any part of their hand or an object to make contact with any area of the head, face, or body with sufficient force to produce a sound. We defined head-banging as any instance in which the participant's head contacted a piece of furniture, door, window, or wall with sufficient force to produce a sound. We defined self-biting as any instance in which Jeremy's hand made contact with his teeth for at least 1 s.

Interobserver agreement

Interobserver agreement (IOA) was calculated for 33–36% of videos for all participants. A second observer independently coded these videos using the same technology and procedures as the primary observer. Point-by-point agreement percentages were calculated based on a 3 s window of agreement. The percentage of agreement was calculated as the number of agreements divided by the number of agreements plus the number of disagreements and multiplied by 100. Across topographies of SIB, Brent's average IOA was 96.8% (94.4–100%); Jeremy's average IOA was 86.8% (84.6–90.0%); and Tony's average IOA was 95.4% (50.0–100%).

Data analysis

We used the Multiple Option Observation System for Experimental Studies (MOOSES) software (Tapp, Wehby, & Ellis, 1995) to complete all data analyses. For each participant, we obtained total frequencies of SIB for each session, which were then converted to a rate measure by dividing the total number of instances of SIB during each session by the duration of the session. We also used an event lag with pauses method of sequential analysis (Lloyd, Yoder, Tapp, & Staubtiz, 2016) to estimate SIB-SIB contingencies for each session as described in Courtemanche et al. (2018). For each session, in the MOOSES file, 10 s pause events were inserted to represent 10 s periods in which no SIB occurred. Then, for each session, event pairs were tallied into a 2×2 contingency table. Pairs representing the sequence of interest (SIB-SIB) were tallied in Cell A. Cell B included event pairs with SIB as the first event and a pause as the second event (SIB-Pause). Event pairs with a pause as the first event and SIB as the second event were tallied in Cell C (Pause-SIB). Event pairs with of two pauses were tallied in Cell D (Pause-Pause).

Operant Contingency Values (OCV) were then calculated for each session from the 2×2 contingency tables to determine the direction and strength of the SIB-SIB contingency for each session. OCV values were not calculated for sessions in which the rate of SIB was zero.

OCVs were calculated as the probability of SIB given the presence of SIB ($A / A + B$) minus the probability of SIB given the absence of a prior instance of SIB ($C / C + D$). OCVs range from -1 to 1 . Positive values indicate that an occurrence of SIB was more likely to occur in the presence of another SIB occurrence than in its absence. Negative values indicate that an occurrence of SIB was less likely to occur in the presence of another SIB occurrence than in its absence. Zero values indicate an occurrence of SIB was equally likely to occur in the presence or absence of another SIB occurrence.

Design

For Brent and Jeremy, we utilized a multiple baseline design across two participants to evaluate the effects of noncontingent access to preferred items on the rate of SIB and the strength and direction of the SIB-SIB association. For Tony, an ABAB design was used to evaluate the effects of an environmental antecedent modification, specifically going to work or staying home from work, on the rate of SIB and the strength and direction of the SIB-SIB relationship.

Procedures for Brent and Jeremy

Duration-based preference assessment.—For Brent and Jeremy, a preference assessment was conducted to identify possible items with which participants would appropriately engage (Ahearn, Clark, DeBar, & Florentino, 2005). An informal interview was first conducted with staff members to identify potential items for each participant. Participants were given one item at a time and the investigators modeled how to use the item. The participant then had a total of 3 min in which they could engage in with each item. Engagement was defined as any time that the participant was actively manipulating the item. A 10 s whole interval system was used to score engagement. For each 10 s interval, if the participant engaged with the item for the entire 10 s, the interval was marked as a “+.” If the participant was not engaged with the item for the entire 10 s, the interval was marked as a “–.” The percentage of intervals in which the participant engaged with each item was calculated by dividing the total number of intervals in which the individual engaged with the item by the total number of intervals. Each participant was given the opportunity to engage with each item on three opportunities across three days. An average percentage of intervals in which the participant engaged with each item across the three opportunities are presented in Figure 1.

Based on the results of the preference assessment, Brent’s most preferred activity was swinging on a park swing. Jeremy’s preferred engagement activities were pulling and tugging on braided exercise bands that were attached to the ceiling next to his seat while riding in the group home van and holding whiffle balls up to his ears. At home, his preferred items were whiffle balls and toy cars.

Preferred Items Absent.—During this condition, staff members provided participants with social praise and/or edible items on an average of once every minute contingent on the absence of SIB. These were the current procedures that were being using to address SIB; thus, these procedures continued to be used during this phase. There were no other

programmed consequences for instances of SIB and no preferred items were available to the participants.

Preferred Items Present.—During this condition, participants had noncontingent and continuous access to the activities identified in the preference assessment. For Brent, a park swing was installed in his garage to which he had continuous access. Jeremy had continuous access to the braided bands and whiffle balls for the duration of the van ride and had access to the whiffle balls and toys cars while at home. The participants also received behavior-specific praise on a variable interval schedule of once every minute contingent on appropriate engagement with the preferred items (Horner, 1980).

Procedures for Tony

For Tony, there were nine total observations in this study in which antecedent modifications were made. The first three observations served as the baseline and Tony went to work as he normally would. The next two observations were ones in which Tony did not attend work and stayed home. Then, a reversal to baseline occurred for one observation, followed by three additional observations in which he did not attend work.

Results

Figure 2 displays the effects of providing noncontingent preferred items on both the rate and temporal distribution of SIB for Brent and Jeremy. The x-axis represents each session. The left y-axis denotes the rate of SIB per session (closed circles) and the right y-axis denotes the strength of the SIB-SIB association (open bars). When the preferred activities were absent, there was a steep increasing trend in the rate of Brent's SIB (ranging from 19.8 to 33.9 instances/min) with strong positive SIB-SIB associations across sessions (0.4–0.66). When Brent had access to the swing, there was a large, immediate change in level in the rate of SIB with stable low rates of SIB across the remaining sessions (ranging from 0 to 7.1 instances/min), with little to no changes in the strength of the SIB-SIB contingencies compared to baseline. For Jeremy, the rate of SIB was variable in the absence of the preferred items (ranging from 2.4 to 11.7 instances/min) with relatively strong positive associations between instances of SIB (0.33–0.58). After providing Jeremy access to the preferred activities, there were slight reductions in the overall rate of SIB compared with moderate variability in the rate of SIB (ranging from 0 to 4.0 instances) from sessions to session. For Jeremy, there were little-to-no changes in the strength and direction of the SIB-SIB contingencies across sessions and conditions.

Figure 3 depicts the effects of the environmental antecedent modification on both the rate and temporal distribution of SIB for Tony. The x-axis represents each of the nine observations. The left primary y-axis represents the rate of head banging per observation, which is denoted by the line bar on the graph. The right secondary y-axis signifies the strength of the SIB-SIB relationship and is depicted with the bars on the graph. During baseline, the rate of head banging increased for the second observation, with a slight decrease for the third. Additionally, there was a strong SIB-SIB relationship, with OCVs increasing from 0.33 to 0.6. After the introduction of the antecedent modification, rate of SIB decreased substantially; however, the SIB-SIB association was relatively unaffected by

the antecedent modification (0.53 OCV). When Tony returned to work for one session, there was an increase in the rate of head banging and in OCV (0.82). Once Tony stopped attending work, the rate of SIB decreased and slightly negative OCV values were obtained (-0.01 to -0.02).

Discussion

The purpose of the present study was to assess the relationship between the rate and temporal distribution of SIB when specific environmental antecedent modifications were made. The three participants in this study engaged in frequent and sequentially dependent SIB across all the majority of conditions and sessions. These results reproduce others' results that have reported that for many individuals with SIB living in institutions and community settings, the best predictor of SIB is a previous instance of SIB (Courtemanche et al., 2018; Kemp et al., 2008; Marion et al., 2003; Sandman et al., 2008; Sandman et al., 2002).

Additionally, the antecedent manipulations produced changes in the rate of SIB. Although the rate of SIB was substantially different during these antecedent manipulations, both manipulations only had a slight effect on the strength (and in a small number of cases, direction) of the SIB-SIB contingency. Meaning, although the rate of SIB changed, the likelihood of instances of SIB occurring close together in time did not change. For these three individuals, one instance of SIB predicted more instances of SIB regardless of whether those environmental variables (preferred items or attending work) were present or absent. These results suggest that even though the behavior may have occurred less often when the antecedent manipulation was present, when SIB did occur there was an increase in the likelihood that additional instances would occur. Once these participants began to engage in SIB, they may have engaged in several instances of the behavior closely together in time. For some individuals, once they begin to engage in SIB it may be difficult to interfere with the behavior and instances of SIB that are frequent and occur quickly together in time have the potential to cause serious injury. As such, antecedent interventions seem like an important step in the prevention of SIB from happening at all (reducing rate), although in the current study, the antecedent manipulations only reduced the SIB-SIB contingency slightly. Future researchers might assess how the effects of consequence-based interventions affect the strength of SIB-SIB contingencies over subsequent applications.

The current study provides a unique analysis of treatment effects using the addition of temporal distribution, which could be used as a measure to inform treatment options and a measure of treatment efficacy. However, the results of the current study should be interpreted considering the following limitations. Across both studies, only three individuals participated and all participants had long standing SIB with treatment failures. As a result, the outcome of this study may only apply to this type of population. Additionally, observation times were relatively short and as such may not provide an estimate of the effects of the antecedent manipulations for a longer duration of time or in other settings. Finally, Tony's data did not follow similar patterns as the other two participants in the final phase of the reversal design. It is possible that there were insufficient incidents of SIB to accurately assess contingency estimates as the rate of SIB decreased in the final condition.

Despite these limitations, data from this study provide some support that environmental antecedent modifications can reduce the rate of SIB, but may only have a slight effect on the predictive nature of SIB (i.e., OCVs did not change with the manipulation of the antecedent variables). Given that OCVs were relatively unaffected, for these participants, it is likely that SIB will continue to occur once it has been emitted. Therefore, it is important to focus treatment methods on controlling antecedents that may evoke these harmful behaviors.

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Figure 1.

Average percentage of intervals with engagement across items for Brent and Jeremy. *Note.* * indicates items that were chosen.

Figure 2. Rate of self-injurious behavior and OCV values during times when preferred items were present and absent. *Note.* SIB-Self-Injurious Behavior; OCV-Operant Contingency Value

Figure 3. Rate and OCV values for head banging. Dashed line indicates manipulation of the antecedent (i.e., whether he attended or did not attend work). *Note.* SIB-Self-Injurious Behavior. OCV-Operant Contingency Value