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The Effects of Physical Activity on Self-Injurious Behavior

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THE EFFECTS OF PHYSICAL ACTIVITY ON SELF-INJURIOUS BEHAVIOR

A Thesis

by

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ABSTRACT

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Auto-mutilation is a maladaptive coping mechanism and a major problem confronting behavioral medicine with no known treatment to date to place the behavior on complete extinction. The purpose of this experiment is to examine the possible beneficial effects of running relative to caffeine-induced SIB. Female Sprague Dawley rats (n = 4) served as subjects with each having a different extended baseline and treatment condition. Visual analysis of a multiple baseline graph did not support the hypothesis that as treatment (physical activity) was implemented SIB would decrease. It was found that subjects who drank more caffeinated water had higher amounts of activity in the running wheel. Also found was treatment may have increase auto-mutilation in subjects as opposed to decreasing SIB. This may be attributed to subjects experiencing a higher pain threshold after exercise.

DEDICATION

If not for the love and support given by my family the completion of my MA studies would not have been possible. Their guidance and understanding inspired me to continue my academic endeavors. To my mother, Diana Aguilar, my father, Raul Aguilar, my sisters Selina Benoit and Kasandra Aguilar, I wholeheartedly am grateful for all that you have done, are doing and will do to prepare me to venture into the world to begin a new adventure in my life. Thank you for your love and patience.

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CHAPTER 1

INTRODUCTION

An aberrant act that is amongst the most unmanageable, expensive, destructive and unpredictable is self-injurious behavior. It has constituted a major problem confronting behavioral medicine for decades and behavioral scientists continue to try to find a cure. Self-injurious behavior (SIB) has been defined as a "maladaptive coping mechanism aimed at regulating affect that may be found within the bounds of any psychological disorder as well as the general population" (Dellinger & Handler, 2006). To this day no known treatment has been found to place this behavior on complete extinction. However, great strides have been made towards treatments that help lower the frequency or intensity of the act (e.g. environment enrichment, medication) and these findings have given us a better understanding of the underlying physiological mechanisms that play a major role in the maintenance of the behavior. Due to the severity and chronic form of the aberrant behavior it poses a serious risk to those who engage in such acts and represents a challenge to those responsible for treating it. Therefore, the phenomenon is placed in a position which creates interest and obligation to continue research on how to further minimize its occurrence and eventually extinguish the act altogether.

Currently there are two leading SIB theories that have attempted to explain why this aberrant behavior occurs and is maintained. Sandman and Hetrick's (1995) "Opiate Mechanisms in Self-Injury" argued that the act of self-injury is associated with either elevated opiate levels or supersensitive opiate receptors. The *analgesia hypothesis* suggests "high-circulating levels of β-endorphin (BE) in individuals with SIB which reduces the perception of pain" (Sandman &

Hetrick, 1995, 130) because of the opioid analgesic state. The *addiction hypothesis* suggests that "the release of opiates after SIB produce pleasure so as a consequence individuals become addicted to their opiate system" (Sandman & Hetrick, 1995, 130), a form of positive reinforcement.

From the perspective that SIB individuals become addicted to their endogenous opiates, it was natural for scientists to investigate opiate blockers to see if they reduce SIB. Naltrexone and Naloxone are known opiate antagonists that have been administered in clinical studies to test the opiate hypothesis. Barrera, Teodoro, Selmeci and Madappuli argued there have been reports of mixed results in these clinical investigations ranging from very dramatic therapeutic demonstrations of improvement (as cited in Walters et al., 1990, p. 173), to no changes (as cited in Beckwith et al., 1986, p. 186; Davidson et al., 1983, p. 3), and even to paradoxical worsening of SIB symptoms in some cases (as cited in Ryan et al., 1989, p. 302). What this evidence may suggest is that there is an irregularity in a specific biological system of some patients.

A study conducted by Swinkels, Buitelaar, Weijner, Thijssen and Engeland (1996) examined levels of plasma β-endorphins in 33 learning disabled people with self-injurious and/or autistic behavior. What was found was that patients under neuroleptic treatment had significantly lower BE levels than subjects without severe SIB. Another result was lower BE levels in subjects with severe SIB than in subjects without severe SIB. Lastly, BE levels of subjects with mild SIB were found to be very close to the mean BE levels of the subjects without SIB. Consequently, severe SIB may be related to functional disturbances in the endogenous opioid system because reduced BE concentrations is the key variable of severe SIB.

According to Gureick, Kohn and Davis (1994), exercise has also been found to release Beta-Endorphins, one type of endogenous opioid that has been implicated in the regulation of

pain. Increased blood concentrations are associated with increased vigorous exercise. This results in higher pain thresholds in those who engage in physical activity because of a self-induced analgesic state.

It can be argued that because a maintaining variable consistently reinforces both SIB and exercise, and does so at a basic molecular level because endogenous opioids may act as reinforcers, the individual is likely to repeat such behaviors (i.e., working out or self-injury). It is by looking at the function of the behavior that one may begin to try to find a solution to the problem. Therefore, a functional analysis of overt activity with and without exercise may yield information that can be applied in a therapeutic setting.

A different approach to studying SIB has focused on enrichment of the individual's environment and found to be related to decrease SIB. This may be due to the "competition between one or more alternative sources of stimulation and the stimulation provided by aberrant behavior (Ringdahl, Volmer, Marcus, & Roane, 1997, 204)." A study conducted by Iser, DeLeon and Fisher (1999) evaluated the effects of an enriched environment on SIB and negative affect. Both SIB and signs of negative affect were reduced with an enriched environment.

Is it then possible to differentially reinforce another more appropriate behavior such as physical activity to receive the same positive reinforcement of endorphin production? Can enrichment of the environment be a stimulus that promotes exercise, specifically, running? The present study will examine the possible adaptive effects of running relative to caffeine-induced self-injurious behavior in laboratory rats. In order to promote physical activity the subjects will have their environments enriched with stimuli that promote exercise. The independent variable tested was the exercise enriched environment while the dependent variable was the measurement

of SIB. The following hypothesis was tested: An increase in physical activity in an exercise enriched environment will result in a decrease of SIB.

CHAPTER II

METHOD

Animals

Subjects utilized were 12 Sprague Dawley rats ranging in body weight from 200g to 250g. A young cohort ranging in age from three to six months was used because "percent mortality to caffeine is greater… in older than in younger rats" (Peters, 1967, 144), and the selected gender was female since it has been found in previous research that females are three times more susceptible than males". (Ferrer, Costell & Grisolia, 1982, 276). The twelve subjects were randomly assigned into three groups of four and cohorts would be exposed to the experimental protocol until a maximum of four test subjects were attained. Cohort one was the only cohort that completed the entire experimental protocol because it met the criteria standards required in a single-subject, small *n* design.

Drugs

A reproduction of Portoles, Minana, Jorda, and Grisolia (1985) caffeine administration procedures was conducted on the first four subjects once they were placed in the experimental apparatuses. When the cohort completed the experimental protocol they were euthanized. The subjects were fed a standard diet and caffeine in the form of alkaloid monohydrate, U.S.P., in their drinking water which was available *ad libitum* in the activity apparatuses during pre-treatment, baseline, and treatment conditions. The caffeine was administered gradually so subjects became accustomed to the different doses; 2g/l the first three days, 4 g/l the next three days and finally 8g/l the last four to six days, depending on the time needed for the rats to show

symptoms of self-mutilation. Sucrose at 100 g/l was added to the caffeine solution to mask the bitter taste. The subjects received 8g/l caffeine with 100 g/l sucrose from day seven of the caffeine phase until the end of the experimental protocol. The subjects were individually housed in activity apparatuses in a light and temperature controlled room. Rats not participating in the experimental protocol were housed individually in another location.

Measurements

Water intake was recorded every third day starting from the beginning of the caffeine phase to determine self-administered dosing. Knowing the amount of water consumed became a variable examined in relation to SIB that was evoked in each subject.

The tissue damage rating scale from Turner et al. (1999) was used when injuries were examined and the examination procedures from Kies and Devine (2004) were replicated and consisted of visual inspections of each rats head, forepaws, ventrum (ventral thorax and abdomen), hindpaws, and tail. These examinations were closely videotaped and the presence of injuries was scored *in vivo* by the experimenter and a trained observer.

The rats were checked every morning and evening, but evening scores were not included in data analysis. Evening examinations were conducted solely as a precautionary measure to make certain no subjects that had injured themselves would be left overnight without intervention. Animals displaying open lesions scored at level four on the rating scale were immediately euthanized.

A partial interval recording system was utilized to gather data on the frequency of self-injurious behavior after caffeine administration. The subject's behavior was observed for thirty minutes, three times a day, and each session was recorded on a video camera. Daily percentages of self-injurious behavior were scored individually by video tape, and the severity rating scale

was scored *in vivo* by two trained observers. Agreement between two trained observers was calculated for all response topographies analyzed and 100% inter-observer agreement was reached (total agreements ÷ total number of intervals × 100 = % Agreement). Hence, each animal had a total observation period of one hour and thirty minutes a day to record the frequency per minute of SIB. One thirty minute session was one hour after their light cycle had begun; the second thirty minute session was from 11:30a.m. to 12:00 p.m. which was the thirty minutes before treatment and the last session was from 6:00pm-6:30pm which was after treatment had finished for that day. Each minute was divided into fifteen second intervals. An interval was scored with a "Y" if SIB was observed during the interval or an "N" if no SIB was witnessed during the interval.

Self- injury was operationally defined as the following:

1. Manifestation of biting or gnawing on limbs, appendages, tail, or any other selected locations on the surface of the animals own body whether it does or does not cause tissue damage.
2. The vacuous jaw movements such as chewing with nothing in the mouth or gnawing movements also licking not associated with grooming.
3. The plucking of fur from the body with forepaws or mouth distinguishable by a heavy localized loss of fur.
4. The scratching of any selected location on the surface of the animals own body that is not associated with grooming.
5. Any consumption of bedding material.

   As soon as any animal was found to show a level four on the SIB rating scale they were euthanized.

Statistical Analysis

Correlation analysis was used to examine the relationship between water consumption and self-mutilation.

Based on equipment availability of four running wheels a small *n*, single-subject multiple baseline design across subjects was used. Baseline periods ran for three, five, seven, and nine days. This created a four tier design with eight phases including both a baseline and treatment phase with one subject completing each phase. After the designated cohort had completed the entire protocol, data were analyzed and all or most of the six features used to examine within and between phase data patterns as recommended by Kratochwill (2010) were examined: (1.) level-the mean score for the data within a phase, (2.) trend- the slope of the best-fitting straight line for the data within a phase, (3.) variability-the range or standard deviation of data about the best-fitting straight line, (4.) immediacy of the effect-the change in level between the last three data points in one phase and the first three data points of the next, (5.) overlap-the proportion of data from one phase that overlaps with data from the previous phase, and (6.) consistency of data patterns across similar phases-looking at data from all phases within the same condition and examining the extent to which there is consistency in the data patterns from phases with the same condition. These characteristics were the criteria used for demonstrating evidence of a relationship between the independent variable and the outcome variable.

Experimental Procedure

Pre-Treatment Conditions. Before introducing caffeine laced water the twelve subjects were randomly assigned to three cohorts of four.

All twelve subjects were placed on a feeding schedule in which they received food *ad libitum* for the entire duration of the experimental protocol. This was to assure enough food

consumption occurred to reduce the effects of caffeine toxicity that can be caused by food deprivation. Evidence of caffeine toxicity may consist of diarrhea, body or head shake, audible teeth chattering, ptosis, and can, at high levels, result in death. Cohort one began the caffeine phase first. During the caffeine phase subjects had their food and water filled at 9:00 a.m. and water intake was recorded every third day. For the first three days the water had 2g/l caffeine + 100g/l sucrose. The next three days, the water contained 4 g/l caffeine + 100g/l sucrose. Depending on the time needed for the rats to show symptoms of self-mutilation subjects then received water containing 8 g/l caffeine + 100g/l. This dose continued until the entire protocol was complete. The caffeine was increased and administered gradually so the subjects became accustomed to it while simultaneously being monitored for evidence of SIB. Data on water consumption were collected once every third day beginning from the first day of the caffeine phase. Therefore, on days 3, 6, 9, 12 etc. water intake was measured. Data collection on the dependent variable began once subjects exhibited SIB.

Baseline Phase. During the baseline phase SIB data were collected for three, five, seven, and nine days with no treatment implementation. During the baseline phase subjects received food and caffeine laced water at 9:00 a.m. with water intake being recorded every third day. From 10:00 a.m. to 10:30 a.m. the first SIB data recording was conducted. At 10:30 a.m. subjects were examined using the Turner Tissue Damage Rating Scale. From 11:30 a.m. to 12:00 p.m. the second SIB data recording took place. Between 12:00 p.m. to 6:00 p.m. subjects had access to a locked running wheel that prohibited usage. Beginning at 6:00 p.m. to 6:30 p.m. the third set of SIB data was recorded and at 6:30 p.m. to 7:00 p.m. the final tissue damage rating scale was collected before lights out.

Treatment Phase. During the treatment phase data were collected for the designated subjects for the remainder of the experimental protocol with the treatment implemented. During the treatment phase subjects were placed on the same schedule as during baseline, however, during this phase they were given access to an unlocked running wheel from 12 p.m. to 6:00 p.m.

Euthanasia Phase: Once the entire experimental protocol and data collection was completed subjects were given to the proper personnel to be euthanized under the recommended guidelines set by the American Veterinary Medical Association.

CHAPTER III

RESULTS

Sample output: Table 3 shows the amount of caffeinated water that was ingested by all four subjects prior to baseline, during baseline, and during treatment phases. As caffeine doses were augmented Figure 1 depicts a gradual increase in water consumption visible in all four subjects. Subjects one and four consumed the most caffinated water and were recorded to have exerted the most physical activity in the running wheel when revolution data were analyzed. Subjects two and three drank the least of the four, and they exerted the least of physical activity in the running wheel. The two subjects (2, 3) that exerted the least physical activity and drank the least caffeinated water also did not complete the experimental protocol due to caffeine toxicity. Based on a study conducted by Peters (1966), oral administration of a drug on an empty stomach usually increases its toxicity. Therefore, efforts to reduce caffeine toxicity in the present study were made by having food available *ad lib*. However, caffeine toxicity did occur and resulted in subject two dying before euthanasia could be carried out and subject three being euthanized once catatonic behaviors were witnessed. The negative side effects could be attributed to dehydration since caffeine is a known diuretic and the data provide evidence of the subjects' low water intake when compared to the two subjects that completed the study. Also, the simultaneous effects of dehydration and caffeine toxicity may have been the reason for the negative effects exhibited in these two subjects.

As evident from an examination of Figure 3, subjects that did not complete the experimental protocol peaked at a SIB severity rating of level three. Only on the last day for subject three was a rating of four given when obvious catatonic behaviors were exhibited and euthanasia was required. Subject one showed a high level of activity wheel usage, variability in SIB measurements during the treatment phase, but also did not advance to a SIB severity rating of one until the last day of treatment indicating that caffeine itself may not have induced severe SIB, but rather that the treatment may have had an effect of increasing the severity of self-mutilation. Subjects two and three had minimal or no running wheel usage. This may be attributed to the on-coming effects of caffeine toxicity, dehydration, or both. Subject four had the highest amount of physical activity and the highest amount of variability on SIB during the treatment phase.

Visual Analysis: As mentioned previously, characteristics suggested by Kratochwill (2010) were used for demonstrating evidence of a causal relationship between the independent variable (physical activity) and the primary dependent variable (SIB).

Level: The mean score for the data within a phase. The recording sessions taken each day were analyzed and percentages based on that footage were calculated to represent the amount of time subjects were engaged in SIB (Total "Y" ÷ Total Interval × 100 = % SIB). To evaluate whether there was a difference in the level between the baseline and treatment phases for each subject, SIB percentages were used to compute the mean score to analyze if the average SIB percentages differed between phases. Subject one had a baseline mean of 6.3% SIB compared to a treatment had a mean of 5.3%. Subject two's mean during baseline was .11% and during treatment the mean increased to .5% SIB. Subject three exhibited a mean score of .84% SIB and during the treatment phase the mean increased to 1.6% SIB. Subject four displayed a mean at

baseline of 2.12% while treatment SIB increased to 2.34%. All subjects except for subject one showed a gradual increase in SIB percentages during their treatment phase when compared to the mean score of their baseline phase. Subject one did not display this increase however, subject one was also the lowest scorer on the severity rating scale which could also have contributed to the overall low mean score for SIB.

Trend: The slope of the best-fitting staight line for the data within a phase. All subjects show a decreasing slope in the best-fitting straight line indicating a downward trend in SIB responding. According to Johnston and Pennypacker's (2009) "Strategies and Tactics of Behavioral Research" there can also be circumstances in which trends may be considered stable patterns of responding. Therefore, in the current study procedures did produce a trend of stable patterns of responding in baseline phases for subjects 2,3, and 4 but, a stable trend was notshown in their treatment phases. Indicating a causal relationship may be present between the independent variable (exercise) and the dependent variable(SIB).

Variability: The range or standard deviation of data about the best fitting straight line. Subject one had a range of 18.33% for baseline, 21.23% for treatment and showed drastic variability in rate of SIB both in baseline and treatment phases. Subjects two had a range of .31% for baseline and 1.11% for treatment, subject three had a 1.67% range for baseline and 4.44% range for treatment, and subject four had a range of 1.94 % for baseline and 6.67% for treatment. The range(width of a data set) is larger during treatment phases for all four subjects. Subjects two and three exhibited steady rates of behavior on the dependent variable during baseline phases and a larger amount of variablility within their treatment phases. Subject four shows a larger range in variabliltiy between data points in baseline than in treatment, however, steady rates of behavior are evident at the end of baseline making the variability seen throughout

the entrie duration of the treatment phase a significant feature to look at. Variability is visually represented in all treatment phases for these subjects. The cause of the variability may be due to an extinction burst or a causal relationship with the independent variable. Longer treatment phases might have established a clearer basis for the cause for this variability.

Immediacy of Effect: The change in level between the last three data points in one phase and the first three data points of the next. Subject one had a dramatic immediacy of effect from baseline to treatment with the three data point in baseline being at18.61%, 0% and .28% and the first three data point for treatment being at 21.23%, 10% and .6% SIB. Subject two's last three baseline data point was .28%, 0% and 0% while the first three data point for the treatment phase increased to .28%, 1.11% and 1.11% SIB. Subject three exhibited 0%, 0% and .6% for baseline and .56%, 4.72%, and .28% SIB for the first three data point during treatment while subject four showed 0%, .56% and 1.94% during baseline and 1.67%, 6.67% and 1.39% for the initial three data point during treatment. While examining the last three data points in the baseline phase and the first three data points in the treatment phase immediacy of effect is evident in all four subjects.

Overlap: The proportion of data from one phase that overlaps with data from the previous phase. The smaller the proportion of ovrlapping data points (the larger the separation), the more compelling the demonstration of an effect. In Table 4 data points for each day, per subjects, are shown and highlight the amount of overlap seen with the data. Subject one only had one data point (21.23%) that does not overlap with baseline points. Subject two had two data points (1.11% and 1.11%) that do not overlap with baseline data points. Subject three had only one data point (4.72%) that did not overlap with baseline data points and with subject four, all data points in the treatment pahse overlapped with data points in the baseline phase.

Consistency of Data In Similar Phases: Looking at data from all phases within the same condition and examining the extent to which there is consistency in the data patterns from phases with the same conditions. Subjects two, three and four, did demonstrate similar patterns of responding during baseline phases, and all three showed some degree of variability in SIB measurements within their treatment phases. This consistency of variability within the treatment phase after steady rates of behavior had been established in baseline phases increases the probability that the independent variable (physical activity) had a causal effect on the dependent variable (SIB).

CHAPTER IV

DISCUSSION

The purpose of this study was to examine the effects of physical activity on self-injurious behavior. The hypothesis tested was that the implementation of physical activity in an exercise enriched environment would decrease self-injurious behavior in subjects. Visual analysis of 1) level, 2) trend, 3) variability, 4) overlap, 5) immediacy of the effect, and 6) consistency of data patterns across similar phases were used to assess whether the data demonstrated at least three indications of an effect at different points in time.

Once data were analyzed the findings ultimately contradict the original hypothesis of physical activity decreasing self-injurious behavior and there is evidence suggesting physical activity actually increases self-injurious behavior. Subjects who exhibited steady state behavior during baseline in the dependent variable (SIB) only showed variability in the dependent variable after treatment (physical activity via running wheel) had been introduced into their environment. The cause of the variability could be attributed to altered pain perception brought on by an analgesic state after exercise or an extinction burst- *the temporary increase in the frequency, intensity, and/or duration of the target behavior once the maintaining reinforcer is removed*. However, the probability of an extinction burst may be low because by implementing the treatment it was never the intention to remove the reinforcing property maintaining the behavior i.e. endorphins. It was simply the intention to try to introduce a more appropriate behavior (exercise) to decrease SIB. Altered pain perception brought on by an analgesic state after

exercise may be more likely to be a causal factor in increasing SIB scores. Future studies should look at endorphin levels of SIB subjects after exercise treatment has been implemented to further investigate changes found during the treatment phase to test these two hypotheses.

In general subjects with high levels of water intake also had an increased level of activity when compared with subjects with lower water intake who had minimal or no running wheel use. Subject one had high running wheel usage, drastic variability in SIB percentages during treatment but, also had no signs of SIB until the last day of treatment when it reached a rating of one. Subject two and three did not complete the experimental protocol. Steady state behavior was documented in both their baseline phases with variability occurring after the treatment was implemented. Also, an increase in SIB, although small, did occur for subjects two and three. Subject four had the longest baseline and longest duration at a rating three on the severity scale. This subject ingested the largest amount of water and also had the highest running wheel frequency. This subject also showed variability in SIB during treatment after having exhibited steady state behavior at baseline.

Several possibilities could explain the different SIB scores for all subjects in their baseline and treatment phases. The first is that only one cohort with a small *n* was used and two out of the four in the cohort did not complete the entire protocol. Also small SIB may have been attained because rats are nocturnal animals and sleep through most of the day making it difficult to capture SIB footage to score. An additional point that made SIB data difficult to score was the positioning of the subject in front of the camera. If the subjects were not positioned perfectly and had their backs facing the camera for example any behavior that may have been categorized as SIB was not caught on tape and therefore not usable. Some video footage showed the subjects were engaged in some sort of activity, but due to poor positioning in front of the camera the

behavior whether self-injurious or not was undistinguishable therefore, not useable. It was previously determined by researchers that the self-injurious behavior needed to be clearly demonstrated by the subject in order to be classified as a "Y" during interval scoring. This created a dilemma because subjects did show distinct physical signs of SIB and had high severity scores on the rating scale, but low SIB percentages because of lack of video evidence. Another possibility for low SIB percentages is that animals were physically examined twice daily and researchers entered the colony room to turn on and off recording devices during each session. This may have contributed to a lack of SIB data collected on the video as well because subjects aggitation, due to handling, may have influenced their self-injurious behavior.

Further studies examing self-injurious behavior should include more subjects and develop the design as having an experimental and control group. Or if a single-subject design is chosen more cohorts should run and complete the experimental protocol to see if results vary with subjects. Other methods need to be developed to collect SIB data so more accurate measures of self-mutilation can be captured. If data had been collected during subjects natural awake hours rather than sleep hours this may have produced different results. To do this a higher quality of video equipment with night vision capabilities would be needed to take advantage of peak SIB times for subjects. Also to gather data on water intake correlating with SIB or physical activity caffeine administration should be administered differently since an accurate record of ingested water was not gathered because water droppers leaked continuously throughout the day and night making it difficult to monitor subjects exact caffeine ingestion. Results gathered were approximations of caffeinated water ingestion. Future studies should also analyze if our independent variable (physical activity) created results specific for caffeine induced SIB or if SIB induced by pemoline or amphetamines in subjects will present the same results of increasing

SIB. Also further studies should look at endorphin levels of subjects before treatment and after treatment to further investigate if an increase in SIB was related to heightened pain thresholds because of a self induced analgesic sate brought upon by exercise.

This study was another stride taken towards the treatment of self-injurious behavior. Even though results attained by studies on rat models is often difficult to apply to human populations the findings in the present study have given us a better understanding of the underlying physiological mechanisms that play a major role in the maintenance of the behavior. Functional analysis should also be considered when working with developmentally disabled populations since the maintenance of self-injurious behavior is often by a function other than automatic reinforcement. More research needs to be done to further analyze treatments used to decrease SIB so that the implementation of treatment is not just experimental but effective.

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APPENDIX A.

APPENDIX A.

Table 1. *Tissue trauma rating scale, adapted from (Turner et al. 1999)*

Score	Severity	Description
0	No SIB	No tissue damage
1	Very mild SIB	Slight edema, pink moist skin, involves small area
2	Mild SIB	Moderate edema, slight erythema, slightly denuded skin, involves medium area, and/or involves multiple sites.
3	Moderate SIB	Substantial edema and erythema, large area, substantially denuded skin, and/or involves multiple sites
4	Severe SIB	Clear/open lesions, and/or amputation of digit, requires immediate euthanasia.

APPENDIX B.

APPENDIX B.

Table 2. *Subject Weight*

Subject	Baseline Weight	After Treatment Weight
1	226g	197g
2	150g	100g*
3	156g	141g*
4	182g	176g

Weight was taken as a baseline measure prior to caffeine administration and a second measure was collected on the last day during the treatment phase. * Subjects did not complete the entire experimental protocol.

APPENDIX C.

APPENDIX C.

Table 3. *Effects of Caffeine on Fluid Intake*

Subject	Session $1_{(2g/1)}$	Session $2_{(4g/l)}$	Session $3_{(8g/l)}$	Session $4_{(8g/l)}$	Session $5_{(8g/l)}$	Session $6_{(8g/l)}$
1	493/500 ML $_{(P)}$	485/500 ML $_{(P)}$	441/500 $ML_{(P)}$	431/500 ML $_{(P)}$	481/500 $ML_{(B)}$	454/500 $ML_{(T)}$
2	495/500 $ML_{(P)}$	486/500 $ML_{(P)}$	478/500 $ML_{(P)}$	476/500 ML $_{(P)}$	484/500 $ML_{(B)}$	472/500 $ML_{(T)}$
3	498/500 $ML_{(P)}$	491.5/500 $ML_{(P)}$	483/500 $ML_{(P)}$	475/500 $ML_{(B)}$	487/500 $ML_{(B)}$	479/500 $ML_{(T)}$
4	488/500 $ML_{(P)}$	485/500 $ML_{(B)}$	468/500 $ML_{(B)}$	463/500 $ML_{(B)}$	472/500 $ML_{(T)}$	463/500 $ML_{(T)}$

Caffeine was administered during all phases of the experimental protocol in their drinking fluid. The experimental conditons were as described in the text.

APPENDIX D.

APPENDIX D.

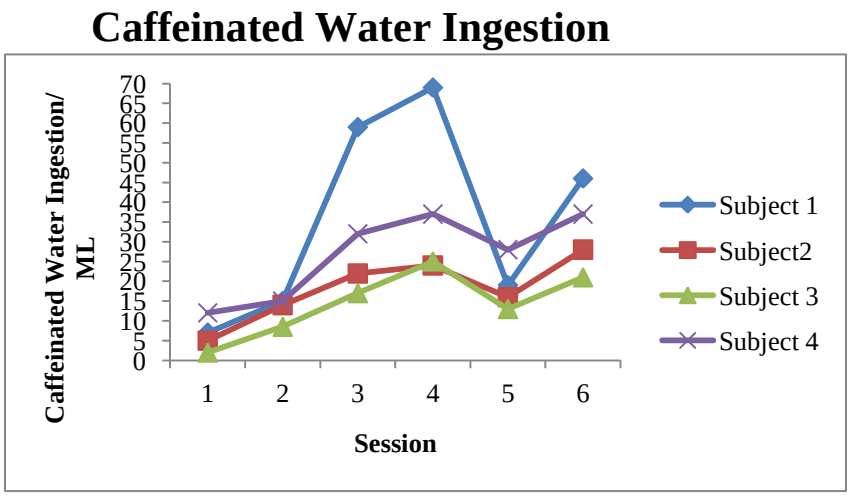

FIG. 1. Water consumption (see table 2) for all four subjects during pre-baseline, baseline and treatment conditions. Water data was collected every third day starting from pre-baseline conditions.

APPENDIX E.

APPENDIX E.

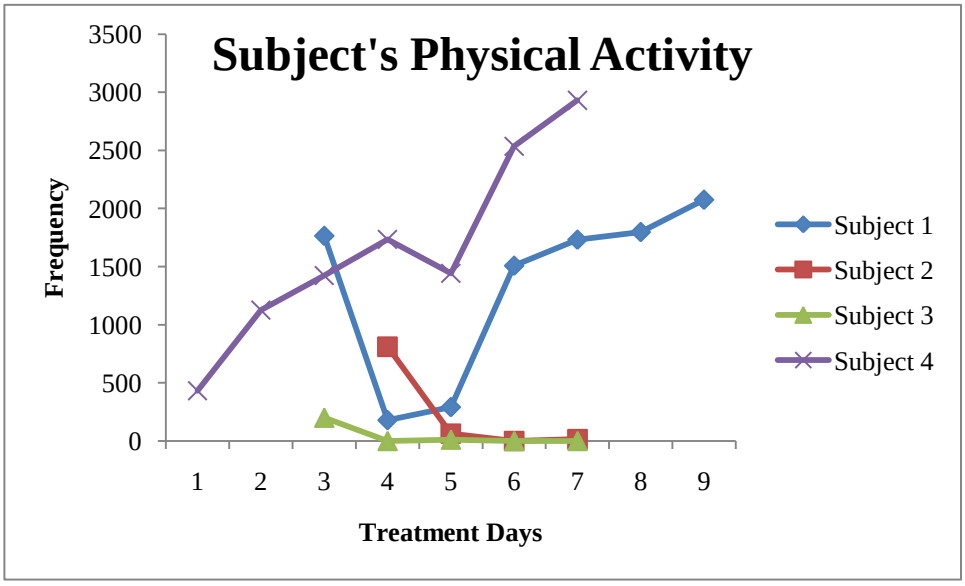

FIG. 2. Revolutions emitted in the running wheel to measure physical activity during treatment phases for all four subjects.

APPENDIX F.

APPENDIX F.

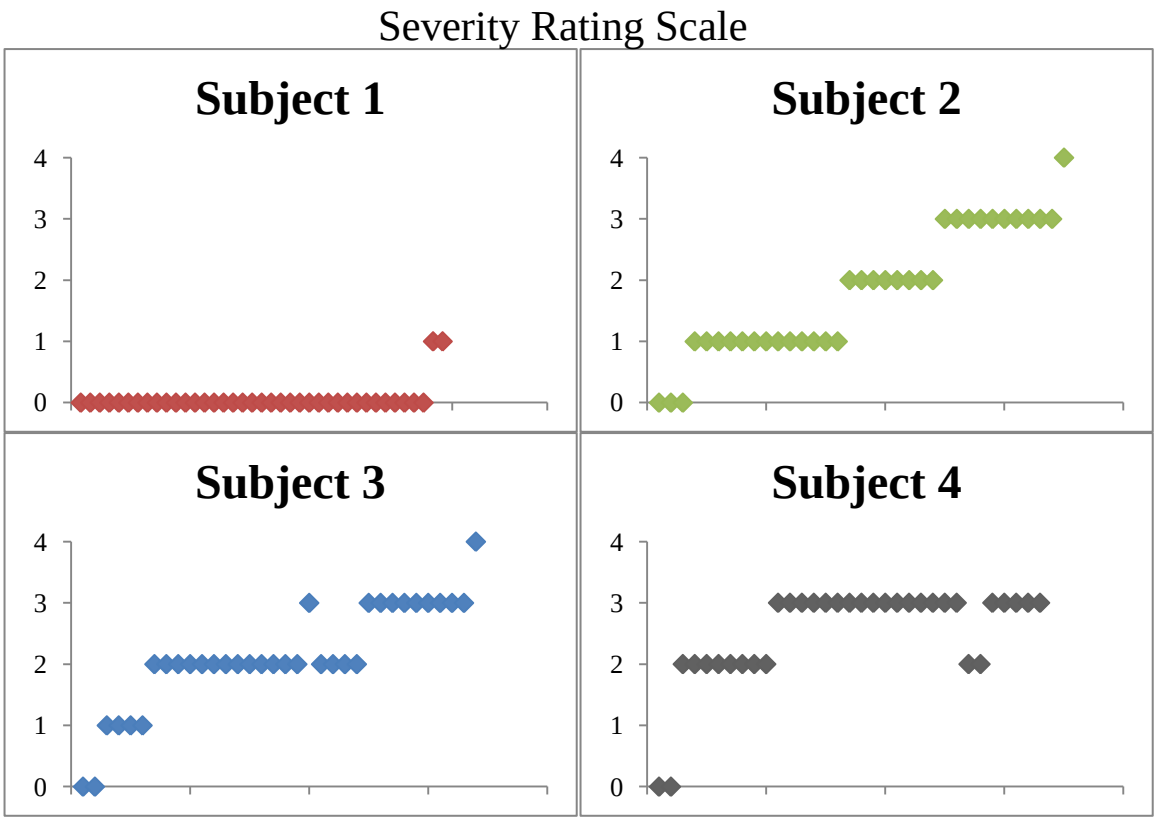

Fig 3. The rat's severity of self-injurious behavior was assessed as detailed in Methods using the Turner Trauma Rating Scale for all four subjects twice daily. 0- (No SIB) No tissue damage; 1- (Very Mild SIB) Slight edema, pink moist skin, involves small area; 2- (Mild SIB) Moderate edema, slight erythema, slightly denuded skin, involves medium area, and/or involves multiple sites; 3- (Moderate SIB) substantial edema and erythema, large area, substantially denuded skin, and/or involves multiple sites; 4- (Severe SIB) Clear/open lesions, and/or amputation of digit, requires immediate euthanasia.

APPENDIX G.

APPENDIX G.

Multiple Baseline Graph: Self-Injurious Behavior

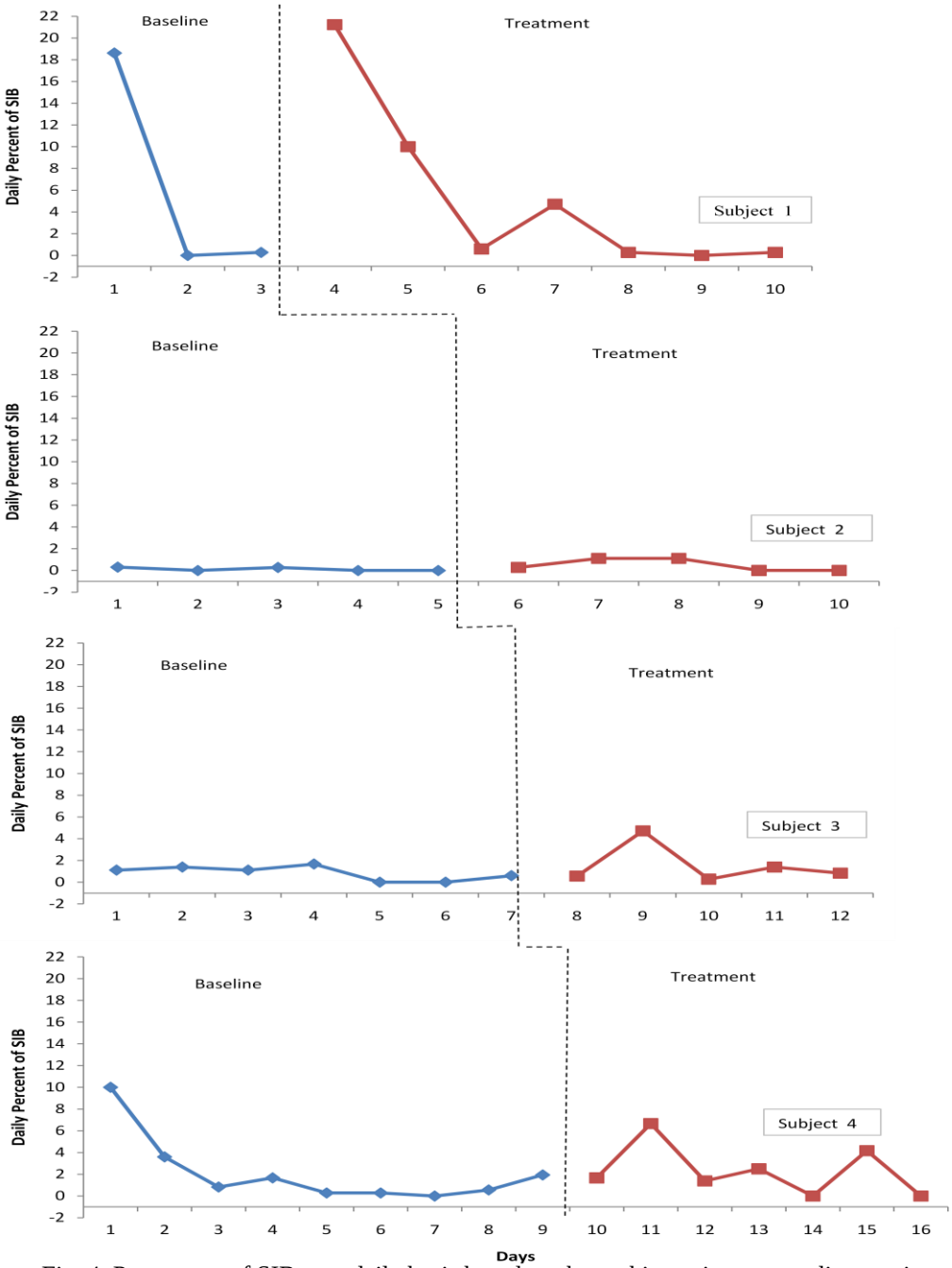

Fig. 4. Percentage of SIB on a daily basis based on three, thirty minute recording sessions where a partial interval recording system was used to collect SIB data for baseline and treatment phases for all four subjects.

APPENDIX H.

APPENDIX H.

Multiple Baseline Graph: Self-Injurious Behavior

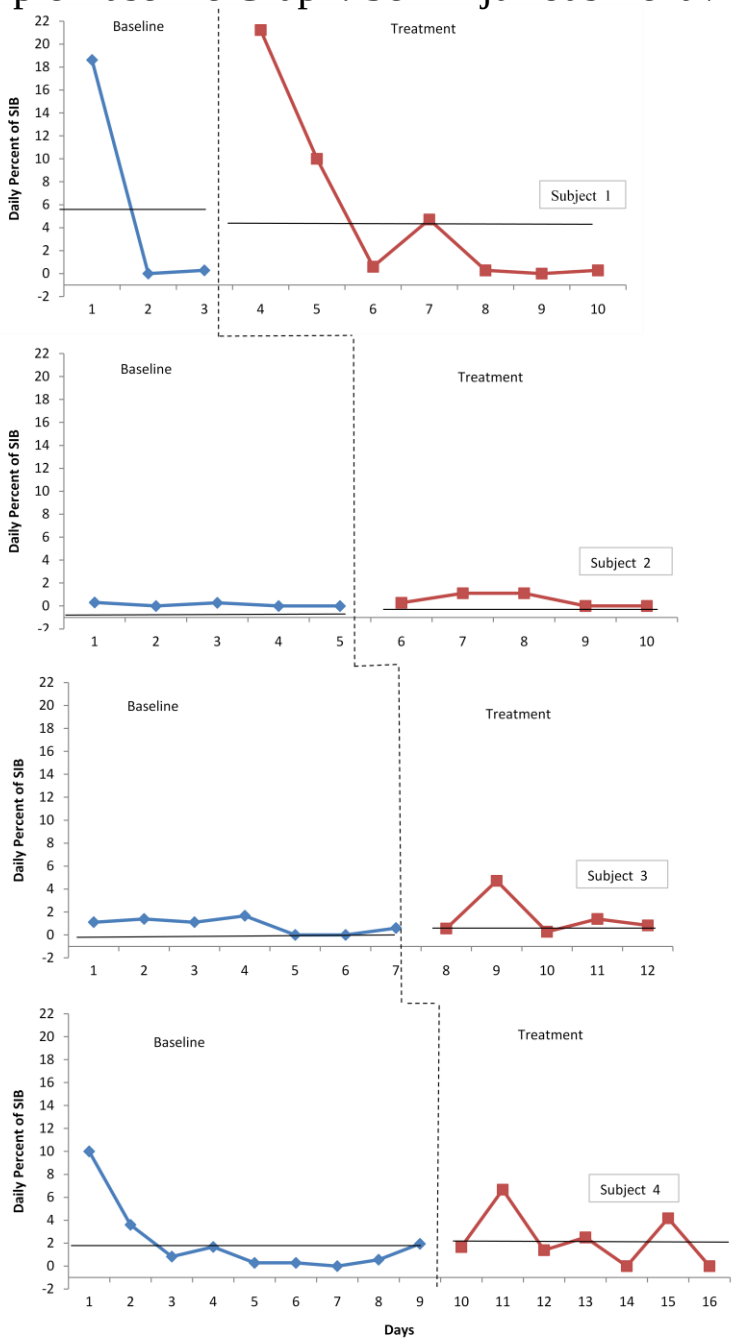

Fig. 5. Percentage of SIB on a daily basis for baseline and intervention phases with the best-fitting straight line included to analyze level and variability.

APPENDIX I.

APPENDIX I.

Multiple Baseline Graph: Self-Injurious Behavior

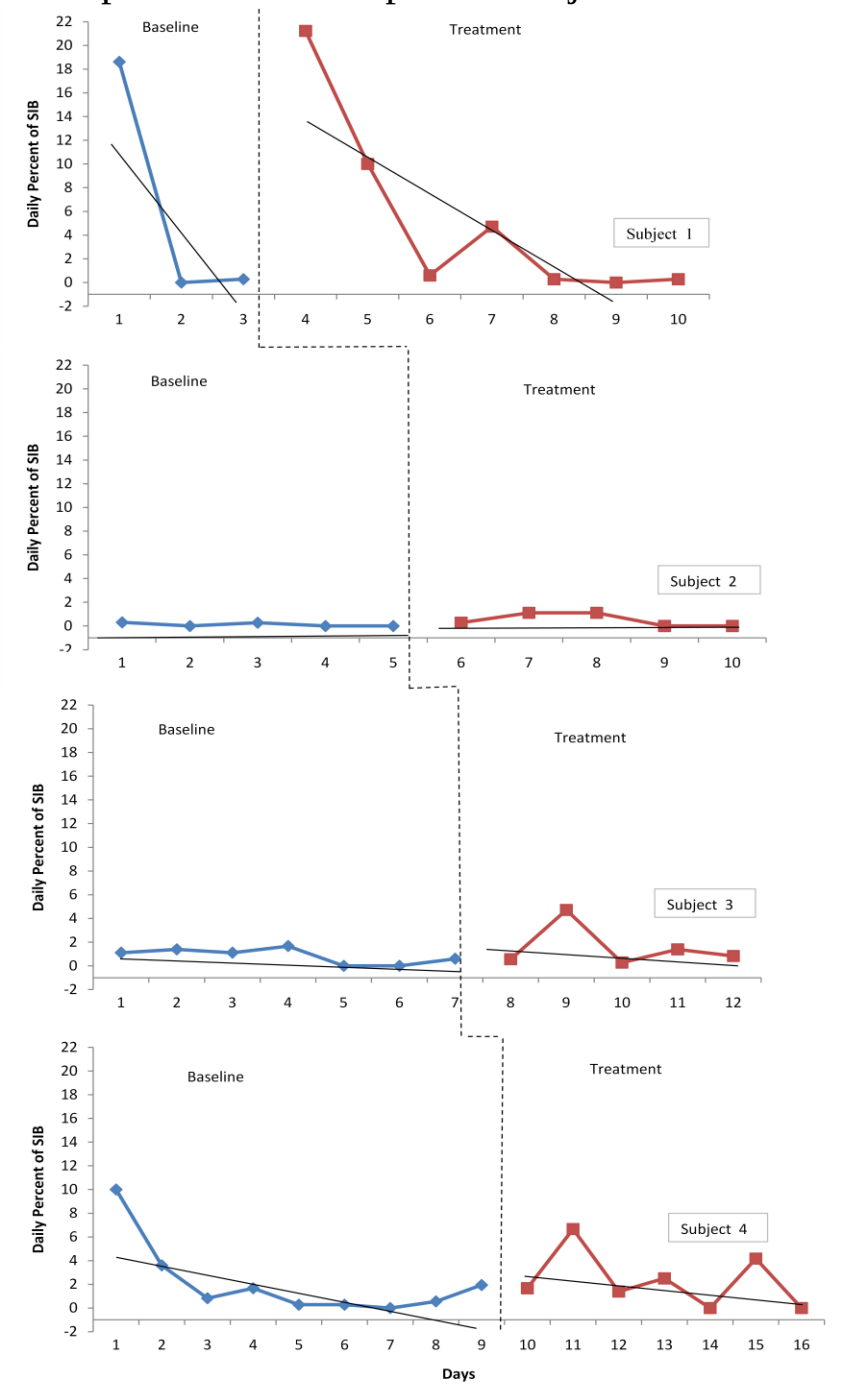

Fig. 6. Percentage of SIB on a daily basis for baseline and intervention phases with the best-fitting straight line included to analyze trending-the slope of the best-fitting straight line for the data within a phase.

APPENDIX J.

APPENDIX J.

Multiple Baseline Graph: Self-Injurious Behavior

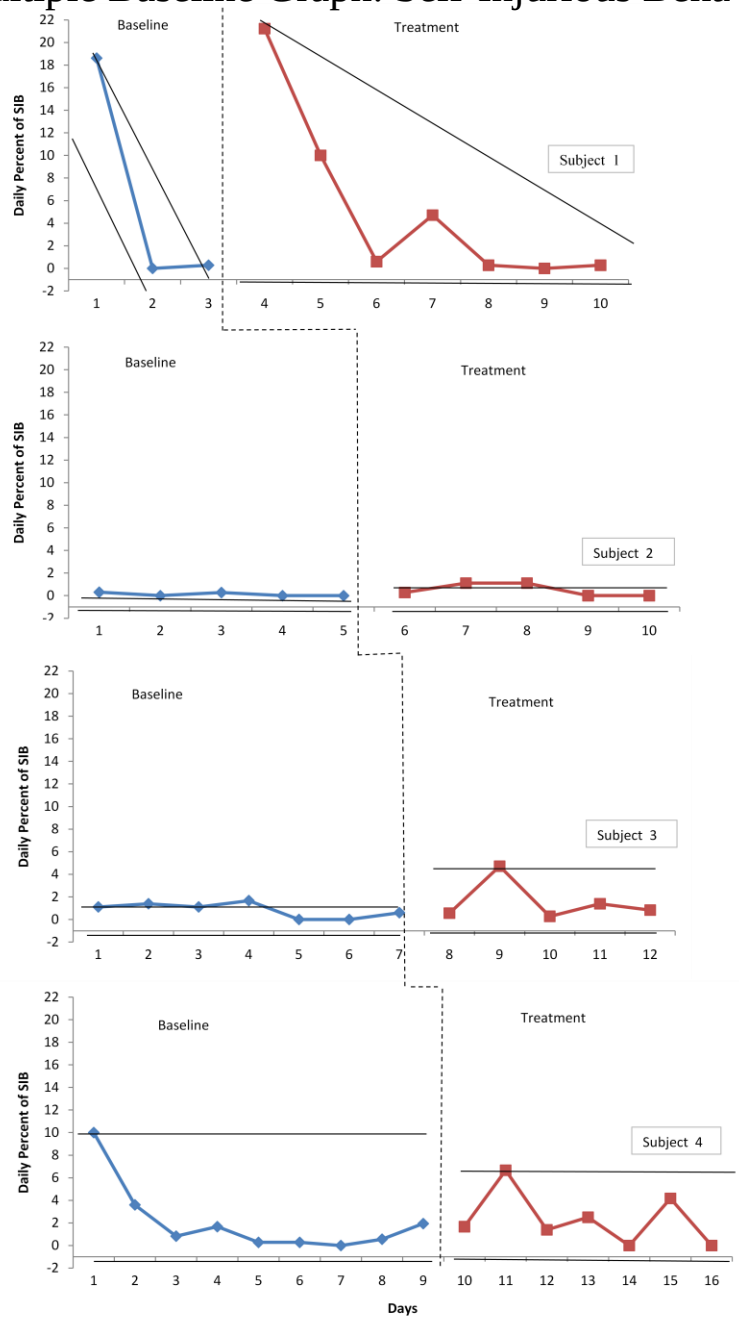

Fig. 7. Percentage of SIB on a daily basis for baseline and intervention phases with the bandwidth for each phase included to analyze variability within a phase.

APPENDIX K.

APPENDIX K.

Multiple Baseline Graph: Self-Injurious Behavior

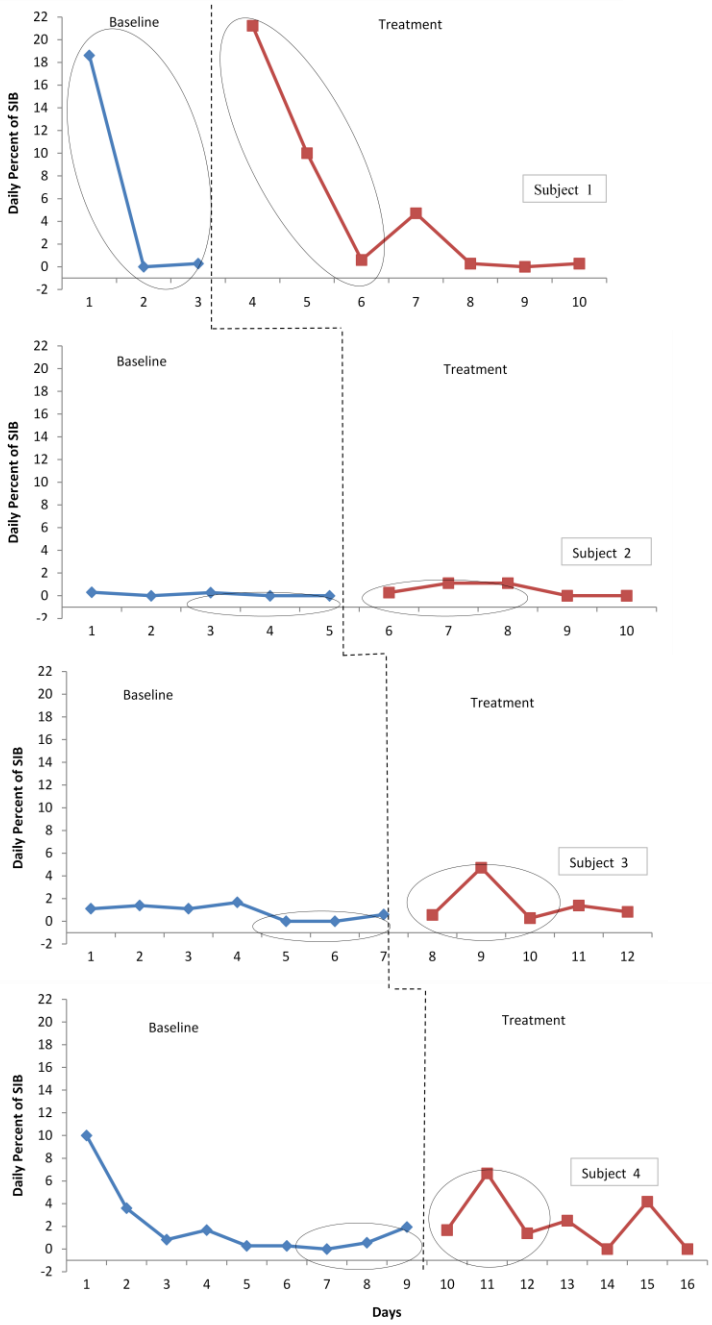

Fig. 8. Percentage of SIB on a daily basis for baseline and intervention phases with the last three baseline data points circled and the first three treatment data points circled to analyze immediacy of effect once the independent variable was implemented.

APPENDIX L.

APPENDIX L.

Table 4. *Self-Injurious Behavior Data Points*

SUBJECT 1		SUBJECT 2	
Baseline	Treatment	Baseline	Treatment
18.61		0.31	
0		0	
0.28		0.28	
	21.23	0	
	10	0	
	0.6		0.28
	4.71		1.11
	0.28		1.11
	0		0
	0.28		0

SUBJECT 3		SUBJECT 4	
Baseline	Treatment	Baseline	Treatment
1.11		10	
1.39		3.6	
1.11		0.83	
1.67		1.67	
0		0.28	
0		0.28	
0.6		0	
	0.56	0.56	
	4.72	1.94	
	0.28		1.67
	1.39		6.67
	0.83		1.39
			2.5
			0
			4.17
			0

Self-injurious behavior percentage data points for baseline and treatment phases for all four subjects. Data points highlighted in yellow did not overlap between phases.

APPENDIX M.

APPENDIX M.

Multiple Baseline Graph: Self-Injurious Behavior

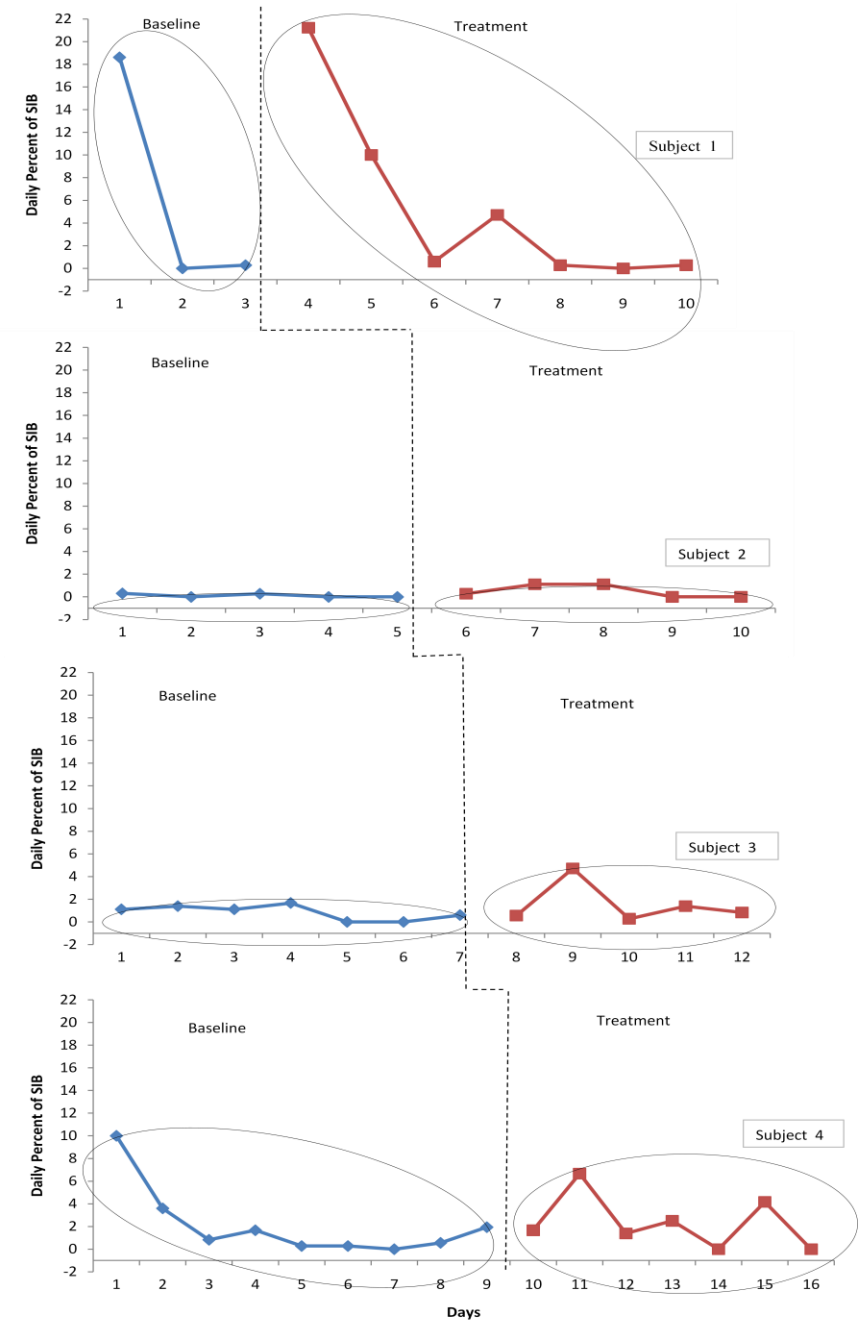

Fig. 9. Percentage of SIB on a daily basis for baseline and intervention phases with the entire phase circled to analyze consistency of data in similar phases-looking at data from all phases within the same condition and examining the extent to which there is consistency in the data patterns from phases with the same conditions.

BIOGRAPHICAL SKETCH

Lynnette Danielle Aguilar is the daughter of Raul and Diana Aguilar. She has two sisters Selina Benoit and Kasandra Aguilar and grew up in La Joya, Texas. All correspondence should be sent to P.O.Box 1205, La Joya, Texas 78560. She was a University Scholar at The University of Texas Pan American and completed her BA in English during the summer of 2009. She was admitted into the Social and Behavioral Sciences program of Experimental Psychology and began her graduate studies emphasizing Behavior Analysis during the fall semester of 2009. She began her internship under the supervision of Dr. Cheryl Fielding at the Autism Treatment Center and now is a Behavior Therapist at Pediatric Rehabilitation and Behavior Services under the supervision of Lupe Castaneda. Lynnette D. Aguilar has a passion for travel, learning about new cultures, and providing Applied Behavior Analysis services to clientele. She has been involved in multiple study abroad and cultural immersion programs all of which have added to this passion and have equipped her with an open-minded attitude towards any new adventure. Her passion for Behavior Analysis has also caused her to become a devotee to the fast evolving field and has given her the drive to pursue her BCBA certification. She ultimately wants to provide Applied Behavior Analysis services internationally while keeping an open collaboration between her and the University of Texas Pan American to assist students in their multi-cultural competence as they gain experience professionally.