Six adults participated in an experiment designed to study the effects of provocation frequency, that is, point subtractions, on free-operant aggressive responding. Subjects were given two response options on separate buttons labeled “A” and “B.” Pressing Button A was maintained by a fixed-ratio 100 schedule of point presentation. A counter was incremented when a point was earned, and these points were later exchanged for money (one point = 10 cents). Subjects were instructed that the completion of each fixed-ratio 10 on Button B subtracted a point from a second subject (fictitious) also responding to accumulate money. Button B responses were operationally defined as aggressive because they ostensibly presented an aversive stimulus (i.e., point subtraction) to another person. To engender Button B responding, the subjects were provoked by having points subtracted from their from their point counter at random intervals (ranging from 6 s to 120 s). Instructions attributed these point subtractions to Button B responding made by another subject (fictitious). Button B responding could initiate periods free from provocation. The duration of these provocation-free intervals was varied in two experiments. Subjects were exposed to five different levels of provocation frequency in order to determine if aggressive responding would be proportionate to the frequency of provocation. This experiment demonstrates that rates of responding on the B button generally increase as the frequency of point subtractions increases. This finding is consistent with the nonhuman research which has shown that the probability of aggressive responding is proportionate to the frequency of aversive stimulus presentation.

Both aggressive and/or escape responses occur at increased probability following aversive stimulus presentation (Azrin, Hutchinson, & Hake, 1967). Responding occasioned by the presentation of aversive

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stimuli typically occurs at a rate that is directly related to the frequency of aversive stimulus presentation. Earlier studies with nonhuman subjects have shown that the frequency of fighting among pairs of rats (Ulrich & Azrin, 1962) and aggressive biting in squirrel monkeys (Azrin, Hutchinson, & McLaughlin, 1965) is directly related to the frequency of electric shock presentation.

The present study determined the effects of a wide range of provocation frequencies (point subtractions) on the rate of human aggressive responding. Although we have examined the effects of different contingencies between aggressive responding and point subtractions (Cherek, Steinberg, Kelly, Robinson, & Spiga, 1990b), small increases in the frequency of point subtraction (Cherek, Spiga, Bennett, & Grabowski, 1991), and increases in the response requirement for aggressive responding (Cherek, Spiga, & Egli, 1992), we have not examined the effects of a full range of provocation frequencies on aggressive responding within single subjects. To do this, the frequency of provocation (point subtraction) was varied by changing the duration of the provocation-free interval, initiated by the subject's aggressive responding. Provocation frequencies varied from seldom, when aggressive responding produced a PFI of 500 s, to frequent, when aggressive responding produced a PFI of 5 s. At the PFI of 5 s, the subject had essentially no control over the frequency of point subtraction, and as a result the subject received frequent point subtractions. At the PFI of 500 s, the subject had maximal control over the frequency of point subtraction. And under these conditions, if the subject responded soon after a point subtraction, only a few point subtractions would occur during the session. In this experiment we determined the relationship between five different frequencies of point subtraction and aggressive responding.

Method

Subjects

Six males between the ages of 22 and 33 (M = 25.8, SD = 3.1) participated after informed consent was obtained. None of these subjects reported previous research participation.

Apparatus

During experimental sessions, subjects sat in a 1.2-m x 1.8-m sound-attenuated chamber. Illumination was provided overhead by a 75-W light bulb and masking noise was provided by a ventilation fan which operated continuously. Located within the chamber were an Apple Ile monochrome monitor and a customized response panel (10.0 cm x 43.0 cm x 25.0 cm). The response panel contained three push buttons (MicroSwitch) labeled “A,” “B,” and “C” which were mounted in a straight line 10.0 cm apart (Button “C” was not used). The response panel’s wire lead was of sufficient length to allow the subject to place the panel onto
his lap. Both the monitor and response panel were controlled by an Apple IIGS computer equipped with an Applied Engineering I/O 32 interfacing system; the computer and its interface were located in an adjacent room. Together, this system allowed the experimenters to control and record all experimental events.

Procedure

Recruitment and screenings. Potential subjects were recruited through advertisements for behavioral research placed in the classified employment section of local newspapers. Subjects were excluded if either a significant psychiatric disorder, including substance abuse, or medical illness was detected during screening exam (determined by a board-certified psychiatrist). The psychiatric screening consisted of a mental status exam and the Schedule for Affective Disorders and Schizophrenia-Lifetime Version (SADS-L), a standardized psychiatric interview (Endicott & Spitzer, 1978). A medical questionnaire, administered by the interviewer, was used to determine if any significant medical conditions existed that would preclude subject participation.

Drug usage was monitored by collecting urine and expired air samples daily each morning shortly after each subject’s arrival (approximately 8:00 a.m.). A urine drug screen was performed on selected urines and was capable of detecting the presence of illicit and therapeutic compounds or their metabolites. These urines were tested using the Enzyme Multiple Immunoassay Technique - Drug Abuse Urine Assay (EMIT d.a.u. by SYLVA Corporation, Palo Alto, CA). A more complete description of this procedure can be found in Cherek et al., 1993. Recent alcohol intake was monitored by collecting an expired air sample using an Intoximeter Model 3000-111 (Intoximeter, Inc., St. Louis, MO).

Information regarding potential earnings, urine drug testing, breath alcohol testing, and the psychiatric and physical exams was given during the screening interview. Subjects were told that they could earn approximately $4-$5 per session through point accumulation (paid daily) and would be paid a $10 per day bonus at the completion of their participation for maintaining drug-free urines while in the study. The study’s purpose was described as a study of motor performance.

Instructions. Subjects were shown a diagram of the testing apparatus and read a standard set of instructions describing the experimental paradigm prior to the subject’s first session of participation.

During each day you will be able to earn money by working at a response panel. This is a drawing of the response panel and computer monitor. As the drawing illustrates, the response panel contains three buttons labeled A, B and C. When each session starts, the letters A and B, and a counter will appear on the computer screen. The counter will be at zero. Pushing the A button will cause the letter B to go off the screen. Pushing the A button approximately 100 times will cause the letter A to go off the screen, and add one point to the counter. Each point is worth
ten cents. After about one second, the letters A and B will come back on the computer screen. At that time, you can continue to press button A and earn another point or switch to button B.

During the session the counter on your computer screen may become larger while flashing off and on and one point will be subtracted. After the point is subtracted, the counter will return to its normal size. This means that one of the other persons has subtracted a point by pushing button B on his/her response panel. Every point that this person subtracts from your counter is added to his counter.

If you push button B on your response panel, the A letter will go off the screen. After you have pushed the B button approximately 10 times, the letter B will go off the screen and one point will be subtracted from the other person's counter. After about one second, the letters A and B will come back on the computer screen. You can continue to press button B and take additional points away from the other person or switch to button A. If you subtract a point from the other person, it will not be added to your counter. Remember, points that are subtracted from your counter by the other person are added to that person's counter.

It is very important that you arrive on time each day, since you will be participating with other people in this study. These other individuals will have response panels and computer screens like yours. These other people are located at another facility. During each day you will participate in several sessions and you can be paired with several other people.

Other than these instructions above, no other information regarding the specific contingencies was provided. When necessary, however, portions of these instructions were repeated to answer questions from the subjects.

**Response options.** During experimental sessions two response options were available to the subject: (1) Completing a fixed-ratio (FR) 100 on Button A was reinforced by adding one point to the subject's point-accumulation counter, displayed on a computer monitor. Only Button A presses separated by at least 0.17 s counted toward completion of the ratio's requirement (Cherek, Spiga, Steinberg, & Kelly, 1990a); and (2) completing a FR 10 on Button B ostensibly subtracted a point from the fictitious subject. Response Buttons A and B were available as nonreversible options: Once either option had been selected it was necessary to complete its ratio requirement before a different option could be chosen.

**Point subtractions.** Points were subtracted from the subject's counter according to a formal schedule. The computer's program randomly selected intervals between 6 and 120 s for point subtractions to occur, and the total number of points that could be subtracted could typically not exceed 25 within any given session. These point subtractions, which were attributed to the fictitious partner in the instructions, occurred while the subject was in either response option.
In order to avoid monetary reinforcement of the aggressive response option, points subtracted from the (fictitious) opponent were not added to the subject's counter. However, in order to provide the subject with some rationale for the point subtractions, subjects were instructed that the points subtracted from them were added to the other (fictitious) subject's point counter.

Provocation-free intervals. Besides ostensibly resulting in point subtractions, completing a FR 10 on Button B could also initiate an interval free from point subtractions (provocation-free intervals). A provocation-free interval (PFI) could be initiated only after at least one point had been subtracted from the subject's counter. Completing the Button B response requirement before either a point had been subtracted, or after a PFI had already been initiated, had no programmed consequence but was counted. Thus, B responses did not postpone the occurrence of the next point subtraction after the initiation of the PFI, that is, not an avoidance response. In the absence of PFI initiation points were subtracted every 6 to 120 s; all intervals were equally represented. When a PFI was initiated, point subtractions were scheduled to occur 6 to 120 s (random interval 63-s schedule) after the PFI had timed out. As a result, all point subtractions could not be avoided, but the total number of point subtractions could be reduced by Button B responding. Button B responding immediately following each point loss would result in fewer total point subtractions in a given session. In the absence of Button B responses, typically no more than 25 point subtractions were presented during a session.

Provocation-free interval manipulations. Subjects participated for six sessions each day Monday through Friday. Twenty-five minute sessions were conducted at 9:00, 10:00, and 11:00 a.m., and 1:00, 2:00, and 3:00 p.m.. Lunch was provided at 11:30 a.m..

The PFI duration was manipulated across sessions. For the first 2 days (12 sessions), the PFI remained at 500 s. For the next 10 days (60 sessions), the PFI was set at 500 s for the first session of each day. For each of the remaining five sessions, the PFI values were varied: either 5, 62.5, 125, 250, or 500 s. The order of these PFI values during the second through sixth sessions was balanced across the 10 days. A predetermined sequence was used, and each subject began at a different point in this sequence.

Evaluation of instructional deception. Subjects were given a questionnaire at the end of the day which asked them to (1) estimate the number of subjects they had been paired with that day, (2) to describe these other subjects, and (3) to estimate whether they or the other subjects subtracted more points. Using this questionnaire we were able to assess whether or not the instructional deception regarding the other fictitious subjects had been established and maintained in these procedures.
Results

All subjects reported that they had been paired with at least one other person during the first 2 days, and with three or more subjects during the next 10 days. Most of the time subjects reported that the other person subtracted more points than the subjects themselves did whether or not this was in fact true. None of the subjects was removed for alcohol or drug use.

Baseline responding. The number of aggressive responses per minute emitted by each subject during each of the 12 baseline sessions, under the lowest frequency of provocation condition (PFI = 500 s), is shown in Figure 1. The mean number of aggressive responses per minute emitted by subjects during baseline sessions was as follows (SEM in parentheses): S-582 = 5.3 (1.2), S-585 = 33.5 (2.34), S-618 = 3.7 (0.7), S-629 = 2.4 (0.3), S-640 = 1.3 (0.2), and S-648 = 8.8 (0.9). Subject S-585 emitted extremely high rates of aggressive responding, even though the low provocation condition was in effect which resulted in

![Graph showing the number of aggressive responses per minute emitted by each subject during 12 baseline sessions.](image)

Figure 1. Shown are the number of aggressive responses per minute emitted by each subject during 12 baseline sessions where the frequency of provocation was very low (PFI = 500 s).
only 2-5 point subtractions per session. From Figure 1 it is apparent that rates of responding quickly stabilized, and the levels of aggressive responding during the first session were fairly predictive of the levels obtained at the end of the 12 baseline sessions.

Subjects differed in the mean numbers of aggressive responses per

Figure 2. The mean rates of aggressive responding (responses per minute) per point subtraction at each of five different PFI values (point subtraction frequencies). Each data point represents the mean of 10 different sessions in which the five PFI values were presented in a balanced sequence over a 10-day period.
point subtraction emitted. Subjects S-585 and S-648 emitted many aggressive responses relative to the few point subtractions that occurred: averaging 180.4 (SEM = 24.5) and 80.7 (SEM = 12.4)

Figure 3. Cumulative records for three subjects under the 250-s PFI condition. Each cumulative record depicts a 25-min testing session. Vertical slash marks indicate the delivery of a point subtraction and incremented responses indicate number of aggressive responses.
responses per provocation, respectively. These mean values were much lower for the remaining subjects (SEM in parentheses): S-582 = 24.7 (6.4), S-618 = 8.1 (3.3), S-629 = 7.5 (1.2), and S-640 = 8.0 (0.9).

**Provocation Frequency (PFI) Manipulations**

After the first 2 days of baseline conditions, 10 days of PFI value manipulations followed. During Session 1 of each day the PFI value remained at 500 s, and during Sessions 2 through 6 five different PFI values were presented (as previously described).

The mean rates of aggressive responding per minute at the various frequencies of point subtraction are shown in Figure 2. Five of the six subjects (S-582, S-585, S-618, S-629, and S-640) showed relatively orderly increases in rates of Button B responding as the number of point subtractions increased (as a result of PFI manipulations). However, Subject S-585's rate of Button B responding was suppressed at the highest frequency of point subtraction. Subject S-648's rate of B button responding decreased slightly as the number of provocations increased.

Aggressive responding typically occurred closely after a point subtraction occurred. Some examples of cumulative records from different subjects for the 250-s PFI condition appear in Figure 3. Aggressive responses typically occurred shortly after provocation (e.g., point subtraction).

The mean number of points subtracted during sessions at each of the five PFI values is shown in Table 1. (Not shown are the points subtracted during the first session of each day.) The mean number of point subtractions ranged from only 2.9-6.4 points when the PFI duration

### Table 1

<table>
<thead>
<tr>
<th>Subject</th>
<th>5</th>
<th>62.5</th>
<th>125</th>
<th>250</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-582</td>
<td>24.7 (0.8)</td>
<td>16.5 (0.7)</td>
<td>11.5 (0.7)</td>
<td>9.1 (0.9)</td>
<td>4.9 (0.4)</td>
</tr>
<tr>
<td>S-585</td>
<td>23.0 (0.6)</td>
<td>15.7 (0.9)</td>
<td>12.9 (1.1)</td>
<td>7.3 (0.4)</td>
<td>6.4 (1.0)</td>
</tr>
<tr>
<td>S-618</td>
<td>23.8 (0.8)</td>
<td>13.8 (0.8)</td>
<td>9.0 (0.4)</td>
<td>5.6 (0.2)</td>
<td>3.8 (0.3)</td>
</tr>
<tr>
<td>S-629</td>
<td>23.9 (1.2)</td>
<td>18.3 (0.9)</td>
<td>12.1 (0.8)</td>
<td>7.8 (0.6)</td>
<td>4.8 (0.5)</td>
</tr>
<tr>
<td>S-640</td>
<td>19.5 (0.8)</td>
<td>13.4 (0.7)</td>
<td>8.9 (0.4)</td>
<td>5.8 (0.3)</td>
<td>3.4 (0.3)</td>
</tr>
<tr>
<td>S-648</td>
<td>18.5 (0.5)</td>
<td>12.0 (0.6)</td>
<td>8.3 (0.6)</td>
<td>5.0 (0.3)</td>
<td>2.9 (0.4)</td>
</tr>
<tr>
<td>M</td>
<td>22.23</td>
<td>14.95</td>
<td>10.45</td>
<td>6.77</td>
<td>4.37</td>
</tr>
</tbody>
</table>

*Note.* The standard error appears below each value in parenthesis.
was 500 s, to 18.5-24.7 points when the PFI duration was 5 s. Note that the number of point subtractions could vary as a result of two factors: (1) when PFIs were initiated by the subject; and (2) the random schedule of point subtraction (randomly generated intervals ranging from 6 to 120 s). Despite the inherent variations in point subtraction, the actual number of point subtractions is similar between subjects.

Table 2
Rates of Point-Maintained Responding at Each of Five Provocation-Free Interval Values

<table>
<thead>
<tr>
<th>Provocation-free interval (PFI) value in seconds</th>
<th>Subject 5</th>
<th>62.5</th>
<th>125</th>
<th>250</th>
<th>500</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S-582</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.1)</td>
<td>(1.0)</td>
<td>(0.1)</td>
<td>(0.1)</td>
<td>(0.1)</td>
</tr>
<tr>
<td></td>
<td>S-585</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.2)</td>
<td>(0.2)</td>
<td>(0.1)</td>
<td>(0.1)</td>
<td>(0.1)</td>
</tr>
<tr>
<td></td>
<td>S-618</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.2)</td>
<td>(0.2)</td>
<td>(0.1)</td>
<td>(0.1)</td>
<td>(0.2)</td>
</tr>
<tr>
<td></td>
<td>S-629</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.1)</td>
<td>(0.1)</td>
<td>(0.1)</td>
<td>(0.2)</td>
<td>(0.1)</td>
</tr>
<tr>
<td></td>
<td>S-640</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.1)</td>
<td>(0.0)</td>
<td>(0.0)</td>
<td>(0.0)</td>
<td>(0.0)</td>
</tr>
<tr>
<td></td>
<td>S-648</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0)</td>
<td>(0.1)</td>
<td>(0.1)</td>
<td>(0.0)</td>
<td>(0.1)</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>3.62</td>
<td>3.63</td>
<td>3.72</td>
<td>3.78</td>
</tr>
</tbody>
</table>

Note. Rates are reported as responses per second and the standard error appears below each value in parenthesis.

Nonaggressive responding. The mean rate of point-maintained responding (responses per second) at each of the PFI values is shown for each subject in Table 2. Rates of responding were high and ranged between 2.2 and 5.0 responses per second. In general, the highest rates of responding were observed under PFI conditions where provocation was infrequent. In other words, the highest rates of responding were emitted under the longest PFI values (250 s and 500 s) and the lowest rates were emitted under the shortest PFI values (5 s and 62.5 s). The exception was Subject S-585, his highest rates of point-maintained responding were recorded under the lowest PFI value, 5 s.

Discussion

The purpose of this experiment was to examine the relationship between the provocation-free interval, which provides some periods free of point subtractions, and the probability of aggressive responding on Button B, which ostensibly subtracts a point from a fictitious subject. The most important finding was that the probability of aggressive responding increased as the length of the PFI decreased (i.e., provocation frequency increased).
Two subjects, S-585 and S-648, emitted higher rates of aggression compared to the other subjects. No information obtained during the interviewing, screening, or debriefing could account for these differences. However, we have recently found that rates of aggressive responding on this paradigm are related to the documented histories of aggression in parolees (Cherek, Moeller, Schnapp, & Dougherty, 1997; Cherek, Schnapp, Moeller, & Dougherty, 1996).

The results from this experiment are consistent with findings from nonhuman studies which have shown that the frequency of both aggressive and escape responding is directly proportionate to the frequency or duration of aversive stimulus presentation. For example, as the force of a physical blow delivered to a monkey's tail increases, the number of attacks to an inanimate object increases (Azrin, Hake, & Hutchinson, 1965); as the numbers or durations of shock increase, fighting between rats increases (Azrin et al., 1967; Daniel, 1943; O'Kelly & Steckel, 1939) and the number of attacks made by monkeys to a ball or bites to a rubber hose both increase (Azrin et al., 1967). Furthermore, our subjects' patterns of aggressive responding resemble the patterns of aggressive responding found in nonhuman subjects, that is, aggressive responding occurs shortly after provocation. Escape responding also increases as the intensity or frequency of shock is increased (Azrin et al., 1967; Ulrich & Azrin, 1962). Five of the six subjects in the present experiment emitted aggressive responding that was proportionate to the frequency of provocation. The present experiment serves to illustrate that the same relationships between provocation frequency and aggressive responding that have been established in nonhuman laboratories can also be reproduced in human laboratories which differ significantly in their experimental methods.

At first, these laboratory procedures may appear to bear little resemblance to the natural environment, but systematic observation of aggressive behaviors in natural settings indicates that laboratory stimuli are functionally similar to the naturally occurring stimuli which evoke aggressive responses (Bandura, 1973; Patterson & Cobb, 1973). For example, aggressive responding is often times occasioned by provocation (e.g., teasing) and negatively reinforced by the reduction of subsequent provocations (Patterson, Littman, & Bricker, 1967). This reciprocal process, which has been studied in laboratories and observed in the natural environment, may be central to the understanding of aggression (Patterson & Reid, 1970; Tedeschi, 1983).

Besides the similarity between "real world" and laboratory aggressive responses, these paradigms have been validated using a number of different methods. Despite some earlier questions regarding validity (e.g., Baron & Eggleston, 1972; Jeavons & Taylor, 1985), recent methodological changes have helped to clear up these earlier concerns. Validity has been shown by correlating aggressive responding with self-rated aggression and violence (Malamuth & Check, 1980; Shemberg, Leventhal, & Allman, 1968), peer ratings of aggression (Williams,
Meyerson, Eron, & Semler, 1967), antisocial behavior (Hartmann, 1969), and criminal records (Wolfe & Baron, 1971). In our laboratory, the Point Subtraction Aggression Paradigm has been validated in a number of different subject populations including violent and nonviolent parolees (Cherek et al., 1997; Cherek et al., 1996), children with attention deficit hyperactivity disorder (Casat, Pearson, Van Davelaar, & Cherek, 1995), as well as drug abusers (Cherek, Roache, Egli, Davis, Spiga, & Cowan, 1993), and alcohol drinkers (Dougherty, Cherek, & Bennett, 1996).

Although we refer to Button B responses as “aggressive” and point subtractions as “provocation” we do recognize that some may not agree with our interpretation. Only through further experimentation can we address this issue fully. However, it is our contention that these are in fact aggressive responses and provocations, and this contention is based upon previous validation studies (Cherek et al., 1997; Cherek et al., 1996) and other experimental studies. In some of these studies we have manipulated the context in which the parameters of this paradigm are carried out. Our results support our contention that it is the social context of our experimental paradigm, established through the instructions, that conveys distinct functional properties on the point subtraction and produces responding that is “aggressive.” For example, when subjects are instructed that the point subtractions are generated by a computer (a nonsocial situation) their patterns of aggressive responding are distinctly different than when subjects are instructed that the point subtractions are generated by another person (Cherek et al., 1990b). Likewise, our instructions impart a social context to Button B responding which is defined as aggressive because such responding ostensibly presents as aversive stimulus, a point subtraction, to another person. Button B responding is defined by its instructional topography, that is, responding on this button will take points away from another subject. This Button B responding is not defined by the escape contingency between aggressive responding and point subtractions. Similarly, aggressive responding outside the laboratory is frequently maintained by an escape from further aggressive behavior directed at the individual. Although such counter aggressive responding could be viewed as escape, because it is maintained by an escape contingency, we define such behavior as aggressive because it is directed at another person, typically the source of the provocation.

References


