LABORATORY MEASURES OF IMPULSIVITY: A COMPARISON OF WOMEN WITH OR WITHOUT CHILDHOOD AGGRESSION

CHARLES W. MATHIAS, DONALD M. DOUGHERTY, DAWN M. MARSH, F. GERARD MOELLER, LISA R. HICKS, KEVIN DASHER, and LEE BAR-ELI

The University of Texas Health Science Center at Houston

This study compared laboratory models of impulsive behavior in 60 women ages 18-40. Three groups (n = 20, each) were recruited: (1) normal controls, (2) women on probation/parole without childhood aggression (Fight-), and (3) women on probation/parole with childhood aggression (Fight+). Two types of impulsivity paradigms were compared: response-disinhibition/attentional [Immediate/Delayed Memory Task (IMT/DMT)] and delayed-reward [Single Key Impulsivity Paradigm (SKIP)] models. The Fight+ group performed more impulsively, responding with more commission errors (IMT/DMT) and shorter delay choices (SKIP) compared to either the Fight- or Control groups. Compared to the SKIP, the IMT and DMT tasks had larger effect sizes and a more orderly pattern of impulsive performance differences between groups. Women classified on the basis of childhood behavior (initiating physical aggression) are behaviorally distinct on laboratory measures of impulsiveness in adulthood.

Impulsivity is a “predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions to themselves or others” (Moeller, Barratt, Dougherty, Schmitz, & Swann, 2001). As such, impulsiveness is a fundamental component to theories of criminal behavior (Gottfredson & Hirschi, 1990) and a principal factor in major public health issues such as substance abuse, psychiatric disorders, delinquent behavior, aggression, and suicide (Barratt, Stanford, Kent, & Felthous, 1997; Pfefferbaum & Wood, 1994; Stein et al., 1993). In light of the serious consequences of elevated impulsivity, a number of recent studies have addressed the relationship of laboratory impulsivity measures and aggression (Cherek, Moeller, Dougherty, & Creson, 1996; Dougherty, Bjork, Huckabee, Moeller, & Swann, 1999).

This research was supported by a grant from the National Institute of Mental Health (R01-MH063908). Correspondence may be addressed to Donald M. Dougherty, Neurobehavioral Research Laboratory and Clinic, The University of Texas Health Science Center at Houston, Department of Psychiatry and Behavioral Sciences, 1300 Moursund Street, Houston, Texas 77030. (E-mail: donald.m.dougherty@uth.tmc.edu).
The current design is one in a series of validation studies comparing laboratory impulsivity measures in a number of different populations. Of particular interest is the contrast of two models of impulsiveness, response-disinhibition/attentional and delayed-reward models. Response-disinhibition/attentional paradigms define impulsiveness as a failure to inhibit inappropriate responses until stimulus processing has been fully completed. Continuous performance tests, like the Immediate Memory Task and Delayed Memory Task (IMT/DMT; Dougherty, 1999), are one type of technique for assessing impulsiveness from the response-disinhibition/attentional perspective. The IMT/DMT requires selective responding to target stimuli among a series of other ongoing stimuli. Responses to stimuli that resemble a target stimulus (i.e., commission errors) have been found to be related to impulsive behavior. Elevated frequencies of commission errors have been reported for impulsive groups like those diagnosed with Conduct Disorder (Dougherty, Bjork, Marsh, & Moeller, 2000), Bipolar Disorder (Swann, Anderson, Dougherty, & Moeller, 2001), Borderline Personality Disorder (Dougherty, Bjork, et al., 1999), Attention Deficit Hyperactivity Disorder (Halperin, Wolf, Greenblatt, & Young, 1991), and disruptive behavior disorders (Bjork et al., 2000; Dougherty et al., in review). Moreover, alcohol consumption increases rates of commission errors (Dougherty, Bjork, et al., 2000; Dougherty, Marsh, Moeller, Chokshi, & Rosen, 2000; Dougherty, Moeller, et al., 1999; Rohrbaugh et al., 1988; Smith, Kendrick, & Maben, 1992). Finally, commission errors have been reported to be positively correlated with scores on a self-reported questionnaire of trait impulsiveness (i.e., the Barratt Impulsiveness Scale; Dougherty, Bjork, et al., 2000). Together these studies have begun to provide validation for response-disinhibition/attentional models of impulsivity.

Delayed-reward models define impulsiveness as an intolerance for delay, which may be expressed as a preference for a smaller more immediate reward over a larger delayed reward. One delayed-reward model, the Single Key Impulsivity Paradigm (SKIP; Dougherty, Wrubel, Marsh, Bjork, & Moeller, 1999) is a money-earning task in which the magnitude of a reward is contingent upon the length of the interval since the previous response. With this task, impulsiveness is indicated by more frequent responding and shorter delays between free-operant responses for reward. Adolescents with disruptive behavior disorders show preference for short delays and emit more responses overall (Dougherty et al., in review). Research using similar delayed-reward measures (i.e., the Two-Choice Delayed Reward Task) has reported preference for shorter delays among impulsive samples such as women with Borderline Personality Disorder (Dougherty, Bjork, et al., 1999) and probation or parole groups (Cherek & Lane, 1999; Cherek, Moeller, Dougherty, & Rhoedes, 1997).

In the present study, the response-disinhibition/attentional and delayed-reward models of impulsivity were compared among three groups of women; healthy normal controls, women on probation or parole without any history of initiating fights (Fight-), and women on probation or parole with a history of initiating physical aggression (Fight+) toward
people and/or animals beginning in childhood (prior to age 15). Comparison of these groups was of particular interest for two reasons: (1) aggression in women is poorly understood due to the relatively limited number of aggression studies; and (2) a pattern of childhood physical aggression is predictive of psychiatric disorders and degree of global impairment later in life (Halperin et al., 1995; Loebner, Green, Lahey, & Kalb, 2000). The current design is therefore a retrospective study in that it focuses on the measurement of impulsivity in adult women who exhibited physical aggression toward people and/or animals starting in childhood. Of the three participant groups, those participants with early onset aggressive behavior would presumably exhibit the highest degree of impulsive responding, followed by women on probation or parole without physical aggression, while controls were expected to have the lowest levels of impulsive responding. In particular, the fight+ group is expected to emit a greater number of commission errors on the IMT/DMT and choose shorter-delay smaller-reward responses more frequently on the SKIP compared to either the fight− or control group.

Method

Participants
Sixty healthy women participated in the study. The participants were closely matched for age ($M = 27.9$, $SD = 7.7$) and other demographic characteristics.

Recruitment and Screening
Potential participants responded to newspaper and flier advertisements for "paid behavioral research study participants." To identify a broad sample of impulsive and aggressive women, advertisements were also posted near parole and probation offices.

For all respondents, an initial telephone screening was conducted to determine suitability for the study (e.g., age 18-40, and physically healthy). Potential participants were invited to the laboratory for a more extensive screening interview for psychiatric illness, which was assessed using: the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; First, Spitzer, Gibbon, & Williams, 1996), the Anti-Social Personality Disorder (ASPD) module of the Structured Clinical Interview for DSM-IV Axis II Disorders (SCID-II; First, Gibbon, Spitzer, Williams, & Benjamin, 1996). Physical health was confirmed by a brief medical survey. Any health questions that arose as a result of this questionnaire were addressed by a medical doctor or a nurse practitioner to determine that the participant was in good health at the time of testing. Each participant provided expired air and urine samples to screen for current alcohol intoxication and drug analysis (marijuana, cocaine, amphetamines, and benzodiazepines; Syva® RapidTest d.a.u.™ 4, Cupertino, CA). Subtraits of aggression were determined by the Buss-Perry Aggression Questionnaire (BPAQ; Buss & Perry, 1992). The I-7 Impulsivity Questionnaire (Eysenck, Pearson, Easting, & Allsopp, 1985) was included as a self-report measure of trait impulsiveness.
Applicants were not admitted into the study if the personal interview indicated the presence of any significant medical history or a current Axis I disorder other than substance abuse. Persons from the potential control group were further excluded on the basis of any previous or current drug abuse or psychiatric disorder, histories of substance abuse were an exclusion criterion for the control group, but not for the fight+ or fight− groups (increased levels of this behavior would be expected for these latter groups). Current drug use (determined by urinalysis) or dependence, however, was an exclusion criterion for all groups. Two of the controls and one participant each from the fight+ and fight− groups were excluded from the study for testing drug positive. These participants were replaced with new volunteers in order to have 20 participants in each group.

**Group Assignment**

The fight+ group \((n = 20)\) consisted of women on parole or probation who reported a pattern of initiating physical aggression toward people or animals beginning prior to age 15. Childhood aggressive history was determined based on responses to the ASPD module of the SCID-II (First, Gibbon, et al., 1996). The majority of participants \((n = 18)\) in this group had a pattern of initiating physical fights with people. The remaining participants \((n = 2)\) had patterns of initiating physical aggression toward animals, although this behavior escalated to fights with people later in adolescence. The fight− group \((n = 20)\) included women on parole or probation without any reported episodes of initiating physical aggression either prior to age 15 or later as adults. Finally, controls \((n = 20)\) were women who reported no history of physical fighting, no criminal history, and were negative for both ASPD and CD.

**Schedule Overview**

On the day of testing, participants arrived at 0800 hr. The intake process involving screening interview lasted about 2 hours. After obtaining informed consent, participants completed the questionnaires and semi-structured interview (described above) in order to determine history of aggression, and physical and mental health status.

As part of the testing schedule participants completed one session each of the IMT/DMT and the SKIP, as well as a number of other computerized tasks that were a part of another study examining the relationship between personality and measures of aggression (to be reported elsewhere). Both testing sessions lasted approximately 20 min each. The single testing day ended by 1600 hr.

**Apparatus**

Participants were tested in a 1.8-m x 1.8-m sound-insulated chamber containing a computer monitor, mouse, and a ventilation fan (providing masking noise). Participants were given standardized instructions prior to each computer task and were asked questions to verify comprehension.
Behavioral Measures

Immediate Memory Task and Delayed Memory Task (IMT/DMT). The IMT/DMT (Dougherty, 1999) is a modified version of the Continuous Performance Test (CPT; Cornblatt, Risch, Faris, Friedman, & Erlenmeyer-Kimling, 1988; Rosvold, Mirsky, Sarason, Breansome, & Beck, 1956) which assesses attentional and memory processes. An innovation of the IMT/DMT is to include stimulus items very similar to target stimuli, allowing for a more stringent criterion for what is termed a commission error and therefore may be a better measure of impulsivity than other CPT. Each session of the test includes two 5-min testing blocks, with a 30-s break between blocks. Two blocks each of the IMT and the DMT are presented in the session in an ABAB design (IMT followed by DMT). A description of these tasks follows.

Immediate Memory Task (IMT). The IMT measures brief attentional capacity. In this test a series of 5-digit numbers (e.g., 35027) are presented in black on the white background (on the computer monitor) for 500 ms. Each number is separated by a 500-ms blackout period prior to the next stimulus (5-digit number). Participants are instructed to respond using the left button of the computer mouse only when the number currently on the monitor is identical to the previous number (target). The probability of presentation of a target stimulus on any trial is equal to .33, and responses to targets are scored as correct detections. Occasionally (probability = .33) stimuli that are very similar (catch stimuli) to the previous number, differing by only a single digit (e.g., 35027 followed by 35087, position and value of the nonmatching digit is random), were presented. Responses made to these catch stimuli prior to the presentation of the next stimulus item are scored as commission errors. Responses to catch stimuli have been attributed to a lack of restraint and responding prior to completion of information processing (Dougherty, Marsh, et al., 2000). It is these commission errors that are elevated in impulsive populations (see introduction). Finally, other computer-generated, random, nonmatching stimuli (novel) are presented (probability = .34). Responses to these novel stimuli are filler errors. Dependent variables for the IMT/DMT include: correct detections, commission errors, correct detection latencies, commission error latencies, discriminability, and response bias.

Delayed Memory Task (DMT). The DMT is similar to the IMT, with the addition of a distracter stimulus presented between the 5-digit numbers. The distracter stimulus is the number “12345,” which flashes three times at the same rate and duration as the other stimuli (500 ms on and 500 ms off). Participants are told not to respond to this distracter stimulus and to respond only to a number that is identical to the number presented immediately prior to the distracter series. The DMT is scored exactly as the IMT, with the addition of recording responses (errors) made to the distracter stimulus.

Single Key Impulsivity Paradigm (SKIP). The SKIP (Dougherty, Wrubel, et al., 1999) measures the rate and pattern of free-operant responses for reward. Participants are instructed to click the left computer
mouse button to earn money across the 20-min session. Each response adds earnings in direct proportion to the time interval since the previous response (1¢ for every 2 s since the prior response). For example, a response given 20 s after the previous response earned the participant 10¢. There are two money counters labeled “Total Accumulated Money” and “Most Recent Response Earnings.” The total accumulated money counter is present at the top of the screen for the entire task, and keeps a running total of the participant’s earnings for the session. The most recent response earnings counter, which appears for 2 s after each response (or until the next response for responses within 2 s) at the bottom of the screen, provides immediate feedback for the relationship between delay and reward without the experimenter having to explicitly describe this contingency in the instructions. The instructions are as follows:

In this task, you will earn money whenever you press this left mouse button. Right after each press you make, the amount of money that press earned you will be shown at the bottom of the screen.

This amount of money will be added to a total money counter, which will be at the top of the screen. You will be paid this amount of money. The session will last about 20 minutes, and the computer will tell you when your session is complete.

The average delay between reward responses, cumulative reward responses, and longest delay between responses were the primary dependent variables of interest. Shorter delay between responses for reward and more reward-directed responses have been previously interpreted as more impulsive responding (Dougherty, Wrubel, et al., 1999).

**Participant Payment**

Each participant was paid at the end of the testing day an amount partially based on their performance. On average, participants earned $7-8 on the SKIP and $5 for the IMT/DMT. As these tasks were part of a larger study, total participant payment for all testing was approximately $55-65.

**Data Analysis**

We hypothesized that the degree of impulsive responding would be expressed in an increasing order of magnitude from controls to fight− and then fight+ participants. Increased level of impulsivity would be demonstrated by the following patterns of performance: (a) greater rates of commission errors on the IMT and DMT, and (b) more total responses emitted and shorter average interval between responses on the SKIP.

A 3 x 2 (Group x Testing Block) repeated-measures ANOVA was computed for each dependent variable (i.e., correct detections, commission errors, commission error to correct detection ratios, discriminability, response bias, and latencies) of the IMT and DMT tasks. When there was no main effect or interaction by block, dependent variables were averaged across the two testing blocks. A one-way
ANOVA was used to analyze each dependent variable (i.e., average delay for reward, cumulative responses, and longest delay for reward) of the SKIP task. Age was included as a covariate because, although groups were not significantly different \( F(2, 57) = 2.34, p = .11 \), previous research has shown that age has powerful moderating effects on response disinhibition/attentional task results (Chen, Hsiao, Hsiao, & Hwu, 1998; Dougherty et al., 1998; Fallgatter, Mueller, & Strik, 1999; Friedman, Boltri, Vaughan, & Erlenmeyer-Kimling, 1986). Significance criterion in all comparisons was set at \( p < .05 \). Type I error rate was controlled on all follow-up comparisons by use of the Bonferroni test (Stevens, 1996).

To compare the magnitude of group differences for the impulsivity variables of interest, estimates of effect sizes were calculated as Cohen’s \( f \) (Cohen, 1988). These estimates are useful when comparing measurement techniques because, unlike \( p \) values, the effect size conveys the magnitude of the phenomenon of interest (Cohen, 1990). For one-way analyses of variance, \( f \) scores of .10, .25, and .40 are conventional definitions of small, medium, and large effect sizes (respectively) (Cohen, 1992).

Results

Demographic characteristics for each of the three groups are summarized in Table 1. Compared to controls, the fight+ group scored significantly higher on each of the BPAQ scales. And compared to the fight— group, the fight+ scored significantly higher on the hostility subscale of the BPAQ. Both fight+ and fight— groups scores significantly higher than controls on the self-report measure of impulsivity, the \( I_7 \).

**IMT and DMT**

**Correct detections (hits).** The percentage of correct detections for the IMT and DMT are shown in Figure 1 (top panel). The main effect of group and the interaction of Group x Testing Block were not significant for the IMT or DMT \( (p > .05) \).

**Commission errors (false alarms).** The percentage of commission errors for the IMT and DMT are shown in Figure 1 (middle panel). The fight+ group produced the highest rate of commission errors followed by the fight— group. There was a significant main effect of group for commission errors on the IMT \( F(2, 56) = 4.30, p = .01, f = .39 \) and a similar trend for the DMT \( F(2, 56) = 1.38, p = .20, f = .22 \).

Individual comparison between groups using the Bonferroni correction revealed that the fight+ group emitted significantly more commission errors than the control group on the IMT \( (p = .02) \). On the DMT commission error rates were also appreciably higher for the fight+ group \( (M = 32.38, SD = 17.06) \), in comparison to the fight— \( (M = 23.87, SD = 12.85) \) and control \( (M = 23.78, SD = 22.83) \) groups, but these differences were not statistically significant. There were no other significant group differences on the IMT or the DMT.

**Ratio of commission errors to correct detections.** Past research with
<table>
<thead>
<tr>
<th>Demographic Characteristics</th>
<th>Control ($n = 20$)</th>
<th>Group Fight– ($n = 20$)</th>
<th>Group Fight+ ($n = 20$)</th>
<th>$p$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>26.25 (7.75)</td>
<td>30.85 (6.85)</td>
<td>26.60 (7.84)</td>
<td>.106*</td>
</tr>
<tr>
<td>I7 Impulsiveness Questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impulsivity</td>
<td>4.95 (3.37) a</td>
<td>10.45 (4.18) b</td>
<td>9.95 (4.24) b</td>
<td>&lt; .001*</td>
</tr>
<tr>
<td>Buss-Perry Aggression Questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anger</td>
<td>11.65 (3.21)a</td>
<td>16.60 (3.21)b</td>
<td>19.65 (5.10)b</td>
<td>&lt; .001*</td>
</tr>
<tr>
<td>Hostility</td>
<td>14.95 (4.86) a</td>
<td>18.05 (5.28) a</td>
<td>22.55 (6.71) b</td>
<td>&lt; .001*</td>
</tr>
<tr>
<td>Physical</td>
<td>13.65 (4.62) a</td>
<td>21.40 (6.21) b</td>
<td>59.95 (8.28) b</td>
<td>&lt; .001*</td>
</tr>
<tr>
<td>Verbal</td>
<td>10.85 (3.57) a</td>
<td>13.45 (2.72) ab</td>
<td>15.75 (4.36) b</td>
<td>&lt; .001*</td>
</tr>
<tr>
<td>Total</td>
<td>51.10 (10.22) a</td>
<td>69.60 (13.39) b</td>
<td>83.90 (19.57) c</td>
<td>&lt; .001*</td>
</tr>
<tr>
<td>DSM-IV Axis II Disorder</td>
<td></td>
<td></td>
<td></td>
<td>&lt; .001**</td>
</tr>
<tr>
<td>CD</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>ASPD</td>
<td>0</td>
<td>2</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>BPD</td>
<td>0</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>SCID Educational Category</td>
<td></td>
<td></td>
<td></td>
<td>.074**</td>
</tr>
<tr>
<td>Grades 7-11</td>
<td>0</td>
<td>4</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>HS grad/GED</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Some college</td>
<td>11</td>
<td>12</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>2 year college grad.</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td>.002**</td>
</tr>
<tr>
<td>Black not of Hispanic origin</td>
<td>6</td>
<td>13</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>White not of Hispanic origin</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Native American</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Asian or Pacific Islander</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

CD = Conduct Disorder, ASPD = Antisocial Personality Disorder, BPD = Borderline Personality Disorder, HS Grad = High School graduate, GED = General Education Degree.

* = group comparison was conducted using a univariate ANOVA.

** = group comparison was conducted using a Kruskal-Wallis.

abc = row means and standard deviation followed by the same letter are not significantly different from one another (based on independent t-tests).

Mean and Standard Deviation are included for Age, I7, and BPAQ score. Frequency count is presented for DMS-IV disorder, SCID educational categories, and ethnicity.

The IMT/DMT (e.g., Dougherty, Marsh, et al., 2000) indicates that a more accurate characterization of impulsivity differences may be found in examining commission error rates relative to the percentage of correct detections. These data are presented in Figure 1 (bottom panel). There was a significant main effect of group for the IMT ratio score ($F(2, 56) = 4.98, p = .01, f = .42$). An orderly increase in the rates of commission error responding from the lowest rates in the control group through the highest rates in the fight+ group was indicated by a significant linear contrast ($F(1, 57) = 9.85, p = .003$) with a nonsignificant quadratic contrast ($F(1, 57) =$...
Figure 1. Percent correct detections, percent commission errors, and proportion of commission errors to correct detections for the Immediate Memory Task (IMT) and the Delayed Memory Task (DMT) for the three groups. Error bars represent the SEM.

0.14, p = .71]. Individual comparisons indicated that the fight+ group had a significantly higher ratio of commission errors to correct detections than the control group (p = .009). Again, the same pattern was observed for the DMT (fight+: M = 0.41, SD = 0.19; fight−: M = 0.31, SD = 0.16; control: M = 0.28, SD = 0.26), although this effect was not statistically significant [F(2, 56) = 1.92, p = .16, f = .26]. And, as in the IMT, a trend for an orderly increase in the rates of DMT commission error responding from the
lowest rates in the control group through the highest rates in the fight+ group was indicated by a linear contrast \( F(1, 57) = 3.68, p = .06 \) with a nonsignificant quadratic contrast \( F(1, 57) = 0.33, p = .57 \).

**Discriminability (A') and response bias (B_\text{d}').** These nonparametric variables are based on formulae from signal detection theory (Donaldson, 1997). A' is a measure of discriminability between the target and the stimuli that were very similar to the target (differing by only a single digit). Scores for A' range from -1.0 (with 0.5 equal chance) to 1.0 (perfect target/catch discriminability, with higher values of A' indicating better discriminability. B_\text{d}' is a nonparametric measure of response bias. The scores range from -1.0 to 1.0 and higher scores on B_\text{d}' indicate a more conservative response strategy.

There were significant group differences for discriminability (A') on both the IMT \( F(2, 56) = 3.64, p = .03, f = .36 \) (fight+: \( M = .81, SD = .06 \); fight−: \( M = .83, SD = .09 \); control: \( M = .88, SD = .08 \)) and the DMT \( F(2, 56) = 3.79, p = .02, f = .36 \) (fight+: \( M = .81, SD = .06 \); fight−: \( M = .84, SD = .08 \); control: \( M = .88, SD = .09 \)). Fight+ scored significantly lower on this measure of discriminability than those in the control group on both the IMT \( p = .03 \) and the DMT \( p = .02 \). There were no significant group differences in response bias \( p > .05 \); IMT fight+: \( M = -.40, SD = .47 \); fight−: \( M = -.19, SD = .37 \); control: \( M = -.21, SD = .50 \); DMT fight+: \( M = -.32, SD = .63 \); fight−: \( M = -.12, SD = .51 \); control: \( M = -.25, SD = .60 \).

**Response latency.** There was a significant interaction of Group x Block for commission error latency on the IMT \( F(2, 56) = 3.78, p = .02, f = .36 \). Although there were no significant simple comparisons, it appears that the fight− (Block 1: \( M = 521.10, SD = 90.44 \); Block 2: \( M = 592.03, SD = 129.20 \)) groups response latency slowed considerably from the first to second blocks, in comparison to the control (Block 1: \( M = 547.16, SD = 80.85 \); Block 2: \( M = 552.70, SD = 81.74 \)) and fight+ (Block 1: \( M = 536.29, SD = 78.26 \); Block 2: \( M = 565.89, SD = 84.00 \)) groups. No other latency differences were noted.

**Filler errors.** Responses to novel, random numbers dissimilar from target stimuli were also tracked, although because of their very low rate of occurrence (less than 1%; Dougherty, Bjork, et al., 2000), these responses are typically not appropriate for inferential statistical analysis.

**SKIP.** The average delay for reward of the SKIP is shown in Figure 2. Of the three groups, the fight+ group had the shortest average delay for reward on the SKIP (fight+: \( M = .39, SD = 1.09 \); fight−: \( M = .71, SD = .81 \); control: \( M = .63, SD = .28 \)). The fight+ group's average delay of for reward was significantly \( F(1, 37) = 4.27, p = .04, f = .34 \) shorter than that of the fight− group. The control group was not significantly different from either of the two probation/parole groups \( p > .05 \). Neither cumulative responses nor longest delay showed any between-group differences, nor were there any significant linear or quadratic contrasts that would indicate orderly changes in response rates between the groups \( p > .05 \).
Figure 2. Average delay for reward on the Single Key Impulsivity Paradigm (SKIP). Error bars represent the SEM.

Discussion

This study, as part of an ongoing series of studies, extends validation of laboratory impulsivity measures to adult women on parole who report childhood histories of physical aggression. The main findings were (1) the frequency of commission errors on both the IMT and DMT increased in a stair-step manner from control, fight−, to fight+; and (2) the average delay for reward on the SKIP was shorter for the fight+ group than for the fight− group.

Particularly important is the fact that these women, classified on the basis of self-reported childhood behavior (initiating physical aggression against people or animals) and judicial status, perform as adults in a manner that is behaviorally distinct from one another in the laboratory. This is a unique approach because it addresses the relationships between specific behavioral histories outside the laboratory to behavior within the laboratory, whereas previous research has largely relied on comparing commission error responding in groups formed around a particular psychiatric diagnostic group, [e.g., Bipolar Disorder (Swann et al., 2001), Conduct Disorder (Dougherty, Bjork, et al., 2000), and Attention...
Deficit Hyperactivity Disorder (Halperin et al., 1995)]. The patterns of performance seen on the IMT/DMT in the current study are analogous to research with impulsive psychiatric groups described in the introduction. Collectively, these studies provide strong support for a relationship between response-disinhibition/attentional models and impulsivity.

The group effects observed with the commission error rates were strengthened when using each subject’s proportion of commission errors made relative to correct detections. This combination of variables appears to take into account differences in discriminability, which has been noted previously in studies that examined the effects of alcohol on commission errors (Dougherty, Marsh, et al., 2000). Although commission errors changed in an orderly manner according to the severity of impulsivity expected, only the two extreme groups (fight+ versus control) performance was consistently statistically different from one another. In no case did groups statistically differ on the percentage of correct detections. Differences observed were restricted to commission error rates, which are thought to be related to disinhibitional processes, or one’s ability to refrain from responding to stimuli that are similar to the target stimuli.

Commission error responding on the IMT was more sensitive to group differences than the DMT. The DMT is the more difficult of the two tasks (Dougherty, Bjork, et al., 2000), has fewer trials per block, and as a result its data are typically more variable than the IMT’s data, which may explain why group differences were more robust for the IMT than the DMT. However, the performance of the fight– group followed the trend of the fight+ group with moderate elevation of commission error rates, suggesting that the IMT/DMT is detecting some quantitative group differences that may exist along a continuum of impulsive behavior. Future research should examine a broader sample of impulsive groups.

The SKIP, a delayed-reward impulsivity model, did not discriminate groups as well as the IMT/DMT. Only one planned comparison, between the fight+ and fight– groups, indicated differential performance on this measure. Specifically, the average delay (amount of reward is contingent upon length of delay) between reward responses was shorter for the fight+ in comparison to the fight– group. This may be interpreted as a preference for the smaller and more immediate rewards, which has been reported for male parolee groups with adult history of aggression using similar delayed-reward measures (i.e., Two-Choice test; Cherek et al., 1997; Cherek & Lane, 1999). Unlike these previous studies, however, the current design did not identify any statistically significant group differences on the total number of reward responses emitted during a testing session or longest period of delay between reward-directed responses. Future research may need to compare several techniques representing delayed-reward models with groups of women to determine if they differ in sensitivity.

Compared to the SKIP, the IMT/DMT demonstrated performance differences more consistently and across a greater range of variables. The IMT/DMT had larger effect sizes (e.g., ratio score on the IMT Cohen’s $f$ =
.42) compared to the SKIP (Cohen’s $f = .34$). Besides the effect size differences between the two models, the IMT/DMT was sensitive to graded increases in impulsive performance across the three groups. The SKIP (average delay to reward), however, only distinguished performance between the two probation or parole groups fight+ and fight–.

In summary, this study provides further validation for two models of impulsivity, the IMT/DMT and the SKIP. Future research is needed to examine the relationship between multiple laboratory measures of impulsivity to determine differences in task sensitivity. Studies like these will also lead to a better understanding of the underlying differences being measured by response-disinhibition/attentional and delayed-reward models of impulsivity.

References


