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# Laboratory assessment of aggression: The Taylor Aggression Paradigm in adults with and without a disorder of impulsive aggression

Matthew A. Timmins [a], Jennifer R. Fanning [b], Michael S. McCloskey [c], Mitchell E. Berman [d], Emil F. Coccaro [a,*]

[a] Clinical Neuroscience and Psychotherapeutics Research Unit, Department of Psychiatry and Behavioral Health, The Ohio State University Wexner Medical School, Columbus, OH, USA

[b] Department of Psychiatry, McLean Hospital, Harvard University, Belmont, MA, USA

[c] Department of Psychology, Temple University, Philadelphia, PA, USA

[d] Department of Psychology, Mississippi State University, MS, USA

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ABSTRACT

*Introduction:* The modified Taylor Aggression Paradigm (TAP) has been used to study impulsive aggression in experimental designs and has been relatively successful in addressing critiques of aggression paradigms; however, little has been done to examine the potential of using the TAP as a direct measure of aggression. This study aimed to explore the psychometric properties of the TAP behavioral indexes as measures of aggression.

*Methods:* A community sample of 962 adults were divided into three groups based on diagnostic assessments: Intermittent Explosive Disorder; Non-Aggressive Psychiatric Disorder; or healthy controls. Participants then completed the TAP and self-report measures to assess construct validity. A subset of 47 participants completed a second TAP within one year to assess reliability. TAP indexes were based on number of "extreme" shocks selected (high shock index), average shock levels selected (mean shock index), and shocks levels selected without provocation (unprovoked aggression).

*Results:* Overall, TAP indexes were consistent and reliable. IED participants had the highest high shock and mean shock indexes of all groups ($X^2 = 49.93$, $p < 0.001$). High shock index was related to trait aggression ($\beta = 0.184$, $p < 0.001$) after including covariates; mean shock index had a trending association with trait anger ($\beta = 0.102$, $p = 0.059$).

*Conclusion:* TAP behavioral indexes demonstrated promising psychometrics as a measure of aggression. High shock index appears to be more strongly associated with aggressive behavior; mean shock index may better measure general hostile responding. Future research might include comparisons specifically with impulse control disorders.

## 1. Introduction

Human aggression is a heterogeneous, multidetermined behavior influenced by interacting social, biological, and psychological factors. Because aggression violates social norms, it is often carried out in private, making it challenging to study in naturalistic settings. When observed, aggression's heterogenous expression and complex array of contributing factors make it difficult to identify specific mechanisms and conditions eliciting the behavior (Anderson and Bushman, 1997). As such, the definition of aggression as a construct has evolved over time, as have laboratory aggression paradigms. Contemporary definitions of aggression generally require the behavior to include the *intent to harm* (e.g., Anderson and Bushman, 2002; Baron and Richardson, 1994; Geen, 2001; Tedeschi and Quigley, 1996, 2000). While aggression is sometimes divided into impulsive (i.e., reactionary and unplanned, typically stemming from anger) and instrumental (i.e., behavior used to reach another goal, often planned) aggression, these subtypes are not mutually exclusive and frequently occur together (Bushman and Anderson, 2001; Fanning et al., 2019). Within the *Diagnostic and Statistical Manual of Mental Disorders* - 5th *Edition* (*DSM-5*; American Psychiatric Association,

* Corresponding author. Clinical Neuroscience and Psychotherapeutics Research Unit, Department of Psychiatry and Behavioral Health, The Ohio State University Wexner Medical Center, 1601 Upham Drive, Columbus, OH, 43201, USA.

*E-mail address:* coccaro@osumc.edu (E.F. Coccaro).

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2013) aggressive behavior is considered a criterion, or a supportive feature, of a number of diagnoses (e.g., antisocial or borderline personality disorder). However, impulsive aggression is the key criterion for Intermittent Explosive Disorder (IED), a diagnosis characterized by recurring, unplanned, episodes of aggressive behavior disproportional to the provocation or situation in which they occur. Lifetime prevalence of IED is 4% in adults and 16% in adolescents (Coccaro and Lee 2020) and those with IED face both significant social/occupational dysfunction due to these behaviors (Rynar and Coccaro, 2018) and higher risk for several health conditions (McCloskey et al., 2010).

In research, it can be difficult to verbalize (or provide evidence of) intent during laboratory tasks, particularly for unplanned behaviors, and critics have made valid arguments about the ability to observe aggression in ways mimicking real-world scenarios (Ritter and Eslea, 2005; Tedeschi and Quigley, 1996, 2000). For example, one of the original paradigms, the "aggression machine" (Buss, 1962), avoided intent to address concerns regarding the ability to confirm intent within the task; however, subsequent studies revealed behaviors assumed to be aggressive may have been motivated by a desire to help, depending on how the task was framed to participants (Baron and Eggleston, 1972). Later paradigms have addressed pitfalls while balancing controlled conditions, realistic scenarios, and ethical/pragmatic concerns with relative success (Anderson and Bushman, 1997; Bettencourt and Miller, 1996; Ito et al., 1996; Mitchell, 2012); however, newer paradigms have not been without critiques (e.g., Ritter and Eslea, 2005). Relevant to the current study is the development and evolution of the Taylor Aggression Paradigm (TAP; Taylor, 1967). The original TAP consisted of a reaction-time competition against a fictitious opponent during which the participant selected a shock level from "1″ to "5″ before each trial for the "opponent" to receive if the participant won the trial; ostensibly, the opponent selected shocks for the participant to receive on losing trials. Shock levels were based on a pain threshold procedure prior to the task, and researchers described the "5″ as being equivalent to the highest shock set during the threshold task while the "1″ through "4″ options were progressively lower. Trials were divided into blocks of increasing shock selections by the opponent to establish provocation, and aggression was determined based on the participants' shock selections. Researchers using the TAP have been generally receptive to criticisms and have implemented modifications such as using a "1″ to "10″ scale with a "20″ as an "extreme" shock to more clearly demonstrate intent to harm, one trial that the opponent selects a "20" (the participant wins the trial) to provide a strong provocation (Berman et al., 1993), and including a "no shock" option to mirror the real-world ability to avoid aggression (Zeichner et al., 1999). Some variations have used other noxious stimuli, such as loud noises or monetary loss (e.g., Krämer et al., 2007). Importantly, behavior on the TAP has been found to be associated with trait aggression and hostility but unrelated to potential confounds such as helping behavior, competitiveness, or motivation to win (e.g., Bernstein et al., 1987; Giancola and Parrott, 2008; McCloskey et al., 2008).

An aspect of aggression paradigms, including the TAP, is that they are mostly used to compare group differences. Such differences include experimental manipulations (e.g., social interaction during neuroimaging, Krämer et al., 2007; alcohol intoxication, Chermack and Taylor, 1995; Giancola and Parrott, 2008; psychoactive medications, Berman et al., 2009) and/or participant factors (e.g., psychopathy traits, Fanning et al., 2014; endogenous hormones, Berman et al., 1993); however, these studies largely rely on self-reports to measure participants' propensity for aggression. At the time of writing, little has been reported on using an aggression paradigm to directly measure this propensity. The purpose of this study is to evaluate the validity and psychometric properties of a modified TAP using a large, clinically relevant sample of aggressive adults and control participants as a measure of aggression. We hypothesize aggressive individuals (who meet criteria for IED), will select higher shock intensities on average (mean shock index) and more "extreme" high shocks (high shock index) compared to psychiatric and non-psychiatric control participants. We predict the behavioral indexes will relate to measures of aggression and to related constructs of anger and impulsivity, but that high shock index will more closely relate specifically to measures of aggression, supporting the external and construct validity of the TAP high shock index. We further predict the use of high shocks will relate specifically to aggressive behavior and will show a stronger relationship to aggression compared to mean shock index. Finally, we predict the TAP behavioral indexes will show no relation or only weak relation to measures of negative affect (current depression and anxiety severity) and to pain tolerance, variables which might confound interpretation of the indexes.

## 2. Methods

### 2.1. Participants

Nine-hundred sixty-two adult individuals participated in this study. All participants were physically healthy and were systematically evaluated regarding aggressive and other behaviors as part of a larger program designed to study correlates of impulsive aggression and other personality-related behaviors. Participants were recruited through public service announcements, newspaper, and other media, advertisements seeking individuals who: a) reported psychosocial difficulty related to one or more psychiatric conditions or, b) had little evidence of psychopathology. All participants gave informed consent and signed the informed consent document approved by our Institutional Review Board.

### 2.2. Diagnostic assessment

Syndromal and personality disorder diagnoses were made according to DSM-5 criteria. Diagnoses were made using information from: (a) the Structured Clinical Interview for DSM Diagnoses (SCID-I; First et al., 2016) for syndromal disorders and the Structured Interview for the Diagnosis of DSM Personality Disorder (SIDP; Pfohl et al., 1997) for personality disorders; (b) clinical interview by a research psychiatrist; and, (c) review of all other available clinical data. Information used to make a diagnosis of IED were collected using the (optional) SCID module for IED. Inter-rater reliabilities were in the good to excellent range (mean kappa of .84 ± 0.05; range: 0.79 to 0.93) across anxiety, mood, substance use, impulse control, and personality disorders; see Supplemental Material for more details. Final diagnoses were assigned by team best-estimate consensus procedures involving research psychiatrists and clinical psychologists as previously described. Participants with a current substance use disorder or a life history of any bipolar disorder, schizophrenia (or other psychotic disorder), or intellectual/developmental disability were excluded. In addition, participants with history of traumatic brain injury with loss of consciousness of greater than 30 min were excluded.

After diagnostic assignment, 353 participants had no evidence of any psychiatric diagnosis (Healthy Controls: HC), 377 participants met criteria for a current/lifetime diagnosis of a syndromal psychiatric disorder and/or a personality disorder but not IED (Psychiatric Controls: PC), and 254 participants met criteria for IED. Of the 631 participants with history of a psychiatric disorder, most (66.4%) reported: a) history of formal psychiatric evaluation and/or treatment (51.8%) or b) history of behavioral disturbance during which the participant or others thought they should have sought mental health services but did not (14.6%). Table 1 lists descriptive statistics for demographic, psychosocial functional/life satisfaction, and psychometric behavioral variables for all groups; Table 2 lists the syndromal and personality disorder diagnoses for the psychiatric groups.

### 2.3. Psychometric assessment of aggression, impulsivity, and related behaviors

Aggression was assessed with the aggression scales of the Life History

**Table 1**
Demographic and psychometric variables by group.

| | Healthy Controls | Psychiatric Controls | Intermittent Explosive Disorder | | |
|---|---|---|---|---|---|
| | ($n$ = 347) | ($n$ = 370) | ($n$ = 245) | $p$ | Group Differences |
| Demographics | | | | | |
| Age (Mean ± SD) | 34.0 ± 10.3 | 35.9 ± 9.4 | 37.8 ± 10.3 | <0.001[a] | HC < PC < IED |
| Sex (% Male) | 42.40% | 44.30% | 43.30% | = 0.869[b] | HC=PC = IED |
| Race (% White) | 79.30% | 83.00% | 49.40% | <0.001[b] | HC=PC > IED |
| SES Score (Mean ± SD) | 49.6 ± 10.9 | 47.9 ± 11.9 | 39.7 ± 13.5 | <0.001[a] | HC=PC > IED |
| GAF Score (Mean ± SD) | 82.8 ± 4.8 | 71.1 ± 9.7 | 56.2 ± 9.7 | <0.001[a] | HC > PC > IED |
| Trait Aggression (Mean ± SD) | | | | | |
| LHA | 5.6 ± 3.7 | 7.9 ± 4.8 | 17.5 ± 4.3 | <.001 | HC < PC < IED |
| BPA | 27.0 ± 7.9 | 29.8 ± 8.6 | 44.0 ± 12.5 | <.001 | HC < PC < IED |
| Trait Anger (Mean ± SD) | | | | | |
| BPA | 13.5 ± 4.6 | 15.4 ± 5.2 | 23.5 ± 6.8 | <.001 | HC < PC < IED |
| STAXI-2 | 13.4 ± 3.1 | 16.3 ± 4.7 | 24.9 ± 7.6 | <.001 | HC < PC < IED |
| Trait Impulsivity (Mean ± SD) | | | | | |
| LHIB | 27.7 ± 17.8 | 39.2 ± 18.6 | 54.2 ± 18.5 | <.001 | HC < PC < IED |
| BIS-11 | 58.4 ± 9.7 | 62.9 ± 9.6 | 69.6 ± 11.3 | <.001 | HC < PC < IED |
| State Mood (Mean ± SD) | | | | | |
| BDI-2 | 3.1 ± 6.8 | 7.14 ± 9.4 | 15.0 ± 12.8 | <.001 | HC < PC < IED |
| BAI | 23.4 ± 3.4 | 26.5 ± 6.4 | 30.8 ± 9.2 | <.001 | HC < PC < IED |

*Note.* Means ± SD based on raw data; SES = socioeconomic status; GAF = Global Assessment of Functioning; LHA = Life History of Aggression; BPA = Buss-Perry Aggression Questionnaire; STAXI-2 = State-Trait Anger Expression Inventory-2; LHIB = Life History of Impulsive Behavior; BIS-11 = Barratt Impulsivity Scale – 11-Item; BDI-2 = Beck Depression Inventory – 2; BAI = Beck Anxiety Inventory.
[a] By ANOVA.
[b] By Chi-Square.

of Aggression assessment (LHA: α = 0.86; Coccaro et al., 1997) and of the Buss-Perry Aggression (BPA: α = 0.90; Buss and Perry, 1992) questionnaire. LHA Aggression assesses history of actual aggressive behavior while the BPA assesses aggressive tendencies as a personality trait. LHA Aggression is a widely used five-item measure that quantitatively assesses one's life history of overt aggressive behavior, not aggressive thoughts or urges, conducted as a semi-structured interview. BPA Aggression, another widely used assessment of trait aggression, is composed of the BPA's Physical Aggression (α = 0.89) and Verbal Aggression (α = 0.79) subscales. Impulsivity was assessed with the Barratt Impulsiveness Scale (BIS-11: α = 0.86; Patton et al., 1995), which measures frequency of impulsive behaviors, and the Life History of Impulsive Behavior (LHIB: α = 0.95; Coccaro and Schmidt-Kaplan, 2012), which measures the number of times one has engaged in specific impulsive behaviors. Trait anger was assessed using the BPA Anger subscale (α = 0.88) and State-Trait Anger Expression Inventory (STAXI-2; Spielberger, 1999) Trait Anger subscale (α = 0.95), which measures predisposition to anger. State depression and state anxiety were assessed with the Beck Depression Inventory-2 (BDI-2: α = 0.96; Beck et al., 1996) and the Beck Anxiety Inventory (BAI: α = 0.91; Beck and Steer, 1993). Quality and satisfaction of life experience was assessed by the Quality of Life Experience and Satisfaction Questionnaire (Q-LES-Q: α = 0.94; Endicott et al., 1993); overall psychosocial function was assessed with the Global Assessment of Function (GAF) scale during the diagnostic assessment. Socio-economic status (ses) was estimated by the method of Hollingshead (1975).

**Table 2**
Current and lifetime syndromal disorders and personality disorders in psychiatric control and intermittent explosive disorder groups.

| | Psychiatric Controls | Intermittent Explosive Disorder | $p$ |
|---|---|---|---|
| | ($n$ = 370) | ($n$ = 245) | |
| Current Syndromal Disorders: | | | |
| Any Depressive Disorder | 22 (5.9%) | 58 (23.7%) | <0.000* |
| Any Anxiety Disorder | 59 (15.9%) | 61 (24.9%) | 0.007 |
| Stress and Trauma Disorders | 20 (5.4%) | 34 (13.9%) | <0.001* |
| Obsessive-Compulsive Disorders | 5 (1.4%) | 8 (3.3%) | 0.151 |
| Eating Disorders | 5 (1.4%) | 13 (5.3%) | 0.006 |
| Non-IED Impulse Control Disorders | 0 (0.0%) | 2 (0.8%) | 0.158 |
| Lifetime Syndromal Disorders: | | | |
| Any Depressive Disorder | 142 (38.4%) | 169 (69.0%) | <0.001* |
| Any Anxiety Disorder | 86 (23.3%) | 79 (32.2%) | = 0.016 |
| Any Substance Use Disorder | 129 (34.9%) | 123 (50.2%) | <0.001* |
| Stress and Trauma Disorders | 69 (18.4%) | 54 (22.0%) | = 0.302 |
| Obsessive-Compulsive Disorders | 13 (3.5%) | 13 (5.3%) | = 0.309 |
| Eating Disorders | 28 (7.6%) | 28 (11.4%) | = 0.085 |
| Non-IED Impulse Control Disorders | 5 (1.0%) | 24 (3.5%) | = 0.116 |
| Personality Disorders: | | | |
| Any PD | 125 (33.8%) | 201 (82.0%) | <0.001* |
| Cluster A (Odd) | 6 (1.6%) | 36 (14.7%) | <0.001* |
| Cluster B (Dramatic) | 20 (5.4%) | 103 (42.0%) | <0.001* |
| Cluster C (Anxious) | 47 (17.0%) | 57 (23.3%) | = 0.001* |
| PD-NOS | 62 (17.0%) | 63 (25.0%) | = 0.001* |

To assess divergent validity, extraversion and positive thoughts were measured using the Eyesnck Personality Inventory – Extraversion (EXT: α = 0.85; Eysenck, 1964) subscale and the Automatic Thoughts Questionnaire – Positive (ATP: α = 0.94; Ingram et al., 1995) subscale, respectively.

### 2.4. *Analog laboratory assessment of aggression: Taylor Aggression Paradigm (TAP)*

The TAP procedure begins by attaching fingertip electrodes to the index and middle fingers of the participant's non-dominant hand. The experimenter informed the participant that they would be competing in a task against another (fictitious) participant who was in a different room in the research suite. The experimenter then excused themselves "to prepare the other participant" for the experiment. After a short delay, an upper shock pain threshold was determined by administering increasingly intense shocks at 100-μA intervals until the participant reported that the shock was "very unpleasant." To increase the credibility of the experimental situation, this procedure was repeated with the other "participant" (an audiotape of a same sex confederate) and overheard by the participant. After the threshold determination, task instructions were provided via intercom to both "participants," indicating that the purpose of the task was to see which participant could lift a finger off a reaction-time key the fastest. Before each reaction time trial, each participant was to select a shock from 0 through 10 (standard shock levels) or 20 (extreme shock level) by pressing 1 of 12 buttons on the bottom of the console. The slower person on each trial would receive the shock chosen by their opponent before that trial. The 10 shock was equivalent to the shock level judged very unpleasant. The 9 shock was set at 95% of this maximum, 8 at 90%, 7 at 85%, and so forth. The participant was informed that the 20 shock would administer a “severe” shock, twice the intensity of the 10. While the participant can select a 20-level shock to be delivered to the fictitious opponent at any time during the TAP, the participant only received the threat of a 20 level shock once from the opponent during the fourth block; the participant does not receive the shock because the participant “wins” that trial. Accordingly, a 10-level shock selected by the participant represents high aggression, and a 20-level shock represents extreme aggression, towards the opponent. Participants were told that if they selected a 0, no shock would be administered to their opponent on losing trials (a nonaggressive response option included to increase the ecological validity of the task). Participants next completed 28 reaction-time trials consisting of an initial trial, followed by four 6-trial blocks of increasing provocation by the opponent. The average shock setting by the fictitious opponent across the first three blocks was 2.5, 5.5, and 8.5, respectively. The fourth block differs from the third block only in that a highly aversive “20” shock is ostensibly selected by the opponent on one trial. Blocks were separated by a trial of intermediate intensity to smooth the transition between blocks. The participant lost (received the opponent shock) on half the trials, with the frequency of wins and losses pre-programmed by the experimenter.

### 2.5. Test-retest TAP assessments

In addition to a single TAP on all participants, data was also available from another TAP session within the same year (mean [±SD] interval: 17.1 ± 5.5 weeks; range: 11–45 weeks) for 47 study participants (Controls = 22, IED = 25). Study participants who underwent TAP procedures more than once did not differ from the rest of the group on any demographic (age, sex, ethnicity, ses status) variable.

### 2.6. Pre- and Post-TAP assessments

Prior to and immediately after the TAP, 777 of the 962 participants (81%) completed five 100 mm Visual Analog Scales (VAS) regarding their emotional state (i.e., calm, happy, angry, nervous, sad). Participants also completed a post-task questionnaire to confirm that the social conditions of the TAP were accepted by the participant. Only individuals who accepted the conditions of the study (i.e., paired with an opponent in another room) were included in this study.

### 2.7. Statistical analysis and data reduction

For the TAP, we examined three TAP outcomes: a) mean “overall” shock level (Mean TAP), b) mean “high and extreme” shock level (i.e., shock levels 10 and 20: TAP-10/20), both selected by the participant block to block and, c) Unprovoked TAP Aggression is the level of shock selected by the study participant on the very first trial before any shock had been delivered to the study participant. The three main TAP variables did not follow a normal distribution and, thus, these variables were log-transformed ($\log_{10}$). Two of the log TAP outcome variables (Mean TAP, Unprovoked TAP) had no “outliers” (defined as a value that was three standard deviations above/below the mean); only 2.1% of log TAP-10/20 values represented outlier values and all were used in the data analysis. Statistical procedures included Chi-square, *t*-test, and analysis of covariance (ANCOVA) as appropriate. All reported analyses were adjusted for age, sex, ethnicity, and socio-economic status (ses). Assessment of test-retest reliability was done through Pearson correlation and paired *t*-test. A two-tailed alpha value of 0.05 was used to denote statistical significance for all analyses except in cases where a correction for multiple comparisons was appropriate. Post-hoc analyses involved adjustment for comorbid syndromal disorders (lifetime, depressive, substance use, and stress/trauma disorders) and for state depression state anxiety scores.

## 3. Results

### 3.1. Demographic and psychometric characteristics of the sample (Tables 1 and 2)

The three diagnostic groups differed modestly, but significantly, in age, SES score, and ethnicity distribution but not in sex distribution. Accordingly, all relevant analyses included sex, race, and SES as covariates. The groups differed in all psychosocial function/satisfaction and in all psychometric behavioral variables, as expected (Table 1). Finally, PC and IED groups did not significantly differ in rates of syndromal comorbidity except for lifetime depressive, lifetime substance use, and current and lifetime stress/trauma disorders (Table 2).

### 3.2. TAP aggressive responding: block to block

Raw mean TAP values increased in stepwise fashion across the four blocks (Block 1: 2.50 ± 2.08; Block 2: 3.63 ± 2.48; Block 3: 4.84 ± 3.13; Block 4: 4.97 ± 3.30) in the context of increasing shock level set by the fictitious opponent from low (2.5), medium (5.5), to high shock (8.5) to high shock with threat of extreme aggression (~10.0) in Block 4. The increase in TAP aggressive responding from Block 1 to 2 and from Block 2 to 3 were both highly significant ($p < 0.0001$) and large in size ($d = 0.82$, $d = 0.75$, respectively); the increase from Block 3 to 4 was significant ($p = 0.005$) but much smaller in size ($d = 0.09$).

### 3.3. Psychometric properties of TAP variables

#### 3.3.1. Internal consistency

Alpha coefficients for log mean TAP across the four blocks was 0.96. The alpha coefficient for log mean TAP-10/20 was lower but still high ($\alpha = 0.85$). These two TAP variables were highly correlated ($r = 0.67$, $p < 0.001$) and only overlapped by 45% ($r^2 = 0.45$). Alpha coefficients for the behavioral self-ratings ranged from 0.79 (“nervous”) to 0.95 (“happy” or “sad”); mean (±SD) for $\alpha = 0.87 \pm 0.08$.

#### 3.3.2. Test-retest reliability

*3.3.2.1. Mean TAP & TAP-10/20 aggressive responding.* The test-retest correlation coefficients were 0.73 ($p < 0.001$) for log mean TAP values and 0.63 ($p < 0.001$) for log mean TAP-10/20 values. For both, the magnitude of log mean TAP values was modestly, but non-significantly, higher during the second session (i.e., Δ log mean TAP = 0.04 ± 0.26, $p = 0.247$, $d = 0.17$; Δ log mean TAP-10/20 = 0.07 ± 0.40, $t_{46} = 1.24$, $p = 0.222$; $d = 0.18$). Despite the wide interval between the two sessions (mean [±SD]: 17.1 ± 5.5 weeks; range: 11–45 weeks), there was no correlation between number of days between TAP 1 and TAP 2 and the difference between TAP 1 and TAP 2 values expressed as log mean TAP (r = −0.03, p = 0.853), log mean TAP-10/20 (r = 0.01, p = 0.951) values.

*3.3.2.2. Unprovoked aggression.* The test-retest correlation coefficient for log mean unprovoked aggression values was 0.70 ($p < 0.001$). The difference between TAP sessions was small ($d = 0.08$) and non-significant ($t_{46} = 0.56$, $p = 0.581$). As with log mean TAP and log mean TAP-10/20 values, there was no significant correlation between number of days between TAP 1 and TAP 2 and the difference between log mean unprovoked aggression values (r = −0.14, p = 0.342).

### 3.4. Convergent validity

#### 3.4.1. Correlations with assessments of trait aggression, anger, and impulsivity

Mean log TAP values correlated positively with Composite Trait Aggression (β = 0.102, $p = 0.004$), Composite Trait Anger (β = 0.129, $p < 0.001$), and Composite Trait Impulsivity (β = 0.101, $p = 0.003$) scores examined individually. When placed in the same model, however, only Composite Trait Anger correlated significantly with mean log TAP values (β = 0.102, $p = 0.059$); beta values for Composite Aggression and Composite Impulsivity were 0.004 ($p = 0.949$) and 0.044 ($p = 0.258$), respectively. Mean log TAP-10/20 values displayed larger relationships with these variables (Aggression: β = 0.245, $p < 0.001$; Anger: β = 0.212, $p < 0.001$; Impulsivity: β = 0.140, $p < 0.001$) individually. Placing each variable in the same model revealed that mean log TAP-10/20 values correlated with Composite Aggression scores only (β = 0.184, $p < 0.001$); beta values for Composite Anger and Composite Impulsivity were 0.068 ($p = 0.191$) and 0.034 ($p = 0.347$), respectively, and non-significant.

#### 3.4.2. Correlations with specific forms of trait aggression

Multiple regression analysis including both BPA Physical Aggression and BPA Verbal Aggression in the model revealed that log mean TAP values reflected Physical Aggression (β = 0.074, $p = 0.089$) to a greater degree than Verbal Aggression scores (β = 0.041, $p = 0.328$), though neither reached significance. Similar analysis using log mean TAP-10/20 values, however, revealed stronger and significant relationships with both Physical Aggression (β = 0.158, $p < 0.001$) and Verbal Aggression (β = 0.109, $p = 0.006$) scores.

### 3.5. Divergent validity

Correlations between log mean TAP values and variables chosen, *a priori*, to have no relationship with aggression (i.e., EXT and ATP) were small and non-significant (EXT: β = −0.049, $p = 0.139$; ATP: β = 0.007, $p = 0.869$). The same was found for log mean TAP-10/20 (EXT: β = −0.033, $p = 0.305$; ATP: β = 0.014, $p = 0.721$) and for log mean unprovoked TAP (EXT: β = 0.027, $p = 0.415$; ATP: β = 0.008, $p = 0.841$) values.

### 3.6. Discriminate validity

#### 3.6.1. TAP values block to block

Both log mean TAP and log mean TAP-10/20 values increased from Block 1 to Block 4 in each group; Figs. 1 and 2. In both comparisons, TAP and TAP-10/20 values were similar between HC/PC compared with IED participants for each block (except for Block 3 where PC participants had higher log mean TAP values than HC participants).

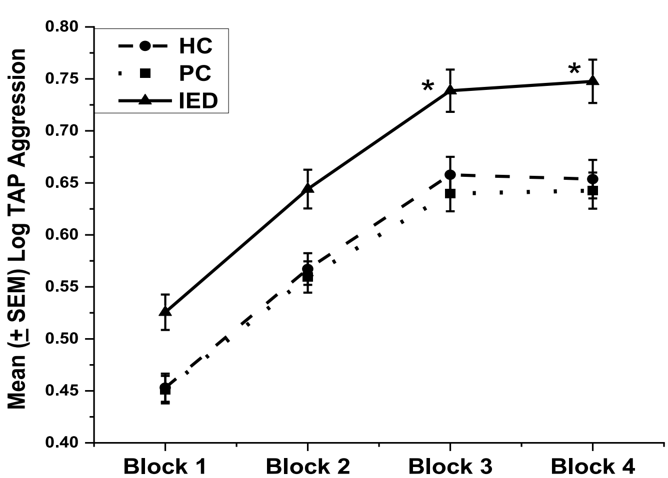


**Fig. 1.** Log mean TAP aggression by groups across blocks.

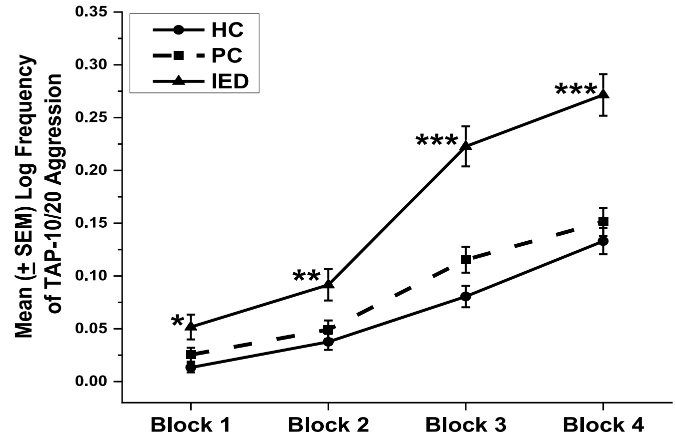


**Fig. 2.** Log mean TAP-10/20 aggression by groups across blocks.

#### 3.6.2. Mean TAP values overall

Mean log TAP values discriminated between both groups of controls (HC/PC) from those with IED ($F[1932] = 4.13$, $p = 0.016$), as did mean log TAP-10/20 values ($F[1932] = 18.20$, $p < 0.001$), though the effect size for the former ($d$ for HC vs. IED = 0.21, $d$ for PC vs. IED = 0.24) was smaller than the latter ($d$ for HC vs. IED = 0.51, $d$ for PC vs. IED = 0.39); Fig. 3. Notably, IED participants were about twice as likely to select high shock (Shock Setting 10) and/or extreme shock (Shock Setting 20) for the opponent at least once compared with HC or PC participants who did not differ in this regard (IED: 58.8% vs. PC: 33.0% vs. HC: 33.4%; $X^2 = 49.93$, df = 2, $p < 0.001$). Similar analyses using those with Antisocial (AsPD) and/or Borderline Personality Disorder (BPD) as the "aggression" group yielded a similar finding, except that the effect size was greater for IED vs. Non-IED than for AsPD/BPD vs. Non-AsPD/BPD (e.g., log mean TAP-10/20: partial $\eta^2 = 0.036$ vs. partial $\eta^2 = 0.012$).

### 3.7. Relationships with other behavioral variables: state depression and state anxiety

Log mean TAP values did not correlate with BDI Depression scores (β = 0.055, $p = 0.109$) but correlated modestly with BAI Anxiety scores (β = 0.120, $p < 0.001$). Log mean TAP-10/20 values correlated with both

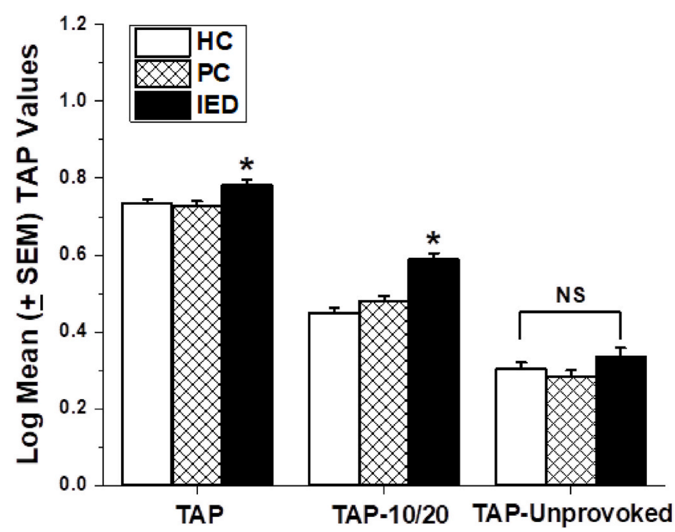


**Fig. 3.** Log mean TAP, log mean TAP-10/20, and unprovoked aggression by group.

scores (BDI: β = 0.108, $p$ = 0.001; BAI: β = 0.117, $p$ < 0.001). The addition of Composite Aggression scores to the models diminished the relationships with both BDI (log mean TAP: β = 0.004, $p$ = 0.919; log mean TAP-10/20: β = 0.001, $p$ = 0.979) and with BAI (log mean TAP: β = 0.102, $p$ = 0.010; log mean TAP-10/20: β = 0.089, $p$ = 0.017). Notably, however, beta values for Composite Aggression scores were significant for log mean TAP-10/20 values (β = 0.212, $p$ < 0.001) but not for log mean TAP values (β = 0.054, $p$ = 0.180).

### 3.8. Unprovoked aggression

#### 3.8.1. Overall

The magnitude of shock settings for the first TAP trial (i.e., "unprovoked aggression") correlated both with mean log TAP ($r$ = 0.50, $p$ < 0.001) and mean log TAP-10/20 ($r$ = 0.39, $p$ < 0.001) values. Despite this, participants did not differ in unprovoked aggression as a function of diagnostic status ($F$[2932] = 1.58, $p$ = 0.206); Fig. 3 (right).

#### 3.8.2. Correlations with relevant behavioral variables

Unprovoked aggression values were modestly related to Composite Aggression (β = 0.077, $p$ = 0.026), Anger (β = 0.074, $p$ = 0.028), and Impulsivity (β = 0.077, $p$ = 0.041) scores individually. Together, however, these variables explained only 0.8% of the variance above that explained by the demographic covariates (i.e., Step 2 of the model; $\Delta R^2$ = 0.008, $p$ = 0.047). By comparison, log mean TAP values explained variance beyond those of the covariates by two-fold ($\Delta R^2$ = 0.016, $p$ = 0.002), and log mean TAP-10/20 values explained variance beyond the covariates by seven-fold ($\Delta R^2$ = 0.056, $p$ < 0.001). Finally, mean log unprovoked aggression values did not correlate with either BDI Depression or BAI Anxiety scores.

### 3.9. Behavioral self-ratings

Only the VAS score for "nervous" displayed a significant difference over time ($F$[1770] = 11.03, $p$ = 0.001), with a large reduction in "nervous" rating from prior to and after the TAP (28.02 ± 27.73 vs. 10.27 ± 16.53; $d$ = 0.08) for all participants. Despite this, there was no significant effect of group ($F$[2770] = 1.21, $p$ = 0.300) or time × group interaction ($F$[2770] = 2.24, $p$ = 0.107) for VAS "nervous" score. While no other VAS score displayed a significant difference over time, groups differences were observed for overall (Pre- and Post-) scores for VAS "angry" ($F$[2770] = 11.42, $p$ < 0.001; IED > PC═HC) and VAS "sad" ($F$[2770] = 3.54, $p$ = 0.029; IED > HC only). Group differences for VAS "Happy" ($F$[2770] = 10.24, $p$ < 0.001; HC > PC > IED) and VAS "calm" ($F$[2770] = 3.66, $p$ = 0.026; HC > IED only) were also observed but in the opposite direction.

### 3.10. Shock Threshold settings

#### 3.10.1. Relationship with TAP, TAP-10/20, TAP unprovoked aggression values

Relationships between mean log TAP values and the low and high thresholds for shock setting thresholds were small but significant (Low Threshold: β = 0.110, $p$ = 0.002; High Threshold: β = 0.155, $p$ < 0.001). The low shock setting threshold did not correlate with log mean TAP-10/20 values (β = 0.027, $p$ = 0.433) but, correlated modestly with high threshold shock settings (β = 0.134, $p$ < 0.001). Log mean Unprovoked Aggression values were both modestly correlated with Low (β = 0.087, $p$ = 0.012) and High (β = 0.065, $p$ = 0.045) Thresholds for shock settings.

#### 3.11.1. Correlations with relevant behavioral variables

Low, but not high, shock threshold level correlated with the Composite Aggression score (Low: β = 0.104, $p$ = 0.001; High: β = 0.039, $p$ = 0.234). Otherwise, neither shock threshold level correlated with Composite Anger or Composite Impulsivity scores. Finally, neither threshold shock setting correlated with BDI or BAI scores.

## 4. Discussion

We studied a large sample of adult men and women who completed a variation of the Taylor Aggression Paradigm (TAP) that includes an "extreme" shock option as part of a larger, ongoing research program on impulsive aggression. Group assignment was based on diagnostic assessment: 1) those who met criteria for IED, 2) control participants who met criteria for another psychiatric diagnosis (PC), and 3) control participants who did not meet criteria for a psychiatric diagnosis and considered "healthy" (HC). Using these groups, we were able to compare TAP index scores between participants who frequently engage in impulsive aggressive behaviors and those who have relatively low rates of aggressive behaviors in general. While individuals with other disorders (e.g., AsPD and/or BPD) also exhibit aggressive behavior on the TAP (Bertsch et al., 2022), our AsPD/BPD group represented less than a third of all aggressive individuals in the sample and, thus, IED was a more inclusion group for this study.

Our goal was to assess the psychometrics and validity of the TAP as a measure of aggression; specifically, we assessed the overall average shock selection per block (mean shock index), average "high" and "extreme" shocks per block (high shock index), and unprovoked aggression (i.e., shock selection during the "mild" shock block).

Overall, mean shock index, high shock index, and unprovoked aggression were consistent and reliable. Mean shock and high shock indexes were consistent across provocation blocks. In a subsample of participants who completed a follow-up TAP session (11–45 weeks later), all indexes were correlated between sessions; the magnitude of all three indexes did not differ between sessions. Unsurprisingly, mean shock and high shock indexes were significantly correlated; however, they only shared 45% of their variance, suggesting the two represent distinct yet overlapping indexes.

When examining TAP indexes across groups, IED participants had higher mean shock and high shock indexes compared to both HC and PC participants. Additionally, the effect size for high shock index was greater than mean shock index, and IED participants were twice as likely to select a "high" (10) or "extreme" (20) shock at least once compared to other participants. Thus, our hypothesis that aggressive individuals would select higher shocks on average and a greater number of "extreme" shocks was supported, meaning that TAP indexes appropriately discriminated individuals who often behave aggressively from those who do not. Analyses of both mean shock and high shock indexes found associations between the two indexes and aggression-related factors: trait aggression, impulsivity, and trait anger. Both indexes were correlated with all three factors individually; also, the correlations were stronger for high shock index compared to those with mean shock index. This supports our second hypothesis that both measures would be related to factors related to aggression, particularly the high shock index, and provides evidence for convergent validity.

In a combined model examining trait aggression, impulsivity, and trait anger for high shock index, only trait aggression remained significant. Follow-up analyses with subscales related to physical and verbal aggression found that both significantly predicted high shock index, but the association with physical aggression was stronger. In comparison, for the mean shock index combined model, only trait anger remained significant; neither physical nor verbal aggression were associated with mean shock index. Limited studies have compared these indexes separately with aggression-related factors and their unique associations (e.g., Giancola and Parrott, 2008; McCloskey et al., 2008). That said, our findings promote the notion that high shock index is more strongly related to trait aggression compared to mean shock index, which itself is more strongly related to trait anger; thus supporting our hypothesis that high shock index would demonstrate a stronger relationship with aggression than mean shock index. While impulsive aggression generally is elicited by feelings of anger and hostility, aggression is not inevitable. Summarily, it appears high shock index is a better measure of impulsive aggression, and mean shock index is a better measure of the propensity to experience anger.

Our final prediction, that TAP indexes would not be strongly related to negative affect and pain tolerance, was generally supported. Both mean shock index and high shock index were correlated with current anxiety; however, inclusion of trait aggression weakened these correlations (βs dropped to 0.102 for mean shock index and to 0.089 for high shock index). Similarly, high shock was correlated with current depression until trait aggression was included in the analysis. Trait aggression was only related to high shock index, further suggesting these indexes measure overlapping but unique constructs. Comparatively, pain perception measures were only slightly to modestly correlated with TAP indexes. Our results also indicated TAP indexes were not associated with extraversion or automatic positive thoughts, factors unrelated to aggression, providing evidence for TAP indexes' divergent validity.

Combined with extant literature, our results provide further evidence of the validity of the modified TAP, including options to not aggress or to clearly to cause pain, as a laboratory aggression task and establish the construct validity and psychometrics of TAP indexes as measures of impulsive aggression and trait anger. Interestingly, although both the high shock index and mean shock index were able to discriminate between participants with a clinically significant history of impulsive aggression versus those without, the indexes were associated with different aggression-related factors. Therefore, we propose that high shock index is the better measure of impulsive aggressive responding and that mean shock index is a better measure of general offensive responding - a tendency towards anger and hostility without necessarily acting on those feelings.

Given the large, clinically relevant sample use, we believe our results demonstrate a strong foundation for the use of TAP indexes as stand-alone measures of aggression in addition to an aggression task. Such measures are becoming more necessary as the field has begun to examine neural bases of aggression (e.g., Brunnlieb et al., 2013; Krämer et al., 2007; Lotze et al., 2007), requiring researchers to use efficient, pragmatic methodology given the resource-intensive nature of neuroimaging studies. Future research may build upon this study by comparing participants with IED to those with other impulse-control disorders without aggressive behavior to examine whether the TAP indexes differentiate between clinically significant levels of aggression and impulsivity.

### 4.1. Strengths and limitations

This study had several strengths. The large, clinical sample that included participants with and without IED provided the ability to differentiate aggressive responding on the TAP between those with a significant history of aggressive behavior compared to other general psychopathology. Our sample did include individuals meeting criteria for other psychiatric disorders for which aggression is a supporting criterion or feature; however, a diagnosis of IED was more inclusive of past aggressive behavior in the current sample and demonstrated a stronger effect size when comparing TAP outcomes between diagnostic groups.

While the use of IED for group assignment was more inclusive than other disorders often associated with aggression, this study was limited in the ability to make comparisons with other specific diagnoses. This was largely due to specifically recruiting individuals with a history of impulsive aggression. Future research may benefit from specifically including those with impulse control disorders or other disorders characterized by impulsivity to determine if our results that trait aggression is more strongly related to TAP outcomes than trait impulsivity can be replicated within a generally impulsive sample. Similarly, recruiting a greater number of participants for a second TAP in the future would provide stronger evidence for the reliability of the TAP protocol used in the current study.

## Author statement

E.F.C., M.S.M, and M.E.B. implemented the experimental procedure and task design and E.F.C. developed the study concept. Data collection was supervised by M.S.M. E.F.C. performed the data analysis and wrote the initial draft of the paper with M.A.T. and J.R.F writing the subsequent drafts. All authors contributed to interpretation of the data, provided critical revisions, and approved the final version of the paper for submission.

## Declaration of competing interest

Dr. Coccaro reports being on the Scientific Advisory Board of Azevan Pharmaceuticals and a consultant for Boheringer-Ingelheim Pharmaceuticals; Drs. Timmins, Fanning, McCloskey, and Berman report no biomedical financial interests or potential conflicts of interest.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychires.2023.05.081.

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