



The Overt Aggression Scale Modified (OAS-M) for clinical trials targeting impulsive aggression and intermittent explosive disorder: Validity, reliability, and correlates

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ABSTRACT

While aggressive behavior is common, and a disorder of impulsive aggression has been defined in the DSM-5 (Intermittent Explosive Disorder: IED), there are no currently FDA approved interventions to reduce these behaviors. One obstacle to the development of interventions to treat aggression is the paucity of psychometrically valid measures to assess aggressive behavior in the context of clinical trials, especially those in the outpatients setting. While there are many assessment of trait aggression, very few attempt to assess current aggressive behavior over time and/or in individuals not in a closed setting. The Overt Aggression Scale Modified (OAS-M) was developed to fill this void and this paper reviews its development along with presenting new data on its validity, reliability, and correlates with related constructs. Overall, the OAS-M is a valid and reliable measure of state (e.g., week to week) aggression, has good psychometric properties, and shows evidence of change in clinical trials of agents with putative anti-aggressive efficacy.

1. Introduction

Aggressive behavior is common and has wide ranging ramifications for society both from the viewpoint of those who engage in aggressive behavior and of those upon whom the aggressive behavior is directed (Coccaro et al., 2019a, 2019b). Aggressive behavior can take several forms: it can be predatory/pre-meditated, or more commonly, impulsive/anger based in nature (Fanning et al., 2019a). Most importantly, impulsive aggression appears as a discrete taxon (Ahmed et al., 2010; Fanning et al., 2019b) and can be distinguished from pre-meditated aggression in terms of biological and treatment correlates (Linnoila et al., 1983; Barratt et al., 1997).

While there are no currently FDA approved agents to treat impulsive aggression, DSM-5 (American Psychiatric Association, 2013) best characterizes recurrent, problematic, impulsive aggression as Intermittent Explosive Disorder (IED), a disorder with a lifetime/past year prevalence of 4.0%/2.6% in the U.S. (Coccaro, 2019). Despite the presence of this sizable and largely untreated group (Coccaro and Lee, *In Press*), the development of treatment interventions for impulsive aggression has been limited by the paucity of validated measures to assess changes in these behaviors over time, particularly in outpatient settings.

Most instruments available to assess aggression are trait in nature

and are not suitable to assess changes in aggressive behavior as are needed in clinical trials. These measures include, for example, Life History of Aggression (LHA; Coccaro et al., 1997) and the Buss-Perry Aggression Questionnaire (BPAQ; Buss and Perry, 1992), among others.

The first instrument assessing severity of current aggressive acts was the Overt Aggression Scale (OAS; Yudofsky et al., 1986). The OAS recorded four (4) sub-components of aggressive acts for each aggressive act that occurred on an inpatient psychiatric unit. These sub-components were verbal assault, assault against objects, assault against others and assault against self. Each sub-component was scored according to severity on a 0–5 scale. This was followed, a year later, by the publication of the Staff Observation Aggression Scale (SOAS; Palmstierna et al., 1987), also developed to assess current aggressive acts in inpatient settings. While the OAS and SOAS are appropriate for the assessment of current aggression in inpatient settings, neither is appropriate for use in outpatient settings where the vast majority of individuals with problematic aggressive behaviors are found. This is because it is not possible to have regular and reliable informants on another individual's aggressive behavior in the real world.

In preparation for a clinical trial to test the efficacy of fluoxetine compared with placebo, we developed a modified version of the OAS for use in outpatients (OAS-M; Coccaro et al., 1991). While developing the OAS-M, two other modified versions of the OAS were developed by

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Table 1
Comparison of OAS and OAS-M items for aggression.

Type of Aggression	OAS ^a	OAS-M
Verbal Aggression	Makes loud noises, shouts angrily Yells mild personal insults Curses viciously, foul language, makes moderate threats to others or self Makes clear threats of violence towards others or self N/A	Snapped or yelled at someone Cursed or personally insulted someone Engaged in a verbal argument with someone Verbally threatened to hit someone subject knows Verbally threatened to hit a stranger
Aggression Against Objects	Slams door, scatters clothing, makes a mess Throws objects down, kicks furniture without breaking it, marks the wall Breaks objects, smashes windows Sets fires, throws objects dangerously N/A	Slammed door, kicked chair, threw clothes in anger Broke something in anger Broke several things in anger Set fire, vandalized, or damaged another's property Struck or injured/tortured a pet or other living thing.
Aggression Against Others	Makes threatening gestures, swings at people, grabs clothes Strikes, kicks, pushes, pulls hair (without injury to others) Attacks others, causing mild-to-moderate physical injury (bruises, welts, sprains) Attacks others, causing severe physical injury (broken bones, deep lacerations, internal injury) N/A	Made threatening gestures Assault resulting in no physical harm to another Assault resulting in some physical harm to another Assault resulting in some physical injury to another
Aggression Against Self	Picks or scratches skin, his self, pulls hair (with no or minor injury) Bangs head, hits fist into objects, throws self onto floor or into objects (hurts self without serious injury) Small cuts or bruises, minor burns Mutilates self, causes deep cuts, bites that bleed, internal injury, loss of consciousness, loss of teeth N/A	Assault that required medical attention. Hit, bit, or scratched self Banged head, or hit fists against wall Cut, bruised, or burned self, but only superficially Cut, bruised, or burned self deeply or seriously. Broke teeth, bone, or skull

^a From Yudofsky et al., 1986. MOAS items of Kay et al. (1988) are essentially the same with minor changes in wording.

other groups at around the same time (MOAS-1; Kay et al., 1988; MAOS-2; Knoedler, 1989). One version of the MAOS was developed primarily to study the phenomena of aggression (MAOS-1; Kay et al., 1988), particularly in those with severe mental illness in institutional settings (De Benedictis et al., 2012; Foley et al., 2007; Margari et al., 2005; Nicholls et al., 2009) while the other (MOAS-2; Knoedler, 1989) was developed to assess the anti-aggressive efficacy of beta-noradrenergic blockers. A third version of the MOAS has also been developed to aggression in the context of traumatic brain injury (OAS-MNR; Giles and Mohr, 2007) and has been used in studies of brain injury (Narevic et al., 2011). While OAS-M and its variants were each independently adapted by different groups, each are highly similar with the exception that the OAS-M includes a global score for anger and aggression while the MOAS variants do not.

The MOAS variants have been largely used in the behavioral study of aggression in psychiatric inpatients in the context of a clinical trial or not, while the OAS-M has been employed, primarily, in clinical trials of impulsive aggression (and/or IED). This include five trials with SSRIs (Coccaro et al., 2009, 2015; George et al., 2011; Lee et al., 2008; Silva et al., 2010) four with anticonvulsants (Coccaro et al., 2015; Hollander et al., 2003; Mattes, 2005, 2008) and two with Cognitive Behavioral Therapy (McCloskey et al., 2008; in preparation) In addition, the OAS-M has also been used in a comparative trial of olanzapine and valproic acid (Zarghami et al., 2013). While there are no data comparing any one assessment against another, the limited psychometric data available for each variant suggests that these assessments are, likely, comparable.

In this paper, we present new data from a large group of study participants with OAS-M data obtained in the outpatient setting. These data speak to the psychometric properties, reliability, validity, and relevant correlates of the OAS-M as a state measure of impulsive aggression for randomized clinical trials of individuals with recurrent, problematic, impulsive aggression, individuals who typically meet diagnostic criteria for Intermittent Explosive Disorder (IED).

2. Methods

2.1. Study participants

The data in this report primarily come from an analysis of 460

research study participants. These participants were characterized, after semi-structured research diagnostic interviews in the same manner as previously described (Coccaro et al., 2016) as meeting: a) DSM-5 Criteria for Intermittent Explosive Disorder (IED: $n = 336$), b) DSM-5 Criteria for other non-psychotic/non-bipolar disorders but not IED (Psychiatric Control; PC: $n = 44$), or no lifetime DSM-5 disorder (Healthy Controls; HC: $n = 80$). All subjects signed informed consent documents approved by the Institutional Review Board of the University of Chicago.

2.2. Structure of the OAS-M

The OAS-M is conducted as an interview by a behavioral assessor trained to perform OAS-M assessments (see below). The OAS-M assessor is not required to have a masters or doctoral degree but should have the equivalent of an undergraduate education, preferably in psychology or other related area. First, the OAS-M records the number/nature of impulsive aggressive outbursts (A_1 and A_2 DSM-5 IED criteria). Then, like the OAS, the OAS-M contains four (4) sub-components for an Aggression (AGG) score. Finally, unlike the OAS (or MOAS) the OAS-M contains two items that make up a Global Anger and Aggression (GAA) score.

2.3. Assessment for type of impulsive aggressive outburst

For the purposes of the OAS-M, an impulsive aggressive outburst is defined as an episode of rapidly escalating anger that results in a behavioral outburst (e.g., “temper tantrum”) involving verbal assault (e.g., “heated argument”) and/or physical assault to objects, others, or self. Typically, such outbursts are in response to social threat or frustration and last less than 30 min (McElroy, 1999). The number and nature of the impulsive aggressive (IED) outbursts is assessed and raters are trained to designate each outburst as meeting DSM-5 IED criteria for an A_1 or for an A_2 impulsive aggressive outburst, which are mutually exclusive. An A_1 outburst is designated in the absence of anything being damaged or destroyed and in the absence of serious physical injury (i.e., injury more than superficial in nature); an A_2 outburst is rated when something was damaged or destroyed or when someone was more than superficial injury (even if the injury in question does not lead to medical attention).

2.4. Assessment of overt aggression behavior

The items for the OAS-M Aggression (AGG) score were adapted from that of the OAS (Table 1), which was developed by a clinical research group specializing in aggressive behavior in inpatient psychiatric settings (Yudofsky et al., 1986), after discussions among the research team that assisted in the development of the OAS-M (Coccaro et al., 1991). Instead of four items under each aggression sub-component in the OAS, the OAS-M has five items (not including an item for “no events”); MOAS variants are similar to the OAS except that it also included an item for “no events”. OAS-M items are ordered according to increasing severity of aggressive behavior.

2.5. Assessment of Global Anger and Aggression

The items for the Global Anger and Aggression (GAA) score were taken directly from the “subjective anger” and “objective anger” items from the Schedule for Affective Disorders and Schizophrenia (SADS; Endicott and Spitzer, 1978) diagnostic assessment protocol. When initially developed, these latter items were referred to as a measure of “irritability” rather than “anger” because similar items, in the Buss-Durkee Hostility Inventory (BDHI; Buss and Durkee, 1957), the foremost aggression assessment at the time, were included as part of an “Irritability” scale. “Irritability” in the BDHI was defined as the “readiness to explode with negative affect” (i.e., with anger and/or aggression). The same types of items were later included in the “Anger” subscale of the updated BDHI now referred to as the Buss-Perry Aggression Questionnaire (BPAQ; Buss and Perry, 1992). Since the two items comprising this global score reflect the subjective experience of “anger” and the overt expression of “aggression” we re-named this variable “Global Anger and Aggression”.

2.6. Training for the OAS-M

Training is done through a structured manual which includes a lecture on the OAS-M and an illustrative video case as well as the operationalized rating rules. In addition, the manual contains five (5) detailed scripts demonstrating how the OAS-M is scored. Following this, candidate raters score two (2) videos and check their results with the answer key. If the candidate rater scores for these two video cases are within acceptable limits (i.e., a spread of one point, on either side of the expert rating, for Number of Outbursts and for the GAA score, and a 5% spread on either side of the expert rating, for the AGG score), the candidate rater scores an additional eight videos which are then used to compute an ICC against the Expert Rating. Intra-class coefficient (ICC for absolute agreement) values ≥ 0.75 are considered acceptable for OAS-M Certification, though in practice the ICCs are usually higher. An excerpt from the OAS-M Manual can be found in Supplemental Files.

2.7. Interview procedure for OAS-M

The OAS-M interview begins with the assessor asking the subject about how many impulsive aggressive outbursts he/she may have had in the past week. While those with recurrent problematic impulsive aggression typically know what is meant by an impulsive aggressive outburst, all study participants were informed of the definition of such outbursts (see, 2.2, above). Each outburst is coded as either A₁ or A₂ based on the A₁ and A₂ criteria in the DSM-5. A₁ IED outbursts are high frequency, but low intensity, in nature and exclude IED outbursts in which there is destruction of property or injury to others or to self. A₂ IED outbursts are low frequency, but high intensity, in nature and include outbursts in which there is destruction of property or injury to others or to self. Once the nature of each outburst has been determined, the rater asks about the specifics of the outbursts and scores each outburst on the four (4) sub-components of the OAS-M. These are: Verbal Assault (V-Assault), Assault Against Objects (AA-Objects),

Assault Against Others (AA-Others), and Assault Against Self (AA-Self) and records the number of times that that form of aggression took place for that category. An excerpt from the OAS-M Manual can be found in Supplemental Files.

2.8. Scoring of the OAS-M

The manifestations of aggression within each outburst in the preceding week are recorded on six (6) levels from 0 (no events within that category) to 5 (most severe form of assault within that category). This frequency is then multiplied by the severity level for that category (0–5). For example “snapping at someone” is weighted “1” while “swearing at someone” is weighted “2”, and so on. This produces a raw score for each specific sub-score of OAS-M Aggression (AGG). Similar weights are added for each of the sub-score of aggression. That is, AA-Objects is considered more severe than V-Assault and its score is multiplied by “2”; AA-Others (and AA-Self) is considered more severe than AA-Objects and its score is multiplied by “3”. Total OAS-M AGG scores are calculated by counting up all data across the four sub-scores of aggression. In this paper we first present OAS-M data using basic scoring, and then present OAS-M AGG data after log-transformation. This is done because OAS-M AGG scores are skewed to the right and, thus, raw scores give undue influence to aggressive individuals with very high OAS-M AGG scores. While log-transformation of these scores are used for statistical analyses, other investigators have suggested an alternate method (Mattes, 2010) as follows: No Events = 0, One Event = 1, Two or Three Events = 2 Four to Ten Events = 3, More than Ten Events = 4. Accordingly, we also examined the scoring of the OAS-M both ways to compare and contrast the results of each method.

2.9. Inter-rater reliability

Inter-rater reliability for the assessment of A₁ vs. A₂ outbursts, and for the number of outbursts, was determined using two trained clinicians based on thirty-six individual impulsive aggressive outbursts rated from ten separate videos of OAS-M interviews.

2.10. Validity testing

2.10.1. Face validity

In addition to the fact that the OAS (Yudofsky et al., 1986) and the OAS-M (Coccaro et al., 1991) were developed by psychiatric research professionals with expertise in aggression, face validity was assessed through a targeted internet survey completed by 50 practicing mental health clinicians (27 Psychiatrists; 23 Clinical Psychologists with 16.7 ± 10.0 years of practice) from the United States ($n = 38$), the United Kingdom (UK, $n = 6$), and UK related ($n = 6$) countries. Twenty of the respondents were clinical experts in aggression while the remaining thirty were mental health clinicians in academic settings with similar degrees of clinical experience (17.0 ± 10.5 vs. 16.3 ± 9.3 years). The brief survey asked respondents if they concurred with the order of the twenty individual OAS-M Aggression items and if they judged that the two “irritability” items were best characterized by “Irritability” or by “Global Anger and Aggression”. The survey items are provided in the supplemental materials.

2.10.2. Convergent and divergent validity

While there are limited measures of state aggression, concurrent validity can be assessed with trait measures of aggression, anger, and impulsivity. Measures of trait aggression included the Aggression Scores from the Life History of Aggression (LHA: i.e., history of actual aggressive behavior (Coccaro et al., 1997) and the sum of the Physical and Verbal Assault Scores from the Buss-Perry Aggression Questionnaire (BPA: i.e., tendency to be aggressive; Buss and Perry, 1992). Trait anger was assessed using the Trait Anger Score from the Spielberger Trait Anger Inventory (STAXI: i.e., tendency to become angry;

Spielberger, 1996). Impulsivity, a related construct, was assessed by the Barratt Impulsiveness Scale-11 (BIS: i.e., tendency to act impulsively; Patton et al., 1995). Divergent validity was assessed using the Extraversion Scale from the Eysenck Personality Questionnaire (EPQ; Eysenck and Eysenck, 1991) because this construct is should be unrelated (or inversely related) to aggression. Other measures used for correlative purposes include the Life Experiences Survey (LES; Sarason et al., 1978) and the Hassles and Uplifts Scale (HUS; DeLongis et al., 1988). The LES assesses the impact of major (e.g., job loss, illness of loved one) life events within six months and beyond six month. The HUS assesses the impact of daily minor (e.g., interactions with family/friends/workers) events. All measures used in this study have been documented as having good to excellent psychometric properties.

2.10.3. Discriminate validity

Discriminate validity was assessed by examining differences in OAS-M AGG and OAS-M GAA scores who differ in levels of aggression as in comparing those with IED with Psychiatric (PC) and Healthy (HC) controls, whose scores should proceed in a downward, stepwise fashion.

2.11. Statistical methods

In this report, OAS-M scores are first presented without any adjustment. That said, the skewed nature of OAS-M AGG scores allows for the undue influence of those with very high OAS-M AGG scores. Accordingly, most analyses were performed on log-transformed data for OAS-M AGG scores; log-transformation was not necessary for OAS-M GAA scores (see 3.3, below). Inter-rater reliability was performed in at least two ways. First, a kappa coefficient was calculated between OAS-M raters regarding whether impulsive aggressive outbursts were designated as A₁, or A₂, IED impulsive aggressive type outbursts. Second, intra-class coefficients (ICC) were calculated for the number of all impulsive aggressive outbursts, log OAS-M AGG scores, and for OAS-M GAA scores. ICCs were calculated by SPSS using a model 3 (fixed/random) procedure for absolute agreement (Trevethan, 2017). Other statistical methods included ANCOVA, Pearson or Spearman correlation, and multiple regression analysis. Factor analysis was performed using principle components analysis of the (non-rotated) correlation matrix based on Eigenvalues > 1.0.

3. Results

3.1. Characteristics of study participants

Demographic, functional, and psychometric data from the three diagnostic groups are displayed in Table 2.

3.2. Descriptive characteristics of raw OAS-M Aggression Scores (Table 3)

Within all subjects, raw (i.e., without the severity weighting between the four OAS-M Aggression sub-scores) V-Assault scores were significantly greater than raw AA-Objects scores which were significantly greater than raw AA-Others scores which was significantly greater than raw AA-Self scores. In turn, all sub-scores were significantly different from each other. Between groups, IED subjects had significantly higher raw scores than PC or HC subjects ($\lambda = 0.88$, $F[4,438] = 3.49$, $p < 0.001$) for each raw sub-score ($p < 0.001$ for the first three sub-scores and $p < 0.021$ for the last). PC and HC subjects also differed on these variables as well ($\lambda = 0.89$, $F[4,109] = 3.49$, $p = 0.01$) with significant differences for V-Assault ($p < 0.001$), AA-Objects ($p = 0.008$) and a trend for a difference for AA-Others ($p = 0.06$). Table 3 displays the raw and weighted total OAS-M Aggression scores for the three groups.

3.3. Effect of transformation of OAS-M scores for statistical analysis: log-transformation vs. an alternate method

Raw OAS-M AGG scores displayed a very high degree of variability [coefficient of variation (CV) = 165%], due to a skewness to the right, that gives undue influence to individuals with very high OAS-M AGG scores. Log-transformation of such scores, in contrast, results in a nearly five-fold reduction in variability (CV = 35%). Scoring by an alternate method, described by Mattis (2010), resulted in a smaller reduction of variability (CV = 81%). Despite the observation that results of both scoring methods were highly correlated ($r = 0.92$, $p < 0.001$), log-transformation of OAS-M AGG scores resulted in a significantly lower degree of variability compared with the alternate method ($z = 25.15$, $p < 0.001$). Log-transformation of OAS-M GAA was not required. Accordingly, all analyses below were performed, respectively, on log-transformed OAS-M AGG scores and on raw OAS-M GAA scores.

3.4. Psychometric properties of the OAS-M

3.4.1. Internal consistency of OAS-M AGG and OAS-M GAA items

The Cronbach alpha coefficient for log OAS-M AGG score was 0.78. Alpha coefficients for the individual log OAS-M AGG sub-scores were 0.71 for V-Assault, 0.52 for AA-Objects, 0.39 for AA-Others, and 0.45 for AA-Self. The alpha coefficient for log OAS-M AA-Object score combined with AA-Other score was 0.63 and similar to the alpha (0.65) for all three non-verbal assault items. The alpha coefficient for OAS-M GAA items was 0.88.

3.4.2. Inter-rater reliability of the OAS-M for type and number of aggressive outbursts

The kappa coefficient for determining A₁ vs. A₂ impulsive aggressive outbursts for two raters was 0.84. The ICC value for number of impulsive aggressive outbursts was 0.97. Inter-rater reliabilities for OAS-M AGG and OAS-M GAA scores have been previously published (Coccaro et al., 1991; Endicott et al., 2002).

3.4.3. Temporal stability of OAS-M AGG and GAA scores

Among subjects in the first double-blind, placebo controlled trial of fluoxetine in IED (Coccaro et al., 2009) we observed an ICC of 0.60 for log OAS-M AGG scores from the first weekly assessment (screen) through the third weekly assessment immediately before assignment to active drug. We observed a similar ICC value for OAS-M GAA scores (0.55) over the same time period. These results are consistent with a measure that is relatively stable but also variable over time as it aggressive behavior.

3.4.4. Factor analysis of OAS-M scores

Factor analysis of the four log OAS-M AGG sub-scores revealed the presence of a single factor accounting for 53.8% of all variance with the following factor loadings: 0.84 for V-Assault, 0.83 for AA-Objects, 0.76 for AA-Others, and 0.43 for AA-Self. However, given that a previous, and separate, factor analysis suggested that AA-Self scores may belong to a different factor (Coccaro, 2005), we re-ran the analysis to determine if a two-factor solution better fit these data. The resulting analysis revealed that factor loadings for V-Assault (0.84), AA-Objects (0.83), and AA-Others (0.76) best fit on one factor, explaining 54.2% of variance, while AA-Self (0.90) best fit on a second factor, explaining an additional 23.4% of variance, for a total 77.6% of variance explained.

3.4.5. Face validity of the OAS-M

The OAS-M has face validity for number of impulsive aggressive outbursts and face validity with high agreement for the rank order of individual OAS-M Aggression items ($89.3 \pm 10.5\%$), and for the renaming of the “Irritability” score as “Global Anger and Aggression” (82%) score.

Table 2
Demographic, functional, and psychometric characteristics of study participants.

	HC (N = 80)	PDC (N = 44)	IED (N = 336)	p ^a	Group Differences
<i>Demographic Variables</i>					
Age	32.9 ± 9.6	33.6 ± 9.1	35.8 ± 9.6	< 0.05 ^a	HC = PC = IED HC < IED
Gender (% Male)	56.3%	47.7%	51.5%	= 0.626 ^b	HC = PC = IED
Race (% White)	56.3%	54.5%	44.0%	= 0.043 ^b	HC = PC > IED
SES Score	43.2 ± 11.8	39.7 ± 14.5	39.5 ± 13.2	= 0.078 ^a	HC = PC = IED HC < IED
<i>Psychosocial Function</i>					
GAF Score	84.6 ± 7.6	67.9 ± 13.1	55.5 ± 7.8	< 0.001 ^a	HC > PC > IED
Q-LES-Q Score	50.5 ± 8.7	45.9 ± 10.3	39.4 ± 10.0	< 0.001 ^a	HC > PC > IED

^a Statistical analysis by one-way ANCOVA.**Table 3**
Mean (± SD) raw and weighted total OAS-M aggression scores.

	Raw V-Assault	Raw AA-Objects	Raw AA-Others	Raw AA-Self	Weighted Total OAS-M AGG
IED (n = 336)	71.8 ± 111.6	7.3 ± 17.9	4.0 ± 8.4	1.0 ± 3.4	102.2 ± 137.9
PC (n = 44)	6.8 ± 12.7	1.3 ± 4.1	0.8 ± 3.5	0.1 ± 0.9	11.9 ± 26.7
HC (n = 80)	1.5 ± 3.6	0.1 ± 0.3	0.0 ± 0.6	0.0 ± 0.0	1.8 ± 3.9

3.4.6. Convergent validity (Table 4)

As expected, we found medium to large statistically significant correlations between the OAS-M scores and LHA Aggression, BPA Aggression, STAXI Trait Anger, and BIS-11 Impulsivity scores (with correlations adjusted for age, sex, ethnicity, and socio-economic score). Multiple regression analysis (with demographic covariates on step one) to determine the relative relationships between LHA, BPA, (Step 2), STAXI (Step 3), BIS-11 (Step 4) with OAS-M scores revealed that LHA Aggression and STAXI Trait Anger uniquely correlated with both OAS-M variables when LHA/BPA/STAXI/BIS are in the same statistical model. For log OAS-M AGG: $R = 0.77$ ($F[8,128] = 22.62$, $p < 0.001$); β for LHA Aggression = 0.45 ($p < 0.001$); β for STAXI Trait Anger = 0.33 ($p < 0.001$); β for BPA Aggression = 0.01 ($p = 0.499$); β for BIS-11 Impulsivity = 0.05 ($p = 0.488$). For OAS-M GAA: $R = 0.83$ ($F[8,128] = 34.22$, $p < 0.001$); β for LHA Aggression = 0.54 ($p < 0.001$); β for STAXI Trait Anger = 0.28 ($p < 0.001$); β for BPA Aggression = 0.04 ($p = 0.455$); β for BIS-11 Impulsivity = 0.07 ($p = 0.261$).

3.4.7. Divergent validity

The correlation between EPQ Extraversion for log OAS-M AGG ($r = -0.09$), and OAS-M GAA ($r = -0.14$), scores were inverse and not statistically significant.

3.4.8. Discriminate validity (Table 5)

Discriminate validity of OAS-M scores was demonstrated by significant differences in OAS-M scores among those differing in levels of aggression (i.e., IED > Psychiatric Controls > Healthy Controls). This table also displays mean LHA Aggression, STAXI Trait Anger, and BIS-11 Impulsivity, scores for comparison with log OAS-M AGG and OAS-M GAA scores.

3.5. Relationships within the OAS-M scores and with relevant behavioral variables

3.5.1. IED outbursts and OAS-M AGG/GAA scores

Significant, moderate-sized, correlations were observed between total number of impulsive aggressive outbursts (Criteria: A_1 and A_2), log OAS-M AGG scores ($r = 0.58$, $n = 50$, $p < 0.001$) and OAS-M GAA scores ($r = 0.53$, $n = 50$, $p < 0.001$).

3.5.2. Log OAS-M AGG sub-scores with OAS-M GAA scores (Table 6)

Across log OAS-M AGG sub-scores, correlations among V-Assault, AA-Object, and AA-Other scores were medium to large in size; Table 6. By comparison, correlations between AA-Self and the remaining sub-scores were, statistically significant, but small in size. OAS-M GAA scores were most strongly correlated with V-Assault, followed by AA-Object, and AA-Other, each of which were in the medium to large sized range. The correlation with AA-Self was statistically significant but small in effect size.

3.5.3. OAS-M scores and state depression and state anxiety

Log OAS-M AGG scores displayed statistically significant relationships with BDI state depression ($r = 0.46$, $p < 0.001$) and BAI state anxiety ($r = 0.38$, $p < 0.001$) as did the GAA score ($r = 0.43$, $p < 0.001$ and $r = 0.38$, $p < 0.001$, respectively). Multiple regression analysis revealed that BDI and BAI scores were each uniquely related to log OAS-M AGG (BDI: $\beta = 0.32$, $p < 0.001$; BAI: $\beta = 0.22$, $p = 0.001$) and OAS-M GAA (BDI: $\beta = 0.29$, $p < 0.001$; BAI: $\beta = 0.23$, $p = 0.001$) scores.

3.5.4. OAS-M scores and major and minor life events (Table 7)

In our previously published Fluoxetine/Placebo study in IED (Coccaro et al., 2009), log OAS-M AGG and OAS-M GAA scores did not correlate with severity of major life events (e.g., job loss, death/illness of a loved one) at any time period. In contrast, both OAS-M scores correlated to a moderate degree with relatively minor daily negative events (“Hassles”; e.g., difficulties with family/friends/co-workers) but not with relatively minor daily positive events (“Uplifts”).

Table 4
OAS-M scores with trait aggression, anger, and impulsivity.

	LHA Aggression	BPAQ Aggression	STAXI Trait Anger	BIS Impulsivity
Log OAS-M AGG Score	$r = 0.75$	$r = 0.53$	$r = 0.72$	$r = 0.42$
OAS-M GAA Score	$r = 0.73$	$r = 0.54$	$r = 0.71$	$r = 0.43$

All p values < 0.001.

Table 5Mean (\pm SD) total weighted OAS-M aggression (AGG) and. Global anger/aggression (GAA) scores for study participants.

	HC	PC	IED	Group Differences ^a
AGG	1.8 \pm 3.9	12.1 \pm 26.1	101.1 \pm 136.9	IED > PC > HC
GAA	0.9 \pm 1.1	2.0 \pm 2.5	5.9 \pm 1.8	IED > PC > HC
Related Measures				
LHA Aggression	4.9 \pm 4.0	8.9 \pm 5.6	19.0 \pm 3.8	IED > PC > HC
BPA Aggression	14.2 \pm 5.2	19.1 \pm 5.6	24.0 \pm 6.1	IED > PC > HC
STAXI Anger (Trait)	13.6 \pm 3.7	17.5 \pm 6.7	27.9 \pm 6.6	IED > PC > HC
BIS Impulsivity	55.3 \pm 9.5	64.0 \pm 11.0	68.4 \pm 11.0	IED > PC > HC

^a Statistical analyses (ANCOVA) performed on log-transformed data for OAS-M AGG.**Table 6**

Correlations among log OAS-M AGG sub-scale scores and OAS-M GAA score.

	AA-Objects	AA-Others	AA-Self	GAA
V-Assault	$r = 0.60^{**}$	$r = 0.52^{**}$	$r = 0.22^{**}$	$r = 0.78^{**}$
AA-Objects		$r = 0.47^{**}$	$r = 0.24^{**}$	$r = 0.67^{**}$
AA-Others			$r = 0.16^*$	$r = 0.57^{**}$
AA-Self				$r = 0.23^{**}$

* $p < 0.01$, ** $p < 0.001$.**Table 7**

Correlations for OAS-M scores with major negative life events (LES). and daily hassles and uplifts (HUS) in study participants with IED.

	LES Within Past Six Months	LES Beyond Past Six Months	HUS Hassles	HUS Uplifts
Log OAS-M AGG Score	$r = 0.01$	$r = 0.03$	$r = 0.24^*$	$r = 0.12$
OAS-M GAA Score	$r = 0.07$	$r = 0.08$	$r = 0.37^{**}$	$r = 0.11$

N = 91 * $p < 0.05$, ** $p < 0.001$.

3.6. Response of OAS-M scores during therapeutic interventions

In our previously published Fluoxetine/Placebo study in IED (Coccaro et al., 2009) log OAS-M AGG scores of all subjects randomized to fluoxetine became progressively lower over time compared those randomized to placebo (Fig. 1, left). The same was true for OAS-M GAA scores (Fig. 1, right) though effect sizes with OAS-M GAA scores tended to be higher than those with log OAS-M AGG scores. For example, during the second half of the study effect sizes for OAS-M GAA scores, in favor of Fluoxetine, were 68% higher for Weeks 7–8, 55% higher for Weeks 9–10, 27% higher for Weeks 11–12, and 33% higher for all study participants at endpoint, compared with log OAS-M AGG scores.

4. Discussion

The psychometric properties of the OAS-M are more than adequate to use as a state measure of aggression over the course of one week of observation for the purposes of: (a) cross-sectional research and, (b) for clinical trials of interventions that aim to reduce aggression. The OAS-M has excellent inter-rater reliability, good internal consistency, and demonstrates convergent, divergent, and discriminant validity.

As an overall assessment of impulsive aggression, log OAS-M AGG and OAS-M GAA scores reflect both history of aggressive behavior, anger proneness, and impulsivity. Closer analysis reveals that the relationship between impulsivity and OAS-M variables is not unique but due to its relationship with aggressive behavior and anger proneness.

In addition to aggression and anger, OAS-M scores correlate with other behavioral variables of relevance. OAS-M scores also correlate with assessments of state depression and state anxiety at a moderate

effect size. Since other aggression-related variables also correlate moderately with state depression/anxiety as well (i.e., $r = 0.52$ and $r = 0.45$, respectively, with LHA Aggression, in this data set), and because anger, depression, and anxiety are often co-existing dysphoric states in the same individuals, this observation is not surprising. Accordingly, measures of both state depression and state anxiety should be included in clinical trials of aggression to assess the influence of these dysphoric moods on the response to anti-aggressive interventions. In our Fluoxetine/Placebo study in IED (Coccaro et al., 2009), however, results using log OAS-M AGG and OAS-M GAA scores were not affected by the severity of either state depression or state anxiety. Finally, we found that OAS-M scores were correlated with minor, but not major, negative life events in those with IED. This is consistent with observations that impulsively aggressive outbursts occur in the context of events that are not typically provocative to most individuals (Coccaro et al., 2016).

The relevance of non-suicidal, self-directed aggressive behavior to the assessment of other-directed aggression is clarified in this study. The original OAS included “assaults to self” because this type of aggressive behavior is observed in many psychiatric inpatients, especially those with intellectual disability or autism. While the data here do fit a one-factor solution, a two-factor solution (V-Assault/AA-Objects/AA-Others vs. AA-Self) actually explained more variance in the data. Given this, and the low prevalence of AA-Self in impulsively aggressive individuals (e.g., IED), it may be best to analyze AA-Self data separately or to exclude it from the OAS-M Total AGG score (though exclusion of this variable is unlikely to meaningfully change results; see Table 3).

The scoring of the OAS-M has been critiqued because it is difficult to “count” all aggressive behaviors, especially in those individuals with very high frequencies of aggressive behavior. In response, an alternate method has been proposed to limit the frequency counting of aggressive behaviors to six levels (Mattis, 2010). We found that OAS-M AGG scores calculated by both methods are very highly correlated. Despite this, and the likelihood that raters may find the alternate scoring method easier to use, two downsides of this approach should be noted. First, by constraining the frequency data to only six levels, the alternate method does not collect all available data and, second, the alternate method results in greater variability in OAS-M scores, compared with log-transformed scores. This means there is a possibility that the alternate method may not mitigate the influence of those with very high OAS-M AGG scores to the same degree as log-transformation.

The results of our Fluoxetine/Placebo trial (Coccaro et al., 2009) have been replicated in two later studies (George et al., 2011; Silva et al., 2010). In addition, there are three other positive studies using the OAS-M in clinical trials of aggression involving study participants that had, or otherwise met criteria for, IED. The first study involved a placebo-controlled study of divalproex sodium (Hollander et al., 2003), the second, involved a placebo-controlled study of oxcarbazepine (Mattes, 2005); and a third, involved Cognitive Behavioral Therapy vs. Wait-List (or Supportive Psychotherapy) (McCloskey et al., 2008; McCloskey et al., In Preparation). Three other psychopharmacologic trials using

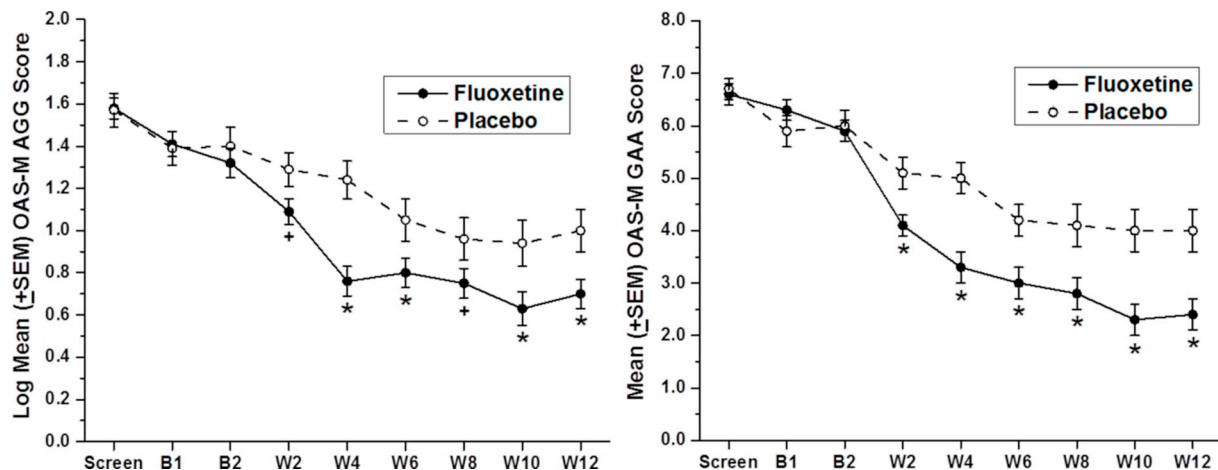


Fig. 1. Fluoxetine vs. Placebo in All Subjects (Visit Wise Data): Mean (± SEM) Log OAS-M AGG (Left) and OAS-M GAA (Right) Scores; + $p < 0.10$; * $p < .005$.

the OAS-M have not, however, reported a drug-placebo effect in favor of the active agent. The first, was a placebo-controlled study of the anti-seizure medication, levetiracetam (Mattes, 2008), the second was a small placebo-controlled study of Fluoxetine in male partner abusers (Lee et al., 2008), while the third was a placebo-controlled trial of Fluoxetine and Divalproex (cited in Coccaro et al., 2015). Reasons for these negative results are not known for certain but may be due to entering study participants with levels of aggressive behavior that are not relatively stable from week to week (Coccaro et al., 2015).

In our experience with clinical trials, OAS-M GAA scores display higher drug-placebo effect sizes compared with log OAS-M AGG scores [e.g., from 27% to 68% higher during the second half of our Fluoxetine/Placebo study (Coccaro et al., 2009)]. OAS-M GAA includes a global rater assessment of aggression and anger while log OAS-M AGG is a severity-weighted summation of all reported aggressive behavior. In our previous treatment studies, both measures were used as co-primary outcomes and both led to the same result. Given the higher effect size with OAS-M GAA scores, compared with that of log OAS-M AGG scores, and the fact that OAS-M GAA includes global rater judgement, an argument can be made for OAS-M GAA being the primary outcome variable with log OAS-M AGG being a confirmatory outcome variable. Use of both scores as co-primary outcome variables would be helpful in exploring if there is any OAS-M related anti-aggressive signal in early Phase II studies. A positive outcome on either would represent a “go” for “go/no go” determinations in early randomized clinical trials. For later confirmatory trials, one or the other may be used as the primary, with the other as a confirmatory, outcome variable depending upon the results the early trial. The more recently added variable for number of DSM-5 IED A₁ and IED A₂ outbursts may also be used as an outcome variable for effects on IED because, while it correlates with log OAS-M AGG and OAS-M GAA scores, its overlap with these variables is less than 35% suggesting that most of the variance in total IED outbursts is not reflected by either OAS-M score. Despite this observation, number of IED outbursts has a very strong relationship with other measures of aggression (e.g., LHA Aggression: $r = 0.74$, $p < 0.001$).

This study has several potential limitations. First, we did not perform a head-to-head comparison between the OAS-M and other variants of the MOAS. Despite the fact that the OAS (and variants) has been in use for three decades, no such comparisons exist in the literature. Second, some question whether a combined OAS-M AGG score with simple weights are appropriate (Smith, 1988). While the OAS-M weightings were set *a priori*, it is generally accepted that aggression against objects is more severe than verbal aggression and that aggression against others (or self) is more severe than aggression against objects or verbal aggression. In fact, individual log OAS-M AGG sub-scores can be analyzed separately without the weightings, though the

lower alpha coefficients for non-verbal aggression may caution against this. Similarly, the ordering of items in each set OAS-M aggression items (e.g., verbal aggression) has been critiqued (Smith, 1988). However, our sub-study conducted with mental health professionals, with expertise/experience with aggressive individuals, revealed substantial agreement with the order of the individual OAS-M AGG items. Third, there is little data on how OAS-M scores taken from study participants compare to OAS-M scores taken from informants. While important, most informants are not in the presence of the individual in question most of the time and, thus, cannot report on all aggressive behavior displayed by the individual being assessed. Fourth, impulsively aggressive individuals may well under-report their own aggressive behavior to investigators or clinicians. That said we have found very good concordance between study participants and informants in making a DSM-5 diagnosis of IED and evidence that such individuals do not deny their socially undesirable behavior (Steakley-Freeman et al., 2018). This may be due to the fact that our study participants came to our studies due to their personal motivation to be evaluated and treated rather than being required to do so by others (e.g., courts). Fifth, the validity and reliability of the OAS-M covering longer intervals than one week have not yet been investigated. Given issues with fidelity of recall of behaviors (Moss and Goldstein, 1979) we suggest that the OAS-M not be used over a greater than two-week interval until prospective data taken over one to four weeks have been evaluated.

In conclusion, the OAS-M, now revised to include assessment of two different types of aggressive (DSM-5 IED A₁ and DSM-5 IED A₂) outbursts, is a valid and reliable measure of state (e.g., week to week) impulsive aggression, has good psychometric properties, and shows evidence of change in clinical trials of agents with putative anti-aggressive efficacy. While there are no currently FDA approved indications for impulsive aggression, DSM-5 IED, represents a novel, untapped, target for drug development with a lifetime prevalence of 4.0% and a current (past year) prevalence of 2.6% (Coccaro & McCloskey, 2019). Accordingly, the OAS-M represents an evidence-based assessment of anti-aggressive efficacy for use in clinical trials of impulsive aggression.

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CRedit authorship contribution statement

Emil F. Coccaro: Formal analysis, Writing - original draft.

Declaration of competing interest

Dr. Coccaro reports being a consultant to Azevan Pharmaceuticals, Inc. and to Avanir Pharmaceuticals, Inc., and being a current recipient of grant awards from NIMH, NIAAA, and the Pritzker-Pucker Family Foundation (PPFF).

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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.2020.01.007>.

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