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Early Childhood Aggression in Autistic and Non-Autistic Preschoolers: Prevalence, Topography, and Relationship to Emotional Reactivity

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Objective: Despite heightened rates of aggressive behaviors among older autistic youth relative to non-autistic peers, less is known about these behaviors during early childhood. This study included 3 objectives to address this gap: (1) to establish the prevalence and topography (frequency, severity, type, context) of aggressive behaviors in a large sample of preschool-aged children using a developmentally sensitive parent-report measure; (2) to identify clinical correlates of aggression; and (3) to investigate whether different subgroups of autistic children can be identified based on their profiles of aggression, emotional reactivity, and autism traits.

Method: Data were analyzed from parents of 1,199 children 2 to 5 years of age (n = 622 autistic children) who completed the Multidimensional Assessment Profiles Scales (MAPS) aggression subscale and the Emotion Dysregulation Inventory–Young Child (EDI-YC) reactivity subscale.

Results: Autistic preschoolers had 2 to 6 times higher odds of experiencing frequent aggression (more days than not) compared with non-autistic preschoolers. Hierarchical multiple regression analyses revealed that autism diagnosis, traits, and suspected and diagnosed attention-deficit/hyperactivity disorder (ADHD) were positively associated with aggression; however, heightened emotional reactivity explained the greatest degree of added variance in aggression total scores. Machine learning clustering techniques revealed 3 distinct subgroups of autistic preschoolers, with cluster membership driven primarily by aggression and reactivity scores, and less so by autism traits.

Conclusion: Autistic preschoolers display more frequent parent-reported aggressive behaviors, and emotional reactivity may play an important role in aggressive behavior presentation. Future developmental screening and early intervention tailoring for aggression may benefit from assessing reactivity early in development.

Plain language summary: In this study of 1,199 children aged 2 to 5 years of age (n = 622 autistic children), parents completed validated questionnaires quantifying disruptive behaviors and emotion dysregulation to evaluate prevalence and topography of aggressive behaviors, identifying clinical correlates of aggression, and determining distinct subgroups of children with autism based on patterns of aggression, reactivity, and autism traits. The authors found that preschoolers with autism had higher rates of frequent aggressive behaviors compared to non-autistic children. Although more aggression was associated with having an autism diagnosis, greater levels of autism traits, and attention-deficit/hyperactivity disorder, high levels of aggression were most strongly associated with heightened emotional reactivity. Subgroups of preschoolers with autism emerged principally on their aggression and emotional reactivity scores, rather than on their levels of autistic traits.

Diversity & Inclusion Statement: One or more of the authors of this paper self-identifies as a member of one or more historically underrepresented racial and/or ethnic groups in science. One or more of the authors of this paper self-identifies as a member of one or more historically underrepresented sexual and/or gender groups in science. One or more of the authors of this paper self-identifies as living with a disability. The author list of this paper includes contributors from the location and/or community where the research was conducted who participated in the data collection, design, analysis, and/or interpretation of the work.

Key words: autism; aggression; emotion dysregulation; irritability; preschool

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Aggressive behavior tends to be more frequently reported for autistic children than for non-autistic children, which can cause significant disruption to autistic children's lives and those of their families. Physical aggression toward others can result in negative outcomes such as injury, property damage, increased use of psychotropic medication and health care services, and residential placements for autistic individuals.[1–3] Without appropriate supports, aggression can have an impact on social and academic outcomes, can create stress,[4] and can affect individual and familial quality of life in the long term[5]; as such, reducing aggressive behaviors is often a common target for intervention.

However, certain amounts and types of aggression can be considered "normative misbehaviors" in that they are

common and developmentally appropriate expressions of anger and emergent problem-solving skills, particularly in the preschool years. Reactive aggression, for example, may occur as an immediate response when frustrated or provoked (eg, reactive sibling-directed aggression) and may be considered more "normative" than proactive aggression, which is planned or may be out of context (eg, highly frequent aggression toward non-caregiver adults).[6–9] As such, understanding and delineating the prevalence and topography (the observable form and features of a behavior, ie, frequency, severity, type, and context) of aggressive behaviors commonly seen in young autistic children, and distinguishing those that may be "normative misbehaviors" from those that are "atypical" or clinically concerning are essential to providing appropriate prevention and intervention-related supports as soon as they are needed.[10]

Prevalence and Topography of Aggressive Behaviors Among Autistic Children

Prevalence rates of parent-reported aggression among autistic youth range from 8% to 68%.[11,12] Such varied estimates come from studies that have used single-item ratings to assess the frequency and severity of aggression overall,[13,14] contain large age ranges,[15,16] evaluate clinically referred children only[11,17] or those who participated in clinical trials.[18] Among preschool-aged autistic children specifically, prevalence estimates of clinically significant aggression range from 8% to 27%[11,19] and are often measured using summative "total scores," which are not able to capture the variation in aggressive behaviors, or the frequency, intensity, and contexts in which they occur.

Few studies have directly compared topography of aggressive behavior among young autistic and non-autistic children, nor have they used measures specifically designed to distinguish "normative misbehavior" from "clinically concerning" aggression. Quetsch *et al.* found higher mean caregiver-reported aggression scores among autistic relative to non-autistic 3- to 17-year old children and adolescents, with physical aggression specifically being higher among 3- to 6-year-old autistic children, and comparable to non-autistic children at older ages.[20] Although the prevalence and frequency of specific behaviors between the groups was not identified, the authors noted qualitatively that the most frequently occurring physically aggressive behaviors were the same between groups (ie, "pinches others," "reacts to insults or teasing by lashing out physically"), suggesting that autistic children may display types of aggressive behaviors similar to those of non-autistic children, but that the frequency or intensity may differ at some developmental stages.

Importantly, there is also substantial variability in aggressive behavior patterns experienced by autistic children. In a randomized controlled trial, Carroll *et al.* identified 5 subgroups of autistic children based on aggression and self-injurious behavior (SIB) profiles: those who (1) primarily experienced "hot" (reactive) aggression, (2) "cold" (proactive) aggression, (3) engaged in SIB with or (4) without aggression, and (5) had no reported aggression.[18] However, their analysis was limited to qualitative coding of semi-structured "parent target problem" narratives that focused on 2 behaviors of primary concern and was unable to incorporate a wide range of possible aggressive behaviors into their subgroupings.

Ultimately, more research is needed to identify whether existing prevalence rates are representative of young autistic children from non-referred, nationally representative samples, using comprehensive measures assessing aggression prevalence rates and topography, and how these compare with those of non-autistic preschoolers. Furthermore, an in-depth analysis aimed at identifying clinical correlates and potential subgroups of autistic preschoolers that vary in aggression severity or type is also needed.

Clinical Correlates of Aggression Among Autistic Youth

Given the heterogeneity in behavioral profiles of autistic children, as well as co-occurring neurodevelopmental differences, consideration of these relevant clinical variables as they relate to the manifestation of aggressive behaviors is necessary. Current evidence of associations between key clinically relevant variables with aggression among autistic youth is mixed. A number of studies have investigated whether autism diagnosis and/or level of autistic traits (ie, social communication and interaction challenges, repetitive behaviors and intense interests, and/or sensory sensitivities) are associated with aggression, with some finding positive associations,[1,14,21,22] no association,[17] or an association between parent-reported, but not clinician assessed, autism traits.[13]

Verbal or speaking ability, and intellectual ability, have both historically been thought to be negatively associated with aggression among autistic individuals (possibly as a response to difficulty communicating one's needs); however, this association has been found in some studies[16,17,23–25] but not in others.[1,13,14,26,27] In addition, relative to non-autistic children, rates of aggression have been found to be elevated among autistic children and children with attention-deficit/hyperactivity disorder (ADHD)–combined type[10,28]; yet, despite the heightened co-occurrence of ADHD among autistic youth,[29] it remains unclear whether also having ADHD has an incremental effect on levels of aggression among autistic children.

Mixed study findings could likely be attributable to varying ability levels or differences in co-occurring diagnoses across study samples, variability in the use of comprehensive and standardized measures, and differing definitions of aggression. Statistical models that include fewer of these relevant variables together can explain separate and shared variance in only certain combinations of variables; as such, using models that are powered to consider as many variables as possible could help to better elucidate relationships between aggression and key variables of interest (eg, clinically relevant factors) while accounting for variation in others (eg, individual and familial sociodemographic factors). Furthermore, inclusion of autistic and non-autistic children, using quantitative methods, may provide additional support for qualitative investigations of possible similarities or differences in aggression between groups.[20]

Relevance of Emotional Reactivity to Aggression in Autism

Emotion dysregulation, or difficulty modulating one's emotional reactions, may be a possible mechanism underlying aggression among autistic individuals. Autistic individuals often experience higher rates of emotion dysregulation than non-autistic individuals.[30–32] A core component of emotion dysregulation involves emotional reactivity, defined as experiencing intense and rapidly escalating emotions, as well as having difficulty regulating negative emotions. Emotional reactivity and its association with aggression has been extensively studied in non-autistic children and adolescent populations,[33] although its measurement in autistic children is still in its infancy. The Emotion Dysregulation Inventory (EDI)[34] was developed to fill this gap and provides a reactivity score. In a previous study, reactivity was found to be strongly correlated ($r = 0.74$) with aggression scores on the Child Behavior Checklist (CBCL) in a combined research registry and inpatient sample of autistic individuals between 4 and 20 years of age (most 6+ years).[34]

Altogether, there is a need to understand the degree to which clinical correlates (eg, autistic traits, emotion dysregulation) may be associated with heightened risk for aggression, particularly among young autistic children. Given higher rates of emotion dysregulation among autistic individuals, and associations between reactivity and aggression in older individuals, it may be critical to elucidate this relationship in autistic (and non-autistic) children during the preschool- age period, when emotion regulation abilities are emerging.

Objectives

The aims of this paper were 3-fold. Aim 1 was to evaluate the prevalence and topography of parent-reported aggressive behaviors in a large non-referred sample of preschool-aged autistic and non-autistic children. Aim 2 was to identify clinical correlates of aggression, including potential contributions of autistic traits and emotional reactivity to aggression in this population. Finally, aim 3 focused on heterogeneity in presentations within the autistic sample and whether distinct subgroups of autistic individuals emerged based on patterns of aggression, reactivity, and autism traits.

METHOD

Procedure

All participants provided their consent to participate in accordance with University of Pittsburgh ethical standards and the Declaration of Helsinki. Cross-sectional data were collected between January 13, 2021, and February 12, 2021. All participants in both samples completed questionnaires online. All study procedures were approved by the University of Pittsburgh Institutional Review Board.

Participants

Participants in this study were obtained from a larger psychometric study of the EDI–Young Child (EDI-YC; described in detail in Day *et al.*[35,36]), a newly developed adaptation of the EDI[34] for measuring emotion dysregulation in 2- to 5-year-old children. Parents of 1,864 children 2 to 5 years of age were recruited as part of that larger study using 2 methods: the Simons Powering Autism Research (SPARK) Research Match (US-based online research registry for autistic individuals and families), and local recruitment from pediatric practices that are part of Pediatric PittNet at the University of Pittsburgh (Supplement 1, available online). Locally recruited parents were asked to indicate whether they had concerns about their child's development and whether their child had a formal autism diagnosis from a licensed psychologist or physician, as indicated in the *DSM-5*[37] or the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (*ICD-10*)[38] or *Eleventh Revision* (*ICD-11*).[39] Standard practice for assessing autistic traits may include a combination of direct behavioral observation, parent interview, and standardized questionnaires or observation tools.

Participants met inclusion criteria for the current study if they had complete data available for 3 parent-report measures: the Multidimensional Assessment Profiles Scales (MAPS)[40,41] (formerly termed the Multidimensional Assessment Profile of Disruptive Behavior [MAP-DB][42]) Preschool Version; the EDI-YC[36]; and the Social Communication Questionnaire (SCQ), Lifetime Version.[43]

Complete data (ie, no missing item-level data) were required to have a cohort (for aims 1 and 2) on which item-level machine learning cluster analyses could be conducted (for aim 3).

The final sample included parents of 1,199 children 2 to 5 years of age (mean = 51.4 months, SD = 13.8 months). The autism group included parents of 622 children with an autism diagnosis. The non-autism group included 577 parents of children without autism, with and without developmental concerns.

Measures

Sociodemographic Survey. Parents were asked to report on parent and child sociodemographic characteristics, including their child's age, sex assigned at birth, racial and ethnic identity, speaking ability, as well as whether their child had any developmental concerns or psychiatric diagnoses. Parents also reported their household income and parental educational attainment.

MAPS Aggression Subscale. The Preschool MAPS[40,41] is a validated caregiver-report questionnaire developed to quantify disruptive behaviors in children 3 to 5 years of age, from "mild," typical, or common manifestations to more intense, challenging behaviors that are less common or rarely occurring (in <10% of the population). Caregivers are asked to rate the occurrence of behaviors over the past month across 4 domains (temper loss, non-compliance, aggression, low concern for others) using a 6-point objective frequency (Likert) scale: 0 = never, 1 = rarely (less than once per week), 2 = some (1-3) days of the week, 3 = most (4-6) days of the week, 4 = every day of the week, 5 = many times each day.

A revised version (V2.0) of the aggression subscale was used in this study. V2.0 was updated from the original version for expanded developmental and contextual coverage (for sample details, see Krogh-Jespersen *et al.*[44]). Twenty-five items on the V2.0 scale evaluate the frequency and intensity of aggressive behaviors toward others (eg, hitting, pinching, and kicking) and property destruction (eg, throwing and breaking things), culminating in an aggression total (summed) score. V1.0 has excellent internal consistency ($\alpha = 0.96$),[40,41] which was also demonstrated in V2.0, henceforth referred to as the "MAPS aggression" subscale ($\alpha = 0.95$, unpublished data, June 2023).

EDI-YC Reactivity Subscale. The EDI-YC[35,36] is a newly developed transdiagnostic measure of emotion dysregulation, validated in autistic and non-autistic preschoolers (2-5 years of age). The EDI-YC was adapted from the original EDI,[34] and similarly measures reactivity and dysphoria (poor upregulation of positive affect, unease). The 15-item reactivity subscale of the EDI-YC was used for this study based on conceptual links between reactivity and aggression. The EDI-YC reactivity scale is also recommended as a measure of irritability,[45] and its items share conceptual overlap with common definitions of irritability.

Caregivers are asked to rate emotion dysregulation severity over the past 7 days on a 5-point Likert scale: 0 = not at all, 1 = mild, 2 = moderate, 3 = severe, and 4 = very severe. The EDI has item response theory calibrated theta scores based on a graded response theory model.[34,36] Raw scores were converted to theta scores based on clinical norms (mean = 0, SD = 1) to represent the degree of latent trait emotion dysregulation. Clinically significant thresholds are equal to 1 SD above the general sample mean (see Day *et al.*[36] for more details). The reactivity scale has excellent internal consistency ($\alpha = 0.98$).[35] Initial comparisons between the EDI-YC reactivity and MAPS aggression subscales found in Day *et al.*[36] identified moderate to large positive correlations for autistic ($r = 0.51$, n = 107) and non-autistic ($r = 0.41$, n = 691) preschoolers.

SCQ. The SCQ-Lifetime version[43] is a 40-item caregiver report questionnaire that measures current and lifetime levels of autistic traits. Each item is dichotomous and scored on whether the behavior is present or absent, culminating in a total (summed) score. The SCQ has excellent internal consistency ($\alpha = 0.90$).[46]

Statistical Analysis

Aim 1. The prevalence and topography of parent-reported aggressive behaviors on the MAPS were evaluated at the item level using χ^2 tests of independence. Odds ratios (ORs) were calculated to quantify the degree to which having an autism diagnosis was associated with an increased likelihood of each item being endorsed by parents as "frequently occurring," relative to not having an autism diagnosis. For this study, behaviors were dichotomized as "frequent" if they occurred more days than not (ie, most days, daily, or many times per day) and as "infrequent" if they occurred never, rarely, or some days of the week. This classification scheme allowed for a stricter definition of "frequently occurring" behaviors that provides more specificity than simple presence or absence of behavior, given that some amount of aggressive behavior is developmentally expected in the preschool years in the general population.

Aim 2. An ordinary least-squares hierarchical multiple regression was run to assess clinical correlates of MAPS aggression total scores. In step 1, we entered sociodemographic variables that differed between the autistic

TABLE 1 Sociodemographic Characteristics of the Study Sample

	Autism group (n = 622)	Non-autism group (n = 577)	χ^2 or *t* (df)	*p*
Age, mo, mean (SD), n = 1,198	55.64 (12.95)	46.83 (13.22)	11.6 (1196)	<.0001
Sex assigned at birth, n (%)				
Male, n = 738	470 (75.8)	268 (46.9)	105.1 (1)	<.0001
Female, n = 453	150 (24.2)	303 (53.1)		
Race, n (%)				
Asian, n = 63	32 (5.1)	31 (5.4)	0.05 (1)	.83
Black, n = 171	69 (11.1)	102 (17.9)	11.1 (1)	.0009
Native American, n = 25	14 (2.3)	11 (1.9)	0.15 (1)	.70
Native Hawaiian, n = 5	5 (0.8)	0 (0.0)	4.6 (1)	.06
White, n = 1,029	552 (88.7)	477 (83.5)	6.8 (1)	.009
Another race, n = 27	21 (3.4)	6 (1.1)	7.3 (1)	.007
Ethnicity, n (%)				
Hispanic/Latino, n = 151	124 (20.0)	27 (4.7)	62.8 (1)	<.0001
Non-Hispanic/Non-Latino, n = 1,039	495 (80.0)	544 (95.3)		
Speaking ability, n (%)				
Nonverbal, n = 202	197 (31.9)	5 (0.9)	500.2 (3)	<.0001
Single words, n = 147	121 (19.6)	26 (4.6)		
Phrase speech, n = 283	195 (31.6)	88 (15.4)		
Fluent speech, n = 555	104 (16.9)	451 (79.1)		
Intellectual disability, n (%)				
Yes, n = 195	191 (35.0)	4 (0.7)	227.6 (1)	<.0001
No, n = 922	355 (65.0)	567 (99.3)		
ADHD, n (%)				
Yes, n = 64	57 (9.2)	7 (1.2)	127.93 (2)	<.0001
Suspected, n = 165	139 (22.5)	26 (4.6)		
No, n = 957	422 (68.3)	535 (94.2)		
Age of autism diagnosis, mean (SD), n = 622	2.42 (0.82)	—	—	—
Household income, n (%)				
Less than $20,999, n = 120	76 (8.1)	44 (12.7)	18.0 (3)	.0004
$21,000-$65,999, n = 395	225 (37.6)	170 (31.4)		
$66,000-$100,999, n = 266	137 (22.9)	129 (36.7)		
$101,000+, n = 359	160 (26.8)	199 (36.7)		
Primary caregiver educational attainment, n (%)				
Without high school diploma, n = 25	17 (2.7)	8 (1.4)	28.8 (3)	<.0001
High school graduate without college education, n = 142	73 (11.8)	69 (12.1)		
Some college education, n = 393	244 (39.3)	149 (26.2)		
Degree from 4-year college or more, n = 629	287 (46.2)	342 (60.2)		
SCQ total score, mean (SD)	19.9 (7.1)	6.7 (5.6)	35.8 (1,166)	<.0001
EDI-YC reactivity theta score, mean (SD)	0.02 (0.96)	−0.90 (.78)	18.2 (1,176)	<.0001
MAPS aggression total score, mean (SD)	20.6 (23.0)	10.9 (14.8)	8.7 (1,071)	<.0001

***Note**: Age, mo: n = 1 missing from non-autism group. Emotion Dysregulation Inventory–Young Child (EDI-YC) reactivity theta score: item response theory calibrated theta score is based on clinical norms (mean = 0, SD = 1) with clinically significant thresholds = 1 SD above the general sample mean. Race: participants were able to "check all that apply" for US Census race categories; thus, values represented in this table do not total to 100%. See Supplement 2, available online, for variable manipulation/data reduction. ADHD = attention-deficit/hyperactivity disorder; MAPS = Multidimensional Assessment Profile Scales; SCQ = Social Communication Questionnaire.*

and non-autistic samples (Table 1) as control variables (ie, parent education, family income, child race and ethnicity, child age, and child sex). In step 2, we entered autism diagnosis, and in step 3 we entered autism-relevant neurodevelopmental factors (ie, intellectual disability, ADHD, verbal speaking ability, and autism traits). Finally, in step 4 we entered emotional reactivity scores to determine whether its addition improved the prediction of

MAPS aggression total scores beyond autism diagnosis and neurodevelopmental factors. Because of some missingness in demographic and neurodevelopmental variables, the sample size for this analysis was reduced from 1,199 to 1,050 (autism group: n = 514, non-autism group: n = 536).

Aim 3. Finally, a random forests machine learning clustering technique[47] was used to identify subgroups of autistic preschoolers with similar aggression, reactivity, and autistic trait presentations. Silhouette scores were used to identify the optimal number of subgroups, and an ensemble clustering method based on the random forests algorithm was subsequently applied.[48] The clustering algorithm was applied to the item-level data of the EDI-YC reactivity, MAPS aggression, and SCQ items. χ^2 Tests of independence were carried out to identify significant associations between the resulting subgroups. In addition, a mean decrease accuracy (MDA) feature selection algorithm was used to identify the clinical features (ie, survey items) that most strongly informed clustering decisions. MDA evaluates the decrease in accuracy between the original clustering results and when a clinical feature is randomly permuted. Clinical features that exhibit a higher decrease in accuracy are considered more significant in the clustering results.[49]

RESULTS

Sociodemographic Group Differences

Table 1 displays the sociodemographic breakdown of the sample by group (autistic and non-autistic preschoolers). The majority of the sample were identified as White (89%; 76% identified as White alone [see Supplement2, available online, for more details on variable categorization]), non-Hispanic (87%), and assigned male at birth (62%), and a little more than half of the parents had graduated from college (53%). Significant group differences were observed among key outcome variables and nearly all sociodemographic variables. On average, the autistic preschoolers tended to be slightly older, more likely to be assigned male at birth, and had a wider range of speaking abilities relative to non-autistic preschoolers; they also were more likely to have reported intellectual disability (ID) and ADHD diagnoses. As expected, the autistic group had higher overall levels of parent-reported autism traits (SCQ scores), EDI-YC reactivity theta scores, and MAPS aggression total scores.

Aim 1: Prevalence and Topography of Aggression Between Autistic and Non-Autistic Groups

Results of χ^2 analyses revealed statistically significant associations between group and frequency of aggressive behaviors, for the majority of MAPS items (22 of 25) (Table 2). Across all items, the percentage of parents that endorsed that a specific aggressive behavior occurred frequently ranged from 3% to 18% in the autism group, and from 2% to 7% in the non-autism group. ORs ranged from 2.16 to 5.79 among the 22 statistically significant items, indicating that the odds of a parent rating particular aggression items as occurring frequently were 2 to 6 times higher for autistic vs non-autistic preschoolers. The 4 items on which autistic and non-autistic preschoolers showed the greatest discrepancies (ie, OR >5.0) were as follows: (1) "try to break or ruin something," and "hit, shove, kick, bite, or pinch..." (2) "other adults" (non-caregiver), (3) "during daily routines," or (4) "when frustrated, angry or upset," which were reported to occur frequently in 12.5% to 15.8% of autistic preschoolers as compared to 2.4% to 3.3% of non-autistic preschoolers.

Notable similarities between groups appeared in the types of behaviors that occurred more or less often. When rank ordering items based on the percentage of parents who endorsed behaviors as occurring frequently, the same top 3 items were endorsed by both groups (ie, "hit someone," "hit, shove, kick, bite, or pinch sibling," and "hit sibling at the slightest provocation"), although the rates were approximately 3 times higher for the autistic group (~17% endorsed these behaviors occurring frequently) than in the non-autistic group (5%-6%). Similarly, the 3 behaviors least endorsed as frequently occurring were shared by both groups (~1%-2% of autistic and non-autistic preschoolers, group differences not significant) and related to physical aggression toward other children (ie, "physically attack another child without provocation [not sibling]," hit another child with toy or other object [not sibling]," and "go over and smack another child)." Overall, items endorsed as frequently occurring in the autistic group (~15%) were also relatively frequently occurring in the non-autistic group (~4%), highlighting similar prevalence and topography patterns between the groups.

Aim 2: Clinical Correlates of Aggressive Behaviors

Results of the hierarchical linear regression are presented in Table 3 (results of regression diagnostics are included in Supplement 3, available online). Clinical correlates were examined after controlling for sociodemographic variables (model 1), which explained only 5.6% of the variance in aggression scores. Adding autism diagnosis to the model (model 2) explained only 4.2% of added variance in aggression scores, and indicated that autistic preschoolers' aggression scores were approximately 0.23 SD higher than those of non-autistic preschoolers. The addition of neurodevelopmental factors (speaking ability, ID, ADHD, and

TABLE 2 Multidimensional Assessment Profiles Scales (MAPS) Aggression Item-Level Comparisons Between Autistic and Non-Autistic Preschoolers, Ranked From Largest to Smallest Odds Ratios

	Autistic group (n = 622)		Non-autistic group (n = 577)					
Item Stem[a]	**Frequent**[b] **n (%)**	**Infrequent**[c] **n (%)**	**Frequent n (%)**	**Infrequent n (%)**	χ^2	*p*	**OR**	**95% CI**
Try to break or ruin something	93 (15.0)	529 (85.0)	17 (2.9)	560 (97.1)	51.78	<.0001	5.79	3.41-9.84
Hit, shove, kick, bite, or pinch other adults	78 (12.5)	544 (87.5)	14 (2.4)	563 (97.6)	43.22	<.0001	5.77	3.22-10.31
Hit, shove, kick, bite, or pinch during daily routines	89 (14.3)	533 (85.7)	17 (2.9)	560 (97.1)	47.95	<.0001	5.50	3.23-9.37
Hit, shove, kick, bite, or pinch when frustrated, angry, or upset	98 (15.8)	524 (84.2)	19 (3.3)	558 (96.7)	52.80	<.0001	5.49	3.31-9.11
Hit, shove, kick, bite, or pinch for no reason	55 (8.8)	567 (91.2)	11 (1.9)	566 (98.1)	27.68	<.0001	4.99	2.59-9.64
Hit, shove, kick, bite, or pinch to get something they want	95 (15.3)	527 (84.7)	22 (3.8)	555 (96.2)	44.65	<.0001	4.55	2.82-7.34
Push someone hard	55 (8.8)	567 (91.2)	13 (2.3)	564 (97.7)	24.29	<.0001	4.21	2.27-7.79
Hit, shove, kick, bite, or pinch parent	92 (14.8)	530 (85.2)	23 (4.0)	554 (96.0)	40.30	<.0001	4.18	2.61-6.70
Hit, shove, kick, bite, or pinch other children (not sibling)	54 (8.7)	568 (91.3)	13 (2.3)	564 (97.7)	23.45	<.0001	4.13	2.23-7.64
Pinch someone when mad	47 (7.6)	575 (92.4)	13 (2.3)	564 (97.7)	17.71	<.0001	3.55	1.90-6.63
Hit sibling at slightest provocation	108 (17.4)	514 (82.6)	30 (5.2)	547 (94.8)	43.49	<.0001	3.83	2.51-5.84
Hit, shove, kick, bite, or pinch when tired, hungry, sick	78 (12.5)	544 (87.5)	21 (3.6)	556 (96.4)	31.30	<.0001	3.80	2.31-6.24
Pull someone's hair when mad	44 (7.1)	578 (92.9)	12 (2.1)	565 (97.9)	16.77	<.0001	3.58	1.87-6.86
Kick someone	56 (9.0)	566 (91.0)	16 (2.8)	561 (97.2)	20.58	<.0001	3.47	1.97-6.12
Try to hurt someone	65 (10.5)	557 (89.5)	20 (3.5)	557 (96.5)	22.17	<.0001	3.25	1.94-5.44
Bite someone when mad	30 (4.8)	592 (95.2)	9 (1.6)	568 (98.4)	10.13	.001	3.20	1.51-6.80
Hit someone	106 (17.0)	516 (83.0)	36 (6.1)	542 (93.2)	34.75	<.0001	3.18	2.13-4.75
Hit, shove, kick, bite, or pinch sibling	111 (17.8)	511 (82.2)	38 (6.6)	539 (93.4)	34.87	<.0001	3.08	2.09-4.54
Hit sibling with toy or another object	66 (10.6)	556 (89.4)	24 (4.2)	553 (95.8)	17.94	<.0001	2.74	1.69-4.43
Physically attack sibling without provocation	39 (6.3)	583 (93.7)	15 (2.6)	562 (97.4)	9.38	.002	2.51	1.37-4.60
Go over and smack sibling	70 (11.3)	552 (88.7)	30 (5.2)	547 (94.8)	14.35	<.0001	2.31	1.48-3.60
Hit another child at slightest provocation (not sibling)	25 (4.0)	597 (96.0)	11 (1.9)	566 (98.1)	4.59	.032	2.16	1.05-4.42

(*continued*)

TABLE 2 Continued

Item Stem[a]	Autistic group (n = 622)		Non-autistic group (n = 577)		χ^2	*p*	OR	95% CI
	Frequent[b] n (%)	Infrequent[c] n (%)	Frequent n (%)	Infrequent n (%)				
Physically attack another child without provocation (not sibling)	17 (2.7)	605 (97.3)	9 (1.6)	568 (98.4)	1.94	0.16	1.77	0.78-4.01
Hit another child with toy or other object (not sibling)	17 (2.7)	605 (97.3)	11 (1.9)	566 (98.1)	.90	0.34	1.45	0.67-3.11
Go over and smack another child	17 (2.7)	605 (97.3)	12 (2.1)	565 (97.9)	0.54	0.46	1.32	0.63-2.80

Note: χ^2*df* = 1. MAPS = Multidimensional Assessment Profile Scales; OR = odds ratio.
[a]Modified for conciseness.
[b]Frequent = most days/every day/multiple times per day.
[c]Infrequent = never/rarely/some days.

SCQ scores) accounted for an additional 11.4% of variance (model 3). Notably, with these variables in the model, autism diagnosis was no longer a significant predictor of aggression scores. Finally, the addition of reactivity scores accounted for an additional 18.4% of the variance in aggression, nearly doubling the total variance explained from model 3 to model 4.

The full regression model was statistically significant (model 4): $R^2 = 0.40$, $F_{21,1028} = 32.05$, $p < .0001$; adjusted $R^2 = 0.38$, a large effect size according to Cohen.[50] When all variables were considered in the full model, autism diagnosis became significant in the opposite direction as expected, with autistic children having slightly lower aggression scores after accounting for other neurodevelopmental factors and emotional reactivity. Parent-report of a suspected or actual ADHD diagnosis, autism traits, and emotional reactivity were all significantly associated with higher aggression scores in this model. Specifically, having a suspected or actual ADHD diagnosis was associated with about a 0.16 to 0.19 SD increase in aggression scores as compared to not having a suspected or actual ADHD diagnosis; a 1 SD increase in SCQ scores was associated with a 0.20 SD change in aggression scores, and a 1 SD change in reactivity was associated with a 0.52 SD change in aggression. Child speaking ability and presence of ID were not associated with aggression scores in the final model.

Aim 3: Subgrouping Autistic Preschoolers Using Machine Learning Clustering Techniques

The random forests machine learning clustering technique was used to identify distinct subgroups of autistic preschoolers based on their responses to the MAPS aggression, EDI-YC reactivity, and SCQ items. The silhouette score, which assesses how well data points fit within their subgroups by measuring both subgroup compactness and separation, was used to determine the optimal number of subgroups. A higher score indicates well-grouped and well-separated subgroups. Silhouette scores were calculated for different numbers of subgroups (2-10) and indicated that the 3-subgroup solution was best, revealing 3 distinct groups of autistic preschoolers exhibiting varying levels of severity in aggression, reactivity, and autism traits. Significant differences were found among all 3 subgroups in reactivity ($F2,619 = 421.06$, and aggression, $F_{2,619} = 270.01$). SCQ scores also differed between groups ($F_{2,619} = 20.61$, p values $<.0001$) with group 3 having higher SCQ scores than both other groups (p values $<.0001$), which did not differ from one another. *Z*-scores for aggression, reactivity, and SCQ for each subgroup are presented in Figure 1.

TABLE 3 Hierarchical Multiple Regression of Predictors (MAPS) of Aggression Total Scores

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	β	B (SE)	β	B (SE)	β	B (SE)	β
Autism diagnosis, yes			9.09 (1.32)	0.23***	−3.74 (1.98)	−0.1	−9.34 (1.76)	−0.24***
Child speaking ability (non-speaking as reference group)								
Single words					3.35 (2.14)	0.05	2.07 (1.88)	0.03
Phrase speech					4.13 (1.89)	0.09*	1.93 (1.66)	0.04
Fluent speech					3.19 (2.18)	0.08	−0.53 (1.92)	−0.01
Intellectual disability, yes					2.31 (1.66)	0.05	0.83 (1.45)	0.02
ADHD (no ADHD as reference group)								
ADHD, suspected					10.62 (1.68)	0.19***	5.82 (1.50)	0.10***
ADHD, yes					14.30 (2.61)	0.16***	9.70 (2.30)	0.11***
Autism traits, SCQ					0.75 (0.09)	0.35***	0.42 (0.08)	0.20***
Emotional reactivity, EDI-YC							10.26 (0.58)	0.52***
R^2	0.056		0.098		0.212		0.396	
Adjusted R^2	0.045		0.086		0.197		0.383	
SE of estimate	18.98		18.57		17.41		15.25	
R^2 change			0.042		0.114		0.184	

Note: ADHD = attention-deficit/hyperactivity disorder; EDI-YC = Emotion Dysregulation Inventory–Young Child; SCQ = Social Communication Questionnaire; SE = standard error.
*p < .05; **p < .01; ***p < .001.

In all, 21% (n = 133) of the autistic preschoolers formed subgroup 1, which consisted of children identified as having typical levels of reactivity relative to general population norms and no aggression. Nearly one-third (28%; n = 173) of children formed subgroup 2, which identified autistic preschoolers with mean reactivity scores nearing the clinical range and 40.5% of the subgroup above the clinical range, but relatively low levels of aggression (ie, mean below the non-autistic general population group mean). The remaining 51% of autistic children (n = 316) formed subgroup 3, having the highest levels of aggression and reactivity scores. Post hoc analyses revealed that subgroups did not differ on any of the sociodemographic variables nor by speaking ability or ID, although subgroup 3 included more children with diagnosed or suspected ADHD (Table 4).

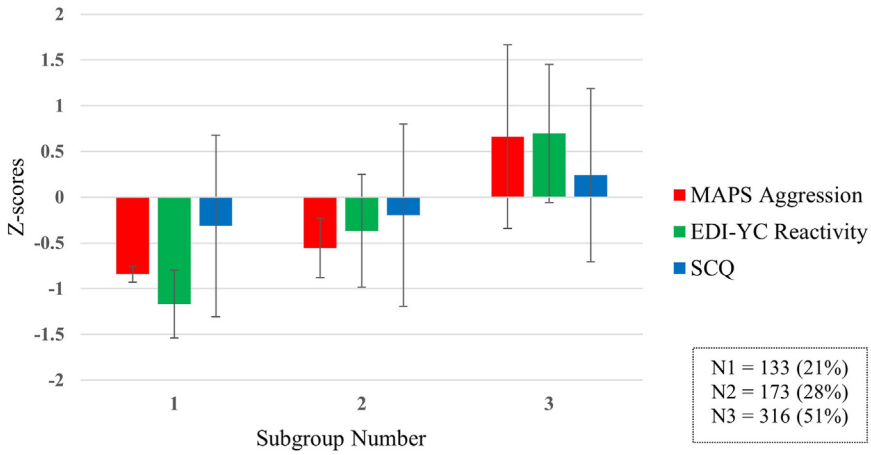
Finally, the feature importance algorithm revealed that MAPS aggression items that were most strongly associated with the clustering decision for autistic preschoolers were "trying to break or ruin something," and "hit, shove, kick, or pinch…," "when tired, hungry, or sick," "when frustrated, angry, or upset," or "during daily routines." Notably, 3 out of 4 of these items are among the top 5 items that distinguish autistic from non-autistic children (Table 2). In addition, EDI-YC reactivity items related to having "explosive outbursts" and "intense reactions," and having difficulty calming or being calmed, were also significant contributors to the clustering decision. SCQ items, on the other hand, showed minimal contribution toward clustering membership decision (Table S1, available online).

DISCUSSION

The present study was the first study to evaluate aggression and emotional reactivity together in a large (N = 1,199) non-referred sample of preschool-aged autistic and non-autistic children. Overall, this study confirms that young autistic children have higher rates of frequent aggressive behavior than non-autistic peers. We show that autistic preschoolers differ from non-autistic peers primarily in frequency, but not so much in type or context of parent-reported aggressive behaviors. The increased frequency of aggression may be explained by the positive association between emotional reactivity and aggression and the significantly higher emotional reactivity among autistic vs non-autistic preschoolers. Identification of subgroups within the autism sample indicates a strong connection between aggression and reactivity overall, but identifies a subgroup of children (group 2) for whom heightened aggression does not appear to go hand-in-hand with heightened reactivity scores. Results from each aim will be discussed in turn below.

Aim 1 indicated that the odds of a given aggressive behavior occurring "frequently" (more days than not) were 2 to 6 times greater for autistic vs non-autistic preschoolers. Importantly, rates of frequent aggression among autistic

FIGURE 1 Z-Score Means and SDs of the Multidimensional Assessment Profiles Scales (MAPS) Aggression Subscale, Emotion Dysregulation Inventory–Young Child (EDI-YC) Reactivity Subscale, and Social Communication Questionnaire (SCQ) for Machine Learning–Derived Autistic Preschooler Subgroups



children tended to be low overall, with even the most common behaviors occurring frequently in only 15% of the sample. Furthermore, the topography of many of the most frequently occurring presentations of aggression were qualitatively similar between groups, suggesting that autistic preschoolers showed greater frequencies of developmentally expected types of behaviors, whereas more atypical expressions of aggression were rare in both groups. The

TABLE 4 Clinical Characteristics of Autistic Participants by Subgroup

	Group 1: low reactivity, no aggression (n = 133)	Group 2: moderate reactivity, low aggression (n = 173)	Group 3: high reactivity and aggression (n = 316)	χ^2/ *F(df)*	*p*
MAPS aggression total score, mean (SD), n = 622	1.25 (1.99)	7.58 (6.46)	35.90 (23.08)	270.01 (2)	<.0001
EDI-YC reactivity theta score, mean (SD), n = 622	−1.34 (.51)	−0.29 (.59)	0.68 (.69)	426.00 (2)	<.0001
Above EDI-YC reactivity clinical cut-off, n (%)	0 (0)	70 (40.5)	277 (87.7)	314.42 (2)	<.0001
SCQ total score, mean (SD), n=622	17.69 (7.08)	18.51 (7.11)	21.66 (6.74)	20.56 (2)	<.0001
Speaking ability, n (%)					
Nonverbal, n = 197	47 (35.9)	53 (30.8)	97 (30.9)	4.05 (6)	.67
Single words, n = 121	24 (18.3)	35 (20.3)	62 (19.7)		
Phrase speech, n = 195	36 (27.5)	51 (29.7)	108 (34.4)		
Fluent speech, n = 104	24 (18.3)	33 (19.2)	47 (15.0)		
Intellectual disability, n (%)					
Yes, n = 191	34 (27.6)	53 (35.3)	104 (38.1)	4.09 (2)	.13
No, n = 355	89 (72.4)	97 (64.7)	169 (61.9)		
ADHD, n (%)					
Yes, n = 57	8 (6.1)	10 (5.8)	39 (12.4)	28.90 (4)	<.0001
Suspected, n = 139	14 (10.7)	36 (20.8)	89 (28.3)		
No, n = 422	109 (83.2)	127 (73.4)	186 (59.2)		

Note: ADHD = attention-deficit/hyperactivity disorder; EDI-YC = Emotion Dysregulation Inventory–Young Child; MAPS = Multidimensional Assessment Profile Scales; SCQ = Social Communication Questionnaire.

comprehensive and dimensional measurement of aggression was a strength of this study and represents a significant advance compared to much of the published literature, which has tended to categorize only the presence or absence of behaviors.[11,13,14,19] It is also the first, to our knowledge, to use the MAPS aggression subscale with autistic children, and our findings highlight that the MAPS may be a valid tool for the dimensional measurement of these behaviors in this population.

In aim 2, clinical correlates that emerged as relevant to aggression in preschoolers included suspected or actual co-occurring ADHD diagnosis, autism traits, and emotional reactivity. These findings corroborate previous findings of positive associations between parent-reported autistic traits and aggression,[1,13,14,22,23] but suggest that autism diagnosis and traits may be less important than previously believed. Instead, emotional reactivity emerged as the strongest (based on standardized β) and most important (based on R^2 change) predictor of aggression. The addition of reactivity to the model actually reversed the estimated impact of having an autism diagnosis on aggression scores, suggesting that the increased aggression in the autism group is not simply a function of their diagnosis. However, levels of autism traits (ie, various aspects of social, communication, and behavioral differences) have more predictive ability than an autism diagnosis, likely due to the greater heterogeneity of scores in the autistic (and non-autistic) group. Aim 3 supported these findings, indicating that subgroups within the autism sample could be determined based largely on aggression and reactivity scores, with autism traits being a less important feature. Ultimately, these findings suggest that the higher prevalence of aggression in autistic vs non-autistic individuals is related to autistic individuals being much more likely to experience clinically significant emotion dysregulation, rather than due to being autistic *per se.*

ADHD was also positively associated with greater levels of aggression in both aim 2 and aim 3 (supporting Mayes *et al.*).[10] Given that impulsivity, which is common in autism and ADHD,[28] is also frequently associated with reactive aggression among non-autistic children,[9] examining the interplay between emotion dysregulation and impulsivity in conferring risk for aggression is needed. Finally, as several others have found,[1,13,14,26,27] speaking ability and intellectual ability were not associated with aggression in either aim. This is notable, as it is often assumed that aggression occurs because of difficulty speaking or communicating. Better understanding of the relationship between communication and aggression would require richer measurement of communication, such as more nuanced assessment of communication about emotions or the ability to communicate during emotional distress, is needed.

The findings of aim 3 revealed that 3 distinct groups were identified based on their levels of aggression and reactivity. The MAPS aggression items that had the highest impact on clustering membership were also among those that most differentiated autistic and non-autistic children, as demonstrated in aim 1. Thus, these items seem to be the ones that distinguish children with high and low aggression generally, whether or not they have an autism diagnosis. This is yet further support for the idea that aggression among autistic children is characterized by quantitative (ie, frequency) rather than qualitative differences from how aggression occurs in non-autistic children.

Group 2 emerged as a particularly interesting case in the clustering analysis. Whereas group 1 exhibited low levels of both reactivity and aggression, and group 3 exhibited high levels of both, group 2 displayed relatively high reactivity but low levels of aggression. This suggests that the children in group 2 are quite emotionally reactive (40.5% above clinical cut-off), but their mean aggression scores remain non-clinical, with scores below the average for non-autistic preschoolers. Thus, although it is clear from the results of aim 2 that reactivity is a strong predictor of aggressive behavior, we identified a subgroup of autistic preschoolers (group 2) for whom reactivity and aggression do not necessarily go together, potentially within this age group or as evaluated cross-sectionally in time. Although none of the clinical features examined in the present study clearly distinguished group 2 from groups 1 and 3 (ie, level of autism traits, speaking ability, ID, ADHD), understanding what distinguishes children whose reactivity is associated with aggression from those who are reactive without aggressive behavior is of significant clinical importance. This suggests that some children may have temper outbursts or poor emotional control without aggression. It is possible that there are alternative behavioral outlets for reactivity that we did not measure (eg, verbal aggression, self-injurious behaviors). Some children also may be at risk for future internalizing or externalizing concerns related to reactivity. For example, increases in reactivity in childhood have also been associated with depression and suicidality in adolescence.[51] It is also possible that protective factors may scaffold the emergence of aggression in this group (eg, supportive environment, positive parenting). It would thus be informative to monitor these subgroups over time to gain insight into the emergence of early reactivity, and later aggression or other clinical concerns.

The strengths of this study should be balanced with acknowledgement of some limitations. First, because we

were interested in item-level analysis of the MAPS, data from autistic and non-autistic participants who did not have siblings (and who therefore had missing scores for several MAPS items) were excluded from the present study. Therefore, it is important to note that results may not be generalizable to only children. There were also a number of sociodemographic differences between our autistic and non-autistic samples, likely due to differences in recruitment strategies between the SPARK data set and local recruitment. Although we controlled statistically for these variables, it will be important for findings of group differences to be replicated in more closely matched samples of autistic and non-autistic preschoolers.

Second, retrospective parent-report of aggressive behavior comes with some inherent limitations and biases. Although it may be a useful and/or necessary method of reporting, particularly for large samples, aggressive behavior observed by caregivers cannot provide complete insight into the autistic child's experience, needs, and intentions. Both emotional reactivity and aggression are likely associated with environmental variables (eg, challenging sensory environments, non-supportive communities) that influence stress, sensory stimulation, and the desire to leave a situation. Supplementing retrospective parent-report with direct observation and/or physiological measures may provide more accurate assessments of reactivity and aggression,[52–54] particularly for children with varying intellectual and speaking abilities. Furthermore, our study focused on physical aggression and emotional reactivity, but a more expansive evaluation of other types of aggression (eg, self-injury) and other components of emotion dysregulation (eg, dysphoria) is warranted. It will be particularly important to consider the role of irritability, which is associated with a tendency to be reactive to negative stimuli and includes affective (anger) and behavioral (temper outburst) components.[45] Although the EDI reactivity scale is also recommended in irritability research,[45] and although reactivity is conceptually similar to irritability, the EDI reactivity scale asks about the past 7 days, which may not capture the chronicity that is thought to be part of irritability. A recent paper using a measure of irritability over the past 2 months found an association with aggression in autism.[28] Future early childhood research could consider measures of irritability with a longer time frame or repeated assessment of reactivity over time to determine the role of chronicity in outcomes.

In summary, the present study highlights that autistic children differ from non-autistic peers primarily in quantity (not quality) of aggressive behavior, and that these differences can be explained largely by differences in emotional reactivity. Whereas behavioral interventions for aggression in non-autistic children often have a component dedicated to targeting underlying emotion dysregulation challenges,[55] such behavioral interventions for autistic children have largely focused on identifying the function of the behavior, teaching alternative communication strategies, and/or are focused on parent training.[56,57] The present findings suggest that assessment and intervention for emotion dysregulation may be critical for supporting autistic children with aggressive behavior.

This article is part of a special series devoted to addressing aggressive behavior as a focus of psychiatric attention and how its manifestations and treatment needs may vary across psychiatric disorders. The series is edited by Guest Editor Joseph Blader, PhD, Deputy Editor Robert Findling, MD, MBA, and Editor Manpreet K. Singh, MD, MS.

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