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## DSM-5 disruptive mood dysregulation disorder: correlates and predictors in young children

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### Abstract

**Background**—Despite the inclusion of disruptive mood dysregulation disorder (DMDD) in DSM-5, little empirical data exist on the disorder. We estimated rates, co-morbidity, correlates and early childhood predictors of DMDD in a community sample of 6-year-olds.

**Method**—DMDD was assessed in 6-year-old children ( $n = 462$ ) using a parent-reported structured clinical interview. Age 6 years correlates and age 3 years predictors were drawn from six domains: demographics; child psychopathology, functioning, and temperament; parental psychopathology; and the psychosocial environment.

**Results**—The 3-month prevalence rate for DMDD was 8.2% ( $n = 38$ ). DMDD occurred with an emotional or behavioral disorder in 60.5% of these children. At age 6 years, concurrent bivariate analyses revealed associations between DMDD and depression, oppositional defiant disorder, the Child Behavior Checklist – Dysregulation Profile, functional impairment, poorer peer functioning, child temperament (higher surgency and negative emotional intensity and lower effortful control), and lower parental support and marital satisfaction. The age 3 years predictors of DMDD at age 6 years included child attention deficit hyperactivity disorder, oppositional defiant disorder, the Child Behavior Checklist – Dysregulation Profile, poorer peer functioning, child temperament (higher child surgency and negative emotional intensity and lower effortful control), parental lifetime substance use disorder and higher parental hostility.

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#### Declaration of Interest

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**Conclusions**—A number of children met DSM-5 criteria for DMDD, and the diagnosis was associated with numerous concurrent and predictive indicators of emotional and behavioral dysregulation and poor functioning.

### Keywords

Disruptive mood dysregulation disorder; early childhood; predictors

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## Introduction

Disruptive mood dysregulation disorder (DMDD), a condition characterized by severe and chronic irritability, was recently added to the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5) for childhood and adolescent disorders (APA, 2013). DMDD is defined by severe temper tantrums that are disproportionate to the situation, inconsistent with developmental level, and occur at least three times per week. Mood between outbursts is persistently angry or irritable, and symptoms must be present for at least 12 months in at least two contexts. DMDD cannot be diagnosed in children before the age of 6 years and must be observed by 10 years. Its inclusion in DSM-5 has been controversial given how little is known about the disorder. Indeed, much of the support for DMDD has been based on research focusing on severe mood dysregulation (SMD), a condition characterized by chronic and severe irritability in conjunction with hyperarousal symptoms, which thus shares symptoms with depression, oppositional defiant disorder (ODD), mania and attention deficit hyperactivity disorder (ADHD) (Leibenluft *et al.* 2003). SMD was originally conceptualized as a possible phenotype for bipolar disorder, but this has not been supported (Leibenluft, 2011). Longitudinal studies demonstrate that both SMD and dimensional measures of chronic irritability predict unipolar depressive and anxiety disorders, rather than bipolar disorder (Brotman *et al.* 2006; Stringaris *et al.* 2009). DMDD was adapted from SMD by excluding the hyperarousal criterion.

Very limited research is available on DMDD. Emerging evidence suggests that it is relatively common in clinical settings, with rates ranging from 26.0% to 30.5% (Axelson *et al.* 2012; Margulies *et al.* 2012). Only one study, to our knowledge, has investigated DMDD in community samples. Copeland *et al.* (2013) examined the epidemiology of DMDD using data from three large community samples of youth ranging in age from 2 to 17 years. The 3-month prevalence rates for DMDD ranged from 0.8% to 3.3%, with the highest rates in preschoolers (who were included despite their exclusion from the DSM-5 diagnosis). DMDD co-occurred with all common psychiatric disorders, with the highest rates of cooccurrence with depression and ODD. DMDD was also associated with elevated rates of social impairments, school suspension, service use and poverty.

Major questions remain regarding DMDD's clinical, biological and psychosocial characteristics, early predictors and course, and familial psychopathology and heritability. The present study investigated DMDD in 6-year-old children using data from the Stony Brook Temperament Study (Dougherty *et al.* 2011; Bufferd *et al.* 2012), a large community-based study of young children followed from 3 to 6 years of age.

To replicate and extend the findings of Copeland *et al.* (2013) in an independent sample, our first aim was to estimate rates and co-morbidity of DMDD in a community sample of 6-year-olds, and extend previous findings by examining a broader range of concurrent correlates. Given evidence that symptoms of chronic irritability show moderate stability (Leibenluft *et al.* 2006), it is likely that indicators of dysfunction are present even in early childhood. Thus, the second aim was to extend the existing literature by examining age 3 years predictors of DMDD at the age of 6 years. No data on early predictors of DMDD have been previously reported. Age 6 years correlates and age 3 years predictors were assessed using a multi-method (interviews, laboratory assessments, and questionnaires), multi-informant (mother, father, and teacher report, and behavioral observation) design. The following six domains were assessed: demographics; child psychiatric disorders; psychosocial functioning (functional impairment, peer functioning, vocabulary); child temperament; parental psychopathology; and the psychosocial environment (observed parenting, recent and early life stress, marital satisfaction).

Based on the limited research on DMDD and the broader literature on SMD and chronic irritability in community samples (Brotman *et al.* 2006; Leibenluft *et al.* 2006; Stringaris *et al.* 2010; Krieger *et al.* 2013), we hypothesized that DMDD would be associated with: high co-morbidity, especially with depression and ODD; functional impairment, even after accounting for psychiatric co-morbidity; early temperamental emotional lability and reactivity; and environments characterized by problematic parenting and parental psychopathology.

## Method

### Participants

We recruited families with a 3-year-old child living within 32 km (20 miles) of Stony Brook University (SBU). Potential participants were identified via a commercial mailing list; eligible families had a child between 3 and 4 years of age with no significant medical conditions or developmental disabilities and at least one English-speaking biological parent. Of the 815 families who were identified as eligible, 66.4% ( $n = 541$ ) entered the study and provided diagnostic information about the child. There were no significant differences on demographic variables between families who did and did not participate. Table 1 presents demographic information on the study sample (also see Bufferd *et al.* 2011, 2012). Census data suggest that the sample is reasonably representative of the surrounding county. The study was approved by the SBU human subjects review committee, and informed consent was obtained from parents.

Of the 541 parents who were interviewed regarding their 3-year-old child (mean = 3.6, *s.d.* = 0.3 years), 462 parents (85.4%) were interviewed again when their child reached the age of 6 years (mean = 6.1, *s.d.* = 0.4 years). There were two significant differences between families who completed both assessments and families who completed only the first assessment: 60.0% (six out of 10) of children with depression at age 3 years participated at age 6 years whereas 85.9% (456 out of 531) of children without depression at age 3 years participated at age 6 years [ $\chi^2(1, n = 541) = 5.27, p < 0.05$ ]; 73.1% (19 out of 26) of children who screened positive at age 3 years for the Child Behavior Checklist – Dysregulation

Profile (CBCL-DP) based on father report participated at age 6 years whereas 88.7% (337 out of 380) of children who screened negative at age 3 years participated at age 6 years [ $\chi^2(1, n = 406) = 5.49, p < 0.05$ ].

## Measures

**Demographics**—We examined child sex, race/ethnicity (white/ non-Hispanic, non-white and/or Hispanic), parental education (either parent graduated college) and parental marital status.

**DMDD**—The primary parent was interviewed regarding their child's psychopathology using the Preschool Age Psychiatric Assessment (PAPA; Egger *et al.* 1999). A 3-month primary period was used to enhance recall, but symptom onset dates were obtained for all criteria. DMDD was defined based on DSM-5 criteria (APA, 2013). Although the PAPA was not designed to assess DMDD, consistent with Copeland *et al.* (2013) it contained information needed to rate DMDD criteria. All PAPA items coded as present were followed up with frequency, setting and age-of-onset information.

Criteria A and B (recurrent and severe temper outbursts) were defined using items from the ODD section assessing temper tantrums and outbursts. When temper outbursts were endorsed, parents were queried regarding the frequency of temper outbursts to determine whether the temper outbursts occurred at least three times per week (criterion C). Chronically irritable or angry mood between temper outbursts (criterion D) was coded using items from the depression section on whether the child was prone to feelings of anger, irritability, annoyance or low frustration tolerance more days than not (i.e.  $\geq 45$  times in the past 3 months). Based on age-of-onset questions, we determined whether frequent temper outbursts and chronically irritable or angry mood had been present for 12 months or more (criterion E). Based on setting information, temper outbursts and chronically irritable or angry mood had to occur in at least two settings (criterion F). Children were assessed at the age of 6 years; thus age-of-onset criteria were met (criteria G and H). Criteria I and J involve exclusions for a history of mania, bipolar disorder and intermittent explosive disorder; however, these were not assessed. Criterion J also states that if a child meets criteria for both DMDD and ODD, only the diagnosis of DMDD is made; however, given our focus on investigating characteristics of DMDD, co-occurring diagnoses of ODD were retained.

**Children's Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV; APA, 2000) psychiatric disorders**—As described elsewhere (Bufferd *et al.* 2011, 2012), DSM-IV disorders assessed with the PAPA at the ages of 3 and 6 years included: any depressive disorder (major depressive disorder, dysthymic disorder, or depression not otherwise specified); any anxiety disorder (specific phobia, separation anxiety disorder, social phobia, generalized anxiety disorder, agoraphobia, selective mutism); ADHD; and ODD. Inter-rater reliability for all diagnoses was good at both assessments ( $\kappa = 1.00$  for all diagnoses at age 3 years;  $\kappa = 0.64$ – $0.89$  for diagnoses at age 6 years) (Bufferd *et al.* 2011, 2012). For information on the interview's psychometric properties, see Egger *et al.* (2006).

**CBCL-DP**—Similar to SMD, the CBCL-DP was originally conceptualized to identify pediatric bipolar disorder, but more recently has been shown to identify children with severe emotional and behavioral dysregulation (Althoff *et al.* 2010; Holtmann *et al.* 2011; Kim *et al.* 2012). Both parents completed the CBCL/1½–5 (Achenbach & Rescorla, 2000) and CBCL/6–18 (Achenbach & Rescorla, 2001) at the ages of 3 and 6 years, respectively. The CBCL-DP (Althoff *et al.* 2010) is based on three subscales: attention problems (five items:  $\alpha = 0.63$  at age 3 years; 10 items:  $\alpha = 0.81$  at age 6 years); anxious/depressed (eight items:  $\alpha = 0.70$  at age 3 years; 13 items:  $\alpha = 0.77$  at age 6 years); and aggressive behavior (19 items:  $\alpha = 0.90$  at age 3 years; 18 items:  $\alpha = 0.87$  at age 6 years). The CBCL-DP was defined by a score of  $\geq 180$  on the summed *t* scores of the three subscales (Kim *et al.* 2012).

**Functional impairment**—The PAPA interviewer completed the Children’s Global Assessment Scale (CGAS) and functional impairment ratings at the age of 6 years. The CGAS is a global measure of children’s level of functioning (Shaffer *et al.* 1983). Scores range from 0 to 100, where 0 indicates the worst functioning and 100 indicates superior functioning. The inter-rater reliability (intra-class correlation; ICC) for the CGAS ratings was 0.86. Impairment was also rated across several domains (parental relationship quality, household and recreational activities, sibling and peer relationships, school life) on five-point scales ranging from 0 (no impairment) to 4 (severe impairment). Ratings were summed across domains for a total impairment score (ICC = 0.84).

**Peer functioning**—Teachers provided ratings of children’s social competence and popularity at the ages of 3 and 6 years. These measures were available for only a subset of the sample ( $n = 194$  and  $n = 241$  at 3 and 6 years, respectively). Children’s social competence (seven items:  $\alpha = 0.87$  at age 3 years,  $\alpha = 0.87$  at age 6 years) was measured using the Ratings of Children’s Behaviors scale (Eisenberg *et al.* 1996). Children’s popularity (three items:  $\alpha = 0.81$  at age 3 years,  $\alpha = 0.73$  at age 6 years) was measured using the Teacher’s Estimation of Child’s Peer Status (E. Lemerise and K. A. Dodge, unpublished instrument; Vanderbilt University, USA).

**Vocabulary skills**—The Peabody Picture Vocabulary Test (Dunn & Dunn, 1997) assessed children’s receptive vocabulary at the ages of 3 and 6 years ( $n = 459$  and  $n = 445$ , respectively).

**Child temperament**—The Child Behavior Questionnaire (CBQ; Rothbart *et al.* 2001) is a 194-item parent-report measure of temperament for 3- to 7-year-old children. It assesses three broad dimensions: negative affectivity (anger/ frustration, sadness, fear, low soothability); surgency (high-intensity pleasure, impulsivity, activity, low shyness); and effortful control (inhibitory control, attentional focusing, low-intensity pleasure). At the age of 3 years, it was completed by 438 mothers and 351 fathers. Coefficient  $\alpha$ ’s for mother and father reports were 0.77 and 0.76 for negative affectivity, 0.82 and 0.80 for surgency, and 0.90 and 0.87 for effortful control. At the age of 6 years, it was completed by 412 mothers and 341 fathers. Coefficient  $\alpha$ ’s for mother and father reports were 0.76 and 0.78 for negative affectivity, 0.79 and 0.79 for surgency, and 0.89 and 0.90 for effortful control.

At each assessment, teachers rated (1 = never to 7 = always) children's general positive emotional intensity (PEI) and negative emotional intensity (NEI) using an adaptation of Larsen & Diener's (1987) Affect Intensity Scale (Eisenberg *et al.* 1995; six items for PEI, e.g. 'When my child accomplishes something difficult, s/he feels delighted'; five items for NEI, e.g. 'When my child experiences anxiety, it normally is very strong'). Coefficient  $\alpha$ 's at the ages of 3 and 6 years for PEI were both 0.84 and for NEI were 0.75 and 0.76, respectively.

**Parental psychopathology**—At the age of 3 years, children's biological parents were interviewed using the non-patient Structured Clinical Interview for DSM-IV (SCID; First *et al.* 1996). SCIDs were obtained from 459 (99.4%) mothers and 385 (83.3%) fathers. When parents were unavailable, family history interviews were conducted with the co-parent. Diagnoses based on family history data were obtained for one mother and 70 fathers. Based on audiotapes of 30 SCIDs,  $\kappa$ 's for inter-rater reliability of lifetime diagnoses were 0.93 for any depressive disorder, 0.91 for anxiety disorder and 1.00 for substance abuse/dependence.

**Psychosocial environment**—At the ages of 3 and 6 years, observed parental hostility (e.g. expressions of anger, frustration, criticism toward the child) and parental support (e.g. expressions of positive regard and emotional support) were assessed in the laboratory using a modified version of the Teaching Tasks battery (Egeland *et al.* 1995). At the age of 3 years, 458 parents (93.7% mothers) and children participated in six interaction tasks (e.g. block-building, matching game). At the age of 6 years, 428 parents (88.6% mothers) and children participated in four interaction tasks (e.g. guessing game and puzzles). Interactions were videotaped and coded for parental hostility and support on a five-point scale and ratings were averaged across tasks. The hostility and support scales showed good internal consistency at the age of 3 years ( $\alpha = 0.76$  and  $0.88$ , respectively) and at the age of 6 years ( $\alpha = 0.88$  and  $0.86$ , respectively); inter-rater reliability was also good for the hostility and support scales at the age of 3 years (ICC =  $0.83$  and  $0.85$ , respectively,  $n = 55$ ) and at the age of 6 years (ICC =  $0.86$  and  $0.84$ , respectively,  $n = 35$ ).

Stressful life events involving the child and immediate family were assessed using the PAPA at the ages of 3 and 6 years. We used two measures of life events: total number of early stressors from the time the child was born until the age 3 years interview; and proximal events in the 12 months prior to the age 6 years interview.

Marital satisfaction was assessed at 3 and 6 years by primary caregivers using the four-item abbreviated version of the Dyadic Adjustment Scale (DAS; Spanier, 1976). At 3 years, 354 parents completed the abbreviated DAS ( $\alpha = 0.83$ ). At 6 years, 396 parents completed the abbreviated DAS ( $\alpha = 0.86$ ).

## Data analysis

We examined 3-month prevalence rates for DMDD and each criterion at the age of 6 years. To examine concurrent and predictive associations, we conducted binary logistic regression analyses, with DMDD diagnosis at the age of 6 years as the dependent variable in all models, and each age 6 years correlate and age 3 years predictor entered as an independent variable in separate bivariate models. Age 6 years correlates and age 3 years predictors



included variables from each of the six domains: demographics; child psychopathology, psychosocial functioning, and temperament; parental psychopathology; and the psychosocial environment. Age 6 years correlates and age 3 years predictors with significant bivariate associations with DMDD at the age of 6 years were entered into multiple logistic regressions to examine which correlates and predictors had unique effects. Data from fathers and teachers were excluded from the multivariate analyses due to limited power from the reduced sample size. Exploratory comparisons between ‘pure’ and co-morbid DMDD and ODD were conducted using one-way analysis of variance; pair-wise comparisons were conducted using the Tukey honestly significant difference test.

Tests of tolerance values to detect multicollinearity were conducted for all multivariate models. Tolerance values for all variables in the predictor multivariate model exceeded 0.70, indicating an acceptable degree of multicollinearity among the variables (Menard, 2002). For the concurrent multivariate model, all tolerance statistics exceeded 0.70 except for the CGAS and impairment ratings. However, results were similar when these variables were excluded.

## Results

### Rates

Table 2 includes the 3-month rates for each DMDD criterion. The estimate for those children meeting all inclusion criteria was 8.2% ( $n = 38$ ). No sex, age or race/ethnicity differences were observed for individual DMDD criteria or the full diagnosis.

Of the 38 children with DMDD at the age of 6 years, 23 (60.5%) met criteria for a concurrent emotional or behavioral disorder: 10 (26.3%) had a co-occurring emotional disorder, 21 (55.3%) had a co-occurring behavioral disorder (Table 3); eight (21.1%) met criteria for concurrent emotional and behavioral disorders. Children with DMDD received diagnoses of any depression (13.2%,  $n = 5$ ), any anxiety (13.2%,  $n = 5$ ), ADHD (10.5%,  $n = 4$ ) and ODD (55.3%,  $n = 21$ ); 15 (39.5%) children were diagnosed with DMDD only. We also looked at the overlap between DMDD and SMD, using SMD criteria specified in Brotman *et al.* (2006). The level of co-occurrence was moderate [odds ratio (OR) = 28.25, 95% confidence interval (CI) 12.16–65.62,  $p < 0.001$ ]: 47.4% ( $n = 18$ ) of children with DMDD met criteria for SMD, and 58.1% ( $n = 18$ ) of children with SMD met criteria for DMDD.

### Concurrent associations

Results from the concurrent bivariate logistic regressions are presented in Table 3. At the age of 6 years, DMDD was significantly associated with co-occurring diagnoses of depression and ODD, maternal- and paternal-reported CBCL-DP classification, greater functional impairment, lower peer functioning, maternal and paternal reports of higher child surgency and lower effortful control, higher teacher-reported child NEI, and lower parental support and marital satisfaction. When the significant bivariate correlates were entered into a multivariate logistic regression, ODD, maternal-reported CBCL-DP and lower parental support remained significant (Table 5).

Given that DMDD was associated with greater functional impairment, we examined whether it provided a unique contribution over and above other psychiatric disorders. Controlling for any depressive disorder, any anxiety disorder, ADHD and ODD at the age of 6 years, DMDD remained significantly associated with the CGAS ( $B = -5.07$ ,  $s.e. = 1.61$ ,  $pr = -0.25$ ,  $p = 0.002$ ) and impairment ratings ( $B = 1.69$ ,  $s.e. = 0.57$ ,  $pr = 0.14$ ,  $p = 0.003$ ). In addition, controlling for the total number of co-morbid emotional and behavioral disorders, DMDD remained significantly associated with the CGAS ( $B = -5.15$ ,  $s.e. = 1.46$ ,  $p < 0.001$ ) and impairment ratings ( $B = 2.17$ ,  $s.e. = 0.52$ ,  $p < 0.001$ ).

Finally, due to the conceptual and empirical overlap between DMDD and ODD, we conducted exploratory analyses comparing children with ODD alone ( $n = 10$ ), DMDD alone ( $n = 15$ ) and co-morbid DMDD and ODD ( $n = 10$ ) on the CGAS and impairment ratings. Both analyses yielded significant effects: CGAS ( $F_{2,32} = 8.01$ ,  $p < 0.01$ ), and impairment ( $F_{2,32} = 9.57$ ,  $p < 0.01$ ). Children with DMDD alone (CGAS: mean = 69.80,  $s.d. = 9.65$ ; impairment: mean = 7.33,  $s.d. = 0.78$ ) and co-morbid DMDD and ODD (CGAS: mean = 68.20,  $s.d. = 8.32$ ; impairment: mean = 7.90,  $s.d. = 0.96$ ) had significantly higher CGAS and significantly lower impairment ratings compared with children with ODD alone (CGAS: mean = 57.20,  $s.d. = 3.99$ ; impairment rating: mean = 12.50,  $s.d. = 0.96$ ;  $p < 0.01$  and  $p = 0.01$ , respectively). Children with DMDD alone and those with co-morbid DMDD and ODD did not differ on either variable.

### Age 3 years predictors

Bivariate predictors of DMDD included age 3 years child ADHD and ODD, maternal-reported CBCL-DP classification, lower peer functioning, higher maternal-rated child surgency, lower maternal- and paternal-rated child effortful control, higher teacher-reported child NEI, parental lifetime substance use disorder, and greater parental hostility (Table 4). When the significant bivariate predictors were entered into a multivariate logistic regression, higher maternal-rated child surgency and parental lifetime substance use disorders remained significant (Table 5)<sup>1†</sup>.

### Discussion

This study examined the new DSM-5 diagnosis of DMDD in a large community sample of 6-year-old children. We assessed prevalence rates, co-morbidity, concurrent correlates and age 3 years predictors of DMDD using a multi-method, multi-informant design. To our knowledge, this is the first study to investigate a broad set of predictors of DMDD. Investigations during early childhood are critical for early prevention and intervention given evidence documenting the long-term negative consequences of chronic irritability in youth (Stringaris *et al.* 2009).

#### <sup>1</sup>Notes

Assuming that some children who subsequently develop emotional and behavioral disorders exhibit subclinical levels of symptoms, we also examined age 3 years symptom scales as predictors of DMDD at the age of 6 years. Results indicated that depressive (OR=1.18, 95% CI 1.05–1.33,  $p=0.007$ ), ADHD (OR=1.05, 95% CI 1.01–1.09,  $p=0.012$ ) and ODD (OR=1.11, 95% CI 1.06–1.17,  $p < 0.001$ ) symptoms at the age of 3 years predicted DMDD at the age of 6 years. When these symptom scales were included in the multivariate predictor model along with the other significant bivariate predictors, ODD symptoms (OR=1.09, 95% CI 1.02–1.17,  $p=0.013$ ), surgency and parental substance use disorders continued to predict DMDD at the age of 6 years.

<sup>†</sup>The notes appear after the main text.



## Rates and clinical characteristics

The 3-month prevalence of DMDD was 8.2%, and co-morbidity was common: 60.5% of children with DMDD also met criteria for a concurrent emotional or behavioral disorder, with the highest levels of co-occurrence for depression and ODD. However, the rate of co-morbidity for DMDD is comparable with other psychiatric disorders in this sample (depressive disorder 75.0%, ADHD 52.0%, ODD 51.2%, anxiety disorder 23.6%; Bufferd *et al.* 2012). In the only other study investigating the prevalence of DMDD in a community sample, Copeland *et al.* (2013) examined three independent samples of youth (study 1: 2–5 years; study 2: ages 9, 11 and 13 years; study 3: ages 9–17 years), and reported similar patterns of co-occurrence. However, the prevalence of DMDD observed in our sample was higher than the rates reported by Copeland *et al.* (2013), which ranged between 0.8% and 3.3%, with the highest prevalence in their preschool sample. The reason for the discrepancy is unclear. Similar methods were employed; however, Copeland *et al.* (2013) did not assess rates in 6-year-old children. Nevertheless, the rates of each DMDD criterion presented in Table 2 are similar to those reported for the preschool sample by Copeland *et al.* (2013) with the exception of the 12-month duration criterion (16.0% in our sample v. 1.5–5.9% in Copeland's samples). Further work is needed to determine whether this discrepancy is due to substantive or methodological factors.

Copeland *et al.* (2013) suggested that the frequency criteria for DMDD temper outbursts and negative mood should possibly be increased for younger children, as temper outbursts and moodiness are more common during earlier developmental periods. Applying a higher threshold in which temper and negative mood are present every day reduced the prevalence of DMDD in our sample to 6.9% ( $n = 32$ ). Nevertheless, even if the DMDD criteria applied in this sample are capturing a broader phenotype, this phenotype was uniquely associated with functional impairment over and above other psychiatric disorders, supporting the clinical utility of DMDD.

Consistent with the findings of Copeland *et al.* (2013), our data suggest that DMDD and ODD are not entirely overlapping constructs, as 45% of the children with DMDD did not have ODD, and DMDD was uniquely associated with impairment over and above the effects of ODD. DSM-5 excludes the diagnosis of ODD in the presence of DMDD. While our data cannot directly address the validity of this criterion, exploratory analyses suggested that DMDD is not simply a more severe form of ODD, as children with ODD alone exhibited poorer global functioning and greater impairment than both children with DMDD alone and those with co-morbid DMDD and ODD. Although these analyses must be viewed cautiously due to the small sizes of the three groups, the latter finding was surprising, as co-morbidity is generally associated with greater impairment. ODD includes three dimensions: irritable; headstrong; and hurtful (Stringaris & Goodman, 2009). Our findings raise the possibility that the irritable dimension contributes more to diagnoses of ODD in youth who also meet criteria for DMDD, while the headstrong and hurtful dimensions predominate in children with ODD alone, and that these latter dimensions may be associated with greater impairment. However, this is speculative and needs to be empirically tested. We also examined the co-occurrence between DMDD and SMD. Similar to our findings with ODD and consistent with Copeland *et al.* (2013), DMDD and SMD co-occurred approximately

half of the time. Our data suggest that research on SMD cannot necessarily be generalized to DMDD, and thus future investigations on DSM-5 DMDD are a high research priority.

To our knowledge, no previous studies have prospectively examined precursors of DMDD. We explored whether psychiatric diagnoses at the age of 3 years predicted the diagnosis of DMDD at the age of 6 years. In bivariate analyses, but not in the multivariate model, ODD and ADHD at the age of 3 years predicted DMDD at the age of 6 years. Using dimensional scales to capture subthreshold levels of symptomatology, age 3 years depressive, ODD and ADHD symptoms predicted age 6 years DMDD diagnoses, and ODD continued to be a significant predictor in the multivariate model. Similarly, bivariate analyses revealed that children with a DMDD diagnosis at the age of 6 years were more likely to screen positive for the CBCL-DP classification at 3 years of age based on maternal reports and at the age of 6 years based on maternal and paternal reports. Similar to DMDD, the profile is associated with both internalizing and externalizing psychopathology and marked impairment (Youngstrom *et al.* 2005; Kim *et al.* 2012). Taken together, these data indicate that, even as young as 3 years of age, children with DMDD showed evidence of mood and behavioral dysregulation.

### **Child temperament and emotionality**

There are no data on the temperamental correlates and predictors of DMDD. Prospectively and concurrently, DMDD was associated with parent reports of higher child surgency and lower effortful control and teacher reports of high NEI. Our findings are consistent with literature in both youth and adults documenting links between negative affectivity and both internalizing and externalizing psychopathology, and associations of both high surgency and low effortful control with externalizing disorders (Clark, 2005; Rettew, 2008). Moreover, maternal-reported surgency at the age of 3 years emerged as a unique predictor in the multivariate analysis. Interestingly, in the multivariate model, child ODD and ADHD at the age of 3 years were no longer significant predictors. The CBQ surgency factor includes high-intensity pleasure (or sensation seeking), impulsivity, activity, and low shyness (or boldness) (Rothbart *et al.* 2001). Given the overlap of surgency with ODD and ADHD, as well as the greater reliability and validity of continuous than discrete measures (Markon *et al.* 2011), it is not surprising that, of the three variables, only surgency accounted for unique variance in predicting DMDD. Young children with high surgency may be at particularly high risk for DMDD as they tend to have a strong motivation to approach and seek rewards, yet when their goals are blocked, these children can be more reactive and prone to anger and frustration.

### **Familial and environmental correlates**

Our study also extends the literature by examining familial and environmental correlates and predictors of DMDD. DMDD at the age of 6 years was associated with concurrent observed low parental support and lower levels of marital satisfaction, and observed low parental support remained significant in the multivariate analysis. Both higher observed parental hostility and parental lifetime substance use disorders assessed at age 3 years predicted DMDD at age 6 years, and parental lifetime substance use disorder emerged as a unique predictor of DMDD in the multivariate analysis. Given evidence linking the irritability

dimension of ODD to maternal depression (Krieger *et al.* 2013), it is somewhat surprising that DMDD was not associated with parental internalizing disorders. In the only other study that examined associations between DMDD and parental psychopathology, Axelson *et al.* (2012) found no association between DMDD diagnosis and parental psychopathology in a clinical sample. Nevertheless, children of parents with substance use disorders are at increased risk for both internalizing and externalizing disorders and poorer social functioning, and parents with substance use problems experience numerous psychological and environmental adversities that contribute to poor parenting and family dysfunction (Francis, 2011).

This study had a number of limitations. First, DMDD diagnosis relied on a parent-reported psychiatric interview that was not designed to assess DSM-5 DMDD. Second, primary caregivers were the only informants for determining a DMDD diagnosis. Nonetheless, the diagnosis evidenced meaningful associations with co-parent and teacher reports and observational data. Third, children who participated at the age of 6 years were less likely to have a depressive disorder and/or screen positive for the father-reported CBCL-DP at baseline. Thus, our findings may underestimate the prevalence of DMDD and its associations with depression and the CBCL-DP. Fourth, we did not assess exclusionary diagnoses of bipolar or intermittent explosive disorder. These are very rare in young children; nevertheless, it will be important to consider them in future studies. Lastly, the sample was largely white and middle class. Future research should extend this research to more ethnically and socio-economically diverse samples.

No single study can establish or refute the validity of DMDD; we aim to add incrementally to the very small existing literature. Our findings suggest that DMDD identifies a group of children with deficits in emotional and behavioral regulation that are impairing and are evident from early childhood. Importantly, the impairment in DMDD cannot be explained by co-morbidity with other disorders; DMDD was associated with concurrent measures of functional impairment over and above the effects of co-morbidity.

In order to further elucidate the nature of DMDD and determine whether it belongs in the nomenclature, a broader body of research is necessary, spanning epidemiology, clinical features, development, long-term course, genetics and pathophysiology. Moreover, future investigations should identify empirically based thresholds to minimize over-pathologizing normative behavior. It remains unknown whether the threshold criteria in DSM-5 are developmentally appropriate for children and adolescents alike. Developmental adjustments to the criteria may be necessary for younger children, given the normative nature of temper outbursts earlier in development.

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**Table 1**

Demographic characteristics of the study sample (n = 462)

	Age 3 years assessment	Age 6 years assessment
Mean age of child, years (s.d.)	3.6 (0.3)	6.1 (0.4)
Mean age of mother, years (s.d.)	36.1 (4.5)	38.6 (4.5)
Mean age of father, years (s.d.)	38.4 (5.41)	40.8 (5.4)
Child sex: female, <i>n</i> (%)	212 (45.9)	
Child race/ethnicity, <i>n</i> (%)		
White/non-Hispanic	401 (86.8)	
Hispanic	39 (8.4)	
Black/African-American	7 (1.5)	
Asian	9 (2.0)	
Other	6 (1.3)	
Child's school status at second assessment, <i>n</i> (%)		
Kindergarten		235 (50.9)
First grade		187 (40.5)
Second grade		20 (4.3)
Other		20 (4.3)
Interviewer respondents, <i>n</i> (%)		
Biological mother	451 (97.6)	426 (92.2)
Biological father	8 (1.7)	35 (7.6)
Both parents	1 (0.2)	0 (0)
Grandparent	2 (0.4)	1 (0.2)
Biological parents' marital status, <i>n</i> (%)		
Married	435 (94.2)	413 (89.4)
Divorced, separated or widowed	9 (1.9)	32 (6.9)
Never married	18 (3.9)	17 (3.7)
Parents' education: graduated college, <i>n</i> (%)		
Mother	258 (56.7)	245 (59.3)
Father	209 (46.7)	195 (47.8)

s.d., Standard deviation.

**Table 2**

Rates of disruptive mood dysregulation disorder and individual criteria at the age of 6 years (n = 462)

<b>Criterion</b>	<b>n (%)</b>
A/B. Severe temper tantrums inconsistent with developmental level	220 (47.6)
C. Frequency	92 (19.9)
D. Negative mood	124 (26.8)
E. 12-month duration	74 (16.0)
F. Multiple settings	39 (8.4)
Full criteria	38 (8.2)

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Table 3

Bivariate associations between concurrent variables and DMDD diagnosis at the age of 6 years

	No DMDD diagnosis ( <i>n</i> = 424)	DMDD diagnosis ( <i>n</i> = 38)	Odds ratio	(95% CI)
Demographic characteristics				
Mean age of child, years (s.d.)	6.07 (0.41)	6.21 (0.44)	2.13	(0.97–4.71) <sup>†</sup>
Child sex: female, <i>n</i> (%)	196 (46.2)	16 (42.1)	0.85	(0.43–1.66)
Child race/ethnicity: white/non-Hispanic, <i>n</i> (%)	401 (94.6)	35 (92.1)	0.67	(0.19–2.34)
Parental marital status: married or cohabitating, <i>n</i> (%)	400 (94.3)	35 (92.1)	0.70	(0.20–2.44)
Mean maternal age, years (s.d.)	38.65 (4.31)	38.11 (5.62)	0.97	(0.90–1.05)
Mean paternal age, years (s.d.)	40.96 (5.29)	39.79 (5.96)	0.96	(0.90–1.02)
Parents' education: ≥ 1 parent college graduate, <i>n</i> (%)	293 (69.4)	24 (63.2)	0.76	(0.38–1.51)
Child psychopathology and functioning				
Depressive disorder, <i>n</i> (%)	20 (4.7)	5 (13.2)	3.06	(1.08–8.68) <sup>*</sup>
Anxiety disorder, <i>n</i> (%)	67 (15.8)	5 (13.2)	0.81	(0.30–2.14)
Attention deficit hyperactivity disorder, <i>n</i> (%)	21 (5.0)	4 (10.5)	2.26	(0.73–6.96)
Oppositional defiant disorder, <i>n</i> (%)	20 (4.7)	21 (55.3)	24.95	(11.42–54.51) <sup>***</sup>
Mother-reported CBCL-DP positive, <i>n</i> (%)	18 (4.2)	10 (28.6)	8.00	(3.34–19.15) <sup>***</sup>
Father-reported CBCL-DP positive, <i>n</i> (%)	17 (5.4)	7 (26.9)	6.48	(2.40–17.52) <sup>***</sup>
Mean child Children's Global Assessment Scale (s.d.)	76.3 (10.7)	64.6 (11.1)	0.92	(0.89–0.94) <sup>***</sup>
Mean child impairment ratings (s.d.)	5.05 (3.68)	9.34 (3.78)	1.30	(1.19–1.41) <sup>***</sup>
Mean teacher-reported popularity (s.d.)	12.58 (2.00)	10.71 (2.97)	0.74	(0.61–0.89) <sup>***</sup>
Mean teacher-reported low social competence (s.d.)	10.62 (3.91)	13.98 (5.59)	1.17	(1.06–1.29) <sup>**</sup>
Mean child PPVT (s.d.)	111.2 (45.2)	106.5 (10.3)	0.98	(0.95–1.01)
Mean child temperament (s.d.)				
Mother-reported CBQ negative affect <sup>a</sup>	−0.12 (2.57)	0.74 (2.89)	1.14	(0.99–1.31) <sup>†</sup>
Mother-reported CBQ surgency <sup>a</sup>	−0.27 (3.34)	2.05 (3.46)	1.22	(1.10–1.35) <sup>***</sup>
Mother-reported CBQ effortful control <sup>a</sup>	0.18 (3.94)	−2.32 (3.72)	0.85	(0.78–0.93) <sup>***</sup>
Father-reported CBQ negative affect <sup>a</sup>	−0.04 (2.67)	0.01 (2.35)	1.01	(0.86–1.18)
Father-reported CBQ surgency <sup>a</sup>	−0.11 (2.71)	1.17 (2.69)	1.19	(1.02–1.38) <sup>*</sup>
Father-reported CBQ effortful control <sup>a</sup>	0.10 (4.05)	−1.64 (4.29)	0.90	(0.81–1.00) <sup>*</sup>
Teacher-reported positive emotional intensity	24.00 (6.65)	25.64 (9.34)	1.04	(0.96–1.11)
Teacher-reported negative emotional intensity	15.26 (5.52)	18.12 (6.90)	1.09	(1.00–1.18) <sup>*</sup>
Mean observed parenting behavior (s.d.)				
Parental hostility	1.13 (0.32)	1.19 (0.37)	1.52	(0.63–3.67)
Parental support	4.30 (0.62)	4.07 (0.51)	0.59	(0.36–0.97) <sup>*</sup>
Mean marital satisfaction and life stress (s.d.)				
Dyadic Adjustment Scale	16.24 (3.63)	14.48 (4.23)	0.90	(0.83–0.98) <sup>*</sup>
Recent stressors	2.28 (1.76)	2.50 (1.94)	1.07	(0.90–1.28)

DMDD, Disruptive mood dysregulation disorder; CI, confidence interval; s.d., standard deviation; CBCL-DP, Child Behavior Checklist – Dysregulation Profile; PPVT, Peabody Picture Vocabulary Test; CBQ, Children’s Behavior Questionnaire.

<sup>a</sup> CBQ values are reported as *z* scores.

<sup>†</sup>  
 $p < 0.10$ ,

\*  
 $p < 0.05$ ,

\*\*  
 $p < 0.01$ ,

\*\*\*  
 $p < 0.001$ .

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Table 4

Bivariate analyses: age 3 years predictors of DMDD at the age of 6 years

	No DMDD diagnosis ( <i>n</i> = 424)	DMDD diagnosis ( <i>n</i> = 38)	Odds ratio	95% CI
Child psychopathology and functioning				
Depressive disorder, <i>n</i> (%)	6 (1.4)	0 (0.0)	0.00	(0.00–0.00)
Anxiety disorder, <i>n</i> (%)	81 (19.1)	8 (21.1)	1.13	(0.50–2.56)
Attention deficit hyperactivity disorder, <i>n</i> (%)	8 (1.9)	3 (7.9)	4.46	(1.13–17.56)*
Oppositional defiant disorder, <i>n</i> (%)	36 (8.5)	11 (28.9)	4.39	(2.01–9.58)***
Mother-reported CBCL-DP positive, <i>n</i> (%)	38 (9.0)	10 (26.3)	3.56	(1.61–7.89)**
Father-reported CBCL-DP positive, <i>n</i> (%)	16 (4.9)	3 (9.4)	1.99	(0.55–7.24)
Mean teacher-reported popularity (s.d.)	12.09 (2.77)	10.50 (3.33)	0.85	(0.73–0.97)*
Mean teacher-reported low social competence (s.d.)	11.41 (4.55)	14.76 (5.66)	1.13	(1.04–1.24)**
Mean child PPVT (s.d.)	102.85 (13.77)	103.03 (11.23)	1.00	(0.98–1.03)
Mean child temperament (s.d.)				
Mother-reported CBQ negative affect <sup>a</sup>	−0.11 (2.67)	0.05 (2.35)	1.02	(0.90–1.17)
Mother-reported CBQ surgency <sup>a</sup>	−0.14 (2.79)	1.34 (2.50)	1.22	(1.07–1.39)**
Mother-reported CBQ effortful control <sup>a</sup>	0.11 (4.03)	−1.56 (4.03)	0.90	(0.83–0.98)*
Father-reported CBQ negative affect <sup>a</sup>	−0.03 (2.68)	0.12 (2.18)	1.02	(0.89–1.17)
Father-reported CBQ surgency <sup>a</sup>	−0.14 (2.78)	0.87 (2.72)	1.14	(1.00–1.31) <sup>†</sup>
Father-reported CBQ effortful control <sup>a</sup>	0.16 (3.74)	−1.56 (3.39)	0.88	(0.80–0.98)*
Teacher-reported positive emotional intensity	26.18 (6.90)	28.18 (7.79)	1.04	(0.98–1.11)
Teacher-reported negative emotional intensity	16.94 (5.77)	21.11 (5.83)	1.13	(1.04–1.22)**
Parental psychopathology, <i>n</i> (%)				
Parental lifetime depressive disorder	177 (42.1)	17 (45.9)	1.17	(0.59–2.29)
Parental lifetime anxiety disorder	194 (46.3)	16 (43.2)	0.88	(0.45–1.74)
Parental lifetime substance use disorder	210 (50.1)	25 (65.8)	2.07	(1.02–4.24)*
Mean observed parenting behavior (s.d.)				
Parental hostility	1.19 (0.33)	1.33 (0.51)	2.23	(1.10–4.50)*
Parental support	4.49 (0.56)	4.33 (0.68)	0.67	(0.41–1.10)
Mean marital satisfaction and life stress (s.d.)				
Dyadic Adjustment Scale	15.99 (3.70)	14.74 (4.50)	0.93	(0.85–1.01) <sup>†</sup>
Early stressors	4.00 (2.70)	4.89 (3.12)	1.11	(1.00–1.24) <sup>†</sup>

DMDD, Disruptive mood dysregulation disorder; CI, confidence interval; CBCL-DP, Child Behavior Checklist – Dysregulation Profile; s.d., standard deviation; PPVT, Peabody Picture Vocabulary Test; CBQ, Children's Behavior Questionnaire.

<sup>a</sup>CBQ values are reported as *z* scores.

<sup>†</sup>*p* < 0.10,

\**p* < 0.05,

\*\*  
 $p < 0.01$ ,

\*\*\*  
 $p < 0.001$ .

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**Table 5**

Multivariate analyses: unique age 6 years concurrent correlates and age 3 years predictors of DMDD at the age of 6 years

	<b>Odds ratio</b>	<b>(95% CI)</b>
Age 6 years correlates		
Depressive disorder	0.34	(0.06–2.14)
Oppositional defiant disorder	13.73	(3.94–47.90)***
Mother CBCL-DP positive	4.57	(1.22–17.01)*
Children's Global Assessment Scale	1.02	(0.94–1.10)
Child impairment ratings	1.07	(0.86–1.32)
Mother-reported CBQ surgency	1.07	(0.93–1.21)
Mother-reported CBQ effortful control	0.98	(0.86–1.12)
Observed parental support	0.45	(0.24–0.88)*
Marital satisfaction	0.96	(0.86–1.07)
Age 3 years predictors		
Attention deficit hyperactivity disorder	1.27	(0.25–6.50)
Oppositional defiant disorder	2.19	(0.77–6.22)
Mother CBCL-DP positive	0.98	(0.31–3.10)
Mother-reported CBQ surgency	1.16	(1.00–1.34)*
Mother-reported CBQ effortful control	0.96	(0.87–1.06)
Parental lifetime substance use disorder	2.22	(1.03–4.79)*
Observed parental hostility	1.69	(0.77–3.69)

DMDD, Disruptive mood dysregulation disorder; CI, confidence interval; CBCL-DP, Child Behavior Checklist – Dysregulation Profile; CBQ, Children's Behavior Questionnaire.

\*  $p < 0.05$ ,

\*\*\*  $p < 0.001$ .