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Less imitation of arbitrary actions is a specific developmental precursor to callous–unemotional traits in early childhood

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Objective: Callous–unemotional (CU) traits in early childhood explain heterogeneity within conduct problems and are associated with higher risk for later diagnoses of childhood disruptive behavior disorders and antisocial behavior in adulthood. Emerging research implicates impairments in affiliative processes in the etiology of CU traits. The current study tests whether the imitation of intentional actions with no functional significance –a behavior that supports the acquisition of social conventions and affiliative bonds, is a specific developmental precursor to CU traits in early childhood. **Methods:** Data came from a longitudinal twin study of 628 children (Age 2: 47% females; Age 3: 44.9% females) with observations of arbitrary (i.e., nonfunctional actions) and instrumental (i.e., functional actions) imitation and parent reports of CU traits and oppositional defiant (ODD) behaviors at ages 2 and 3. **Results:** Lower arbitrary imitation at age 2, but not instrumental imitation, was related to increases in CU traits from ages 2 to 3 ($\beta = -.10$, $p = .02$). **Conclusions:** These findings establish early social and affiliative processes in the etiology of CU traits, highlighting that novel personalized treatment and intervention strategies for CU traits may benefit from targeting these processes to help reduce CU traits and risk for persistent conduct problems in children. **Keywords:** Behavior problems; callous–unemotional traits; developmental psychopathology; social behavior.

Introduction

Conduct problems (CP), including aggressive, oppositional, and rule-breaking behaviors, are a highly prevalent form of childhood psychopathology that confer risk for poor socioemotional, educational, and mental and physical health outcomes across the life span (American Psychiatric Association, 2013). However, CP are highly heterogeneous, which undermines our ability to effectively identify and treat children at risk for persistent CP across development. To better parse this heterogeneity, research has focused on the presence or absence of callous–unemotional (CU) traits among children with CP. CU traits refer to the presence of callous, uncaring, and remorseless behavior, a lack of guilt and empathy, and reduced sensitivity to the emotions of others (Waller & Hyde, 2018) CU traits differentiate a distinct group of children with CP at increased risk for severe and chronic aggression, violence, and psychopathy, beyond risk associated with early oppositional defiant or conduct-disordered behaviors (Frick, Ray, Thornton, & Kahn, 2014; Waller & Hyde, 2017).

Research has begun to establish that CU traits arise from a distinct set of developmental processes, particularly impaired behavioral, physiological, and neural sensitivity to cues of social affiliation, emotion, and threat (Viding & McCrory, 2019). In early childhood, there is emerging evidence that impaired sensitivity to affiliative bonding and low social motivation undermines attachment formation and the development of more complex interpersonal processes, increasing risk for CU traits (Bedford et al., 2017; Viding & McCrory, 2019; Wagner et al., 2016; Waller & Wagner, 2019). For example, lower infant preferential face tracking at 5 weeks (Bedford, Pickles, Sharp, Wright & Hill, 2014) and lower parent-directed affection and eye contact at 18 months (Wagner et al., 2016) and 4 years old (Dadds et al., 2012) have been linked to CU traits in early childhood. This research contributes to our understanding of potential links between deficits in affiliation and CU traits (Waller & Wagner, 2019). However, extant research has primarily focused on narrow aspects of affiliation (e.g., attention) or single social relationships assessed in brief laboratory paradigms (e.g., the parent–child relationship) (Wagner et al., 2016). Moreover, studies on the origins of CU traits have largely not been grounded in what we know more broadly about the emergence of social learning and connection, including the imitation of others' actions or behaviors, a core indicator of early preference for and seeking out of affiliative interactions (Over & Carpenter, 2013).

The early imitation of others is a behavioral phenomenon that forms a vital foundation for social learning processes and social connections. Human

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imitation enriches our understanding of social conventions, the formation of relationships, attachments, and affiliative bonds, and the development of fundamental social beliefs and attitudes, differentiating humans from other species (Over & Carpenter, 2013). Throughout development, and particularly in infancy and early childhood when children are preverbal, two forms of imitation facilitate children's rapid acquisition of knowledge and skills through repeating observed behaviors of peers and adults (Meltzoff, Kuhl, Mövellan & Sejnowski, 2009; Nielsen & Blank, 2011). *Instrumental imitation* refers to children copying the intentional or goal-directed actions of others and ignoring mistakes or failed attempts, thus allowing them to rapidly acquire new skills while avoiding the pitfalls of trial-and-error learning (Lyons, Young & Keil, 2007). *Arbitrary imitation* (also known as 'overimitation') refers to children deliberately copying the behaviors of others even when the model's actions have no apparent purpose or causal function (Lyons et al., 2007; Nielsen, Simcock & Jenkins, 2008; Watson-Jones, Whitehouse & Legare, 2016).

Arbitrary imitation is central to the promotion of social affiliation, and unlike instrumental imitation, is specific to humans and is considered a foundational element of complex social cultures (Nielsen & Blank, 2011; Nielsen et al., 2008). Specifically, arbitrary imitation signals shared intentions, conformity to normative conventions, and a desire to affiliate (Keupp, Behne & Rakoczy, 2013; Over & Carpenter, 2013). Unsurprisingly, arbitrary imitation occurs more often when the individual who demonstrated an action is present at the time of the imitation (Nielsen & Blank, 2011), highlighting the social nature of the action (i.e., centered on *who* is imitated rather than *what* is imitated). In addition, multiple studies have demonstrated that priming social exclusion increases arbitrary imitation in young children (Over & Carpenter, 2009; Watson-Jones et al., 2016), suggesting that arbitrary imitation serves an affiliative function. That is, children use arbitrary imitation as a strategy to promote social affiliation and reinclusion. However, no prior studies have examined whether fewer displays of arbitrary imitation represent a developmental precursor to CU traits during early childhood.

The current study sought to advance our knowledge of social-affiliative processes as a developmental precursor to CU traits in early childhood using a longitudinal design. Specifically, we explored longitudinal associations between instrumental and arbitrary imitation at age 2 and CU traits at age 3. We also examine the associations between instrumental and arbitrary imitation and children's oppositional defiant (ODD) behaviors, a broad set of externalizing problems including defiant, uncooperative, or disobedient behaviors, angry moods, and stubbornness. To establish whether imitation was a distinct and specific precursor of CU traits, we included ODD at age 3 as a covarying outcome in all predictive models. In the context of the literature on arbitrary imitation suggesting that it serves a specific social-affiliative purpose (Over & Carpenter, 2013), we hypothesized that low levels of arbitrary imitation, but not instrumental imitation, would be specifically related to higher CU traits but not ODD behaviors. We tested associations during a critical developmental window of early childhood (i.e., from 2 to 3 years old) when instances of arbitrary imitation serve as a means for preverbal children to bolster their social affiliation and communication (Eckerman & Didow, 1989).

Method

Participants

The participants were drawn from Boston University Twin Project and were recruited from birth records supplied by the Massachusetts Registry of Vital Records. Twins were selected preferentially for higher birth weight and gestational age. No twins with birth weights below 1,750 g or with gestational ages <34 weeks were included in the study. Twins were also excluded if they had a known developmental disorder (e.g., chromosomal abnormalities) that might affect their task performance. Six hundred and twenty-eight twins (314 pairs) participated in the age 2 assessments, and 608 twins returned for the age 3 assessments (96.8% retention rate). There were approximately equal numbers of males and females at each age (age 2: 47% females; age 3: 44.9% females). Race and socioeconomic status were generally representative of the Massachusetts population (85.4% Caucasian, 3.2% Black, 2% Asian, 7.3% mixed, 2.2% other). Written informed consent was obtained from all subjects. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All procedures involving human subjects/patients were approved by the Boston University Institutional Review Board.

Measures

ODD and CU traits. Measures of ODD and CU traits were derived from the Achenbach System of Empirically Based Assessment, Preschool Forms (ASEBA (Achenbach, 1991), also known as the Child Behavior Checklist (CBCL). Primary caregivers (94% mothers) completed the ASEBA for each twin at both the 2- and 3-year assessments. The ASEBA includes a scoring profile drawn from DSM-referenced scales for ODD comprised of six items ('defiant', 'disobedient', 'angry moods', 'stubborn', 'temper tantrum', and 'uncooperative'). Further, Willoughby, Waschbusch, Moore, & Propper (2011) demonstrated that five items drawn from the ASEBA ('no guilt after misbehave', 'punish does not change behavior', 'unresponsive to affection', 'shows little affection', and 'too little fear') could be used to measure individual differences in CU traits at these early ages. Factor analytic studies suggest that CU traits can be assessed as a distinct construct in 2- and 3-year-olds, demonstrating that parents are able to discriminate between CU traits and other behavior problems at young ages (Willoughby et al., 2011). The approach to measuring CU traits used in the current study has been validated in multiple longitudinal samples (Wagner et al., 2016; Waller & Hyde, 2017; Willoughby, Mills-Koonce, Gottfredson, & Wagner,

Figure 1 Demonstration of the Birdhouse Task. The task began when the tester (A) twisted the pin and pulled it from the left side of the birdhouse (instrumental). The tester then (B) opened the door (instrumental) and (C) retrieved the toy bird, making vocalizations and hopping movements with the bird before replacing it in the birdhouse (arbitrary)

2014), including in the current sample (Flom & Saudino, 2016; Flom, White, Ganiban, & Saudino, 2019). Internal consistency for the ODD (age 2, α = .79; age 3 α = .81) and CU traits (age 2, α = .55; age 3, α = .61) are consistent with other studies using this measurement approach at these ages (Bedford et al., 2017; Wagner et al., 2016; Waller et al., 2014; Willoughby et al., 2014).

Imitation. Observations of imitated instrumental and arbitrary actions were coded based on the Birdhouse Task at both ages 2 and 3 and the Trap Tube Task at age 3 (Carpenter, Call, & Tomasello, 2002). The Birdhouse Task apparatus consisted of a wooden birdhouse modified with a wooden pin that slid out of the left side to release the front door. As part of the procedure, an examiner placed the birdhouse on the table facing the child and directed the child's attention to it, saying, 'Look, (child's name)' and 'Watch this.' The examiner then completed both instrumental behaviors (i.e., necessary for retrieving the bird) and arbitrary behaviors and vocalizations (i.e., 'Look! It's a birdy! Cheep cheep cheep') (see Figure 1). The Trap Tube Task consisted of a tube in which a research assistant placed a cracker, which was retrieved with a stick. As before, the examiner completed instrumental behaviors (i.e., retrieval of cracker with the stick) and arbitrary behaviors and vocalizations (i.e., saying, 'one two three,' or tapping the stick on the table) (see Figure 2). Two trials were completed for all tasks at each time point. For trial 1, the child was given 60 s from the first contact with the birdhouse or trap tube to imitate the actions they had seen. Trial 2, which occurred immediately after trial 1, afforded children the same opportunities as trial 1. Experimenters did not replicate any behaviors or vocalizations prior to trial 2. To assess instrumental and arbitrary imitation, we generated two composite scores across the two trials for each task at each age: the proportion of instrumental actions imitated and the proportion of arbitrary actions imitated. These tasks have been widely used to assess children's tendencies to imitate instrumental and arbitrary actions at these ages (Carpenter et al., 2002). Interrater reliability was high (all ICCs≥.80). Additional details regarding procedures and coding are provided in Appendix S1 and Table S1.

Additional covariates. Twin's sex, race (European-American vs. Other), and a semi-continuous measure of parent education were reported by parents and included as covariates in each predictive model. Fewer than 1% of the sample reported only finishing middle school or some high school, about 4% reported completing high school, 2% reported completing trade school, 10.5% had completed some college or university study, 41.6% received a degree from a four-year college, 6.7% had completed some graduate training, and about 32% had earned a graduate degree.

Analytic plan

We estimated a linear path model in which children's ODD and CU traits at age 3 were regressed onto instrumental imitation, arbitrary imitation, and relevant covariates. Specifically, we examined whether observed instrumental and arbitrary imitation at age 2 predicted ODD and CU traits at age 3, controlling for relevant covariates including ODD and CU traits at age 2. All participants with complete or partial data were included in the predictive analyses using full information maximum likelihood (FIML) (Enders & Bandalos, 2001), and both models were saturated. FIML is well recognized as an effective method for analyzing data with moderate to large amounts of missing data and has been demonstrated to provide less biased parameter estimates than other commonly used techniques, such as listwise deletion (Enders & Bandalos, 2001). Total missingness for each measure is reported in Table 1. All analyses were conducted in Mplus 7.1 (Muthén & Muthen, 2017). Corrections to the standard errors in each predictive model to account for nonindependence of observations due to the nested structure of twin data (i.e., twins are nested in families) were implemented using the TYPE = COMPLEX and CLUSTER procedures in Mplus (Asparouhov & Muthén, 2010).

Results

Descriptive statistics

Table 1 provides the bivariate correlations, means and standard deviations for the model covariates and variables of interest. Twin's sex was negatively associated with both ODD and CU traits such that

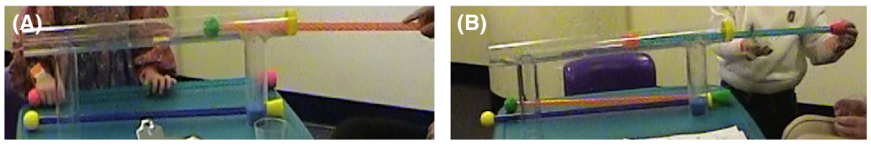

Figure 2 Demonstration of the Trap Tube Task. The task began with the tester (A) placing a cracker in the tube. The tester (B) retrieved the cracker with the stick (instrumental) and said 'one, two, three' or tapped the stick on the table (arbitrary)

Table 1 Zero-order bivariate correlations between model outcomes

	1	2	3	4	5	6	7	8	9	10	11
1. Race	-										
2. Sex	.012	-									
3. Parent Education	.032	.014	-								
4. Instr. Imitation Age 2	−.04	.006	.123**	-							
5. Instr. Imitation Age 3	.051	.019	.051	.043	-						
6. Arbit. Imitation Age 2	−.092	−.028	.078	.075	.053	-					
7. Arbit. Imitation Age 3	.038	−.014	.059	−.016	.133***	.110**	-				
8. CU Traits Age 2	−.112*	−.055	−.078	.026	−.011	.017	−.074	-			
9. CU Traits Age 3	−.071	−.097**	−.083	−.015	−.04	−.087*	−.116***	.475***	-		
10. ODD Age 2	−.087	−.094**	−.107	−.034	−.009	−.026	−.065	.569***	.371***	-	
11. ODD Age 3	−.096	−.062	−.026	.008	−.074*	−.049	−.085**	.437***	.552***	.595***	-
Number	618	627	618	604	592	479	590	620	596	623	598
Mean	4.07	1.47	7.40	0.87	0.91	0.43	0.31	1.54	1.26	2.94	3.19
Standard Deviation	0.65	0.50	1.42	0.19	0.15	0.39	0.19	1.48	1.32	2.35	2.53

Instr. = Instrumental; Arbit. = Arbitrary.
*$p \leq .10$; **$p \leq .05$; ***$p \leq .01$.

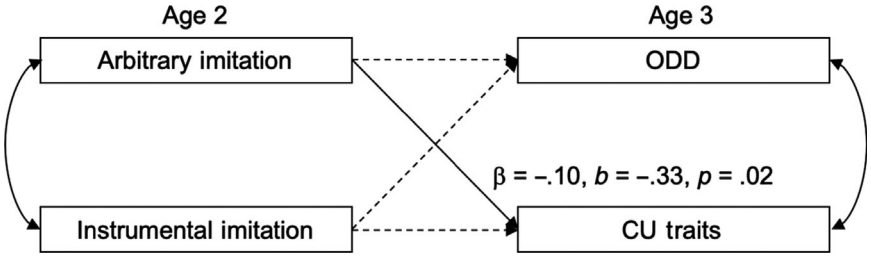

Figure 3 Path model showing significant longitudinal association between imitation at age 2 and CU traits at age 3. Note: Model covariates (race, sex, parent education, ODD age 2, CU traits age 2) have been excluded from the figure; $cov(\zeta_{ODD}\zeta_{CU})$, b = .963, β = .423, p = .001; $cov(\zeta_{ODD}\zeta_{CU})$, b = .01, β = .12, p = .12. ODD, Oppositional defiant behaviors; CU, callous–unemotional

Table 2 Longitudinal path models showing that fewer observations of arbitrary imitation, but not instrumental imitation, were uniquely related to CU traits at age 3

	ODD age 3		CU traits age 3	
Parameter	B (β)	95% CI	B (β)	95% CI
Race	−.154 (−.040)	[−0.517, 0.209]	−.041 (−.021)	[−0.267, 0.185]
Sex	−.066 (−.013)	[−0.437, 0.305]	−.191 (−.072)*	[−0.401, 0.019]
Parent Education	.085 (.047)	[−0.073, 0.242]	−.024 (−.025)	[−0.116, 0.069]
CU Traits Age 2	.258 (.151)***	[0.11, 0.406]	.358 (.400)***	[0.262, 0.453]
ODD Age 2	.549 (.509)***	[0.446, 0.653]	.073 (.130)**	[0.009, 0.138]
Instrumental Imitation Age 2	.232 (.018)	[−0.665, 1.128]	−.093 (−.014)	[−0.546, 0.36]
Arbitrary Imitation Age 2	−.316 (−.048)	[−0.81, 0.179]	−.328 (−.096)**	[−0.601, −0.055]
	$cov(\zeta_{ODD}\zeta_{CU})$ = .963 (.423)***			

CI, confidence interval.
Magnitude and direction of estimates and patterns of significance remain unchanged after controlling for birth weight, gestational age, Mental Development Index from the Bayley Scales (IQ), and the Pervasive Developmental Problems subscale from the Child Behavior Checklist (autism-like traits). Results available upon request.
*$p \leq .10$; **$p \leq .05$; ***$p \leq .01$.

male twins demonstrated higher ODD behaviors at age 2 and higher CU traits at age 3 than female twins. Parent's educational attainment was positively correlated with children enacting more instances of instrumental imitation at age 2 but not age 3. Arbitrary imitation at age 3 was negatively correlated with both ODD and CU traits at age 3. Scores for each of the ODD and CU traits measures at ages 2 and 3 were significantly positively correlated.

Longitudinal associations across ages 2 and 3

A saturated path model was estimated to examine the longitudinal predictive associations between instrumental and arbitrary imitation at age 2 and ODD and CU traits at age 3, controlling for the autoregressive effects of ODD and CU traits at age 2 (Figure 3; Table 2). Lower arbitrary imitation at age 2, but not instrumental imitation, was related to higher CU traits at age 3, β = −.10, b = −.33, p = .02, accounting for autoregressive associations between ODD and CU traits across time and the significant covariance of ODD and CU traits at age 3 $cov_{(odd,cu)}$ β = .42, b = .96, p < .001 (see Table 2). Follow-up analyses show that the unique relation between lower arbitrary imitation at age 2 and CU traits at age 3 persists, β = −.08, b = −.29, p = .03, when a measure of children's attention problems (ADHD) at age 3, β = −.04, b = −.30, p = .27 is included a covarying outcome along with ODD, β = −.05, b = −.29, p = .24 (see Table S2).

Discussion

Social imitation is a pervasive and early emerging phenomenon in development that supports individual learning and skill acquisition, promotes social communication and affiliation, and perpetuates human culture (Nielsen & Blank, 2011; Tomasello & Call, 1997). Unlike instrumental imitation, one of the primary functions of arbitrary imitation is to increase affiliation and social inclusion. The current study is the first to identify fewer displays of arbitrary imitation as a distinct developmental precursor to CU traits. Specifically, we found that less observed imitation of arbitrary actions, but not imitation of instrumental actions, was related to increases in CU traits at age 3. Moreover, these pathways were distinct for CU traits, as we did not find a significant association between arbitrary imitation and ODD. Findings lend further support for investigations into whether and how early etiological

processes differentiate risk for eventual ODD and CU traits early in life, particularly given their, at least partial, conceptual overlap and clinical comorbidity (Frick et al., 2014).

Affiliative inputs, such as facial expressions, vocalizations, and touch, are salient aspects of human experience from birth. The rewarding and repetitive nature of these affiliative experiences, most often with caregivers, is critical for early survival and promote the emergence of more complex social bonds and adaptive future social relationships (Panksepp, Nelson, & Siviy, 1994). The imitation of arbitrary actions in preverbal children is thought to play a critical role in the foundation of these affiliative and social bonds, setting the stage for adaptive and cooperative interpersonal behaviors across the life span (Over & Carpenter, 2013). Emerging evidence suggests that impairments to normative social-affiliative processes may contribute to the development of CU traits in children and the broader psychopathy phenotype in adults (Viding & McCrory, 2019; Waller & Wagner, 2019). The current study contributes to this line of inquiry by demonstrating that reduced arbitrary imitation is predictive of increases in CU traits, but not ODD. This finding suggests that CU traits, and its interpersonal and social correlates, may occur downstream of a lack of motivation for affiliative bonding, indexed via deficits in arbitrary imitation.

Limitations and future directions

The current study is characterized by a number of strengths, including a prospective longitudinal design and use of observational methods for assessing imitation. However, the findings must also be interpreted in the context of several important limitations. First, although the current study was conducted using a twin sample, because of modest magnitude of the bivariate association, our sample does not afford the power to decompose the genetic and environmental sources of covariance between CU traits and observed arbitrary imitation. Nonetheless, in exploratory analyses, we found that only genetic factors contributed to the covariance between arbitrary imitation and CU traits at age 3 thereby supporting future research testing whether the origins of CU traits lie in genetically mediated individual differences in social affiliation (see Table S3).

Second, while the links between arbitrary imitation at age 2 and ODD at age 3 were nonsignificant, unstandardized parameter estimates were similar to those for the association between arbitrary imitation at age 2 and CU traits at age 3. Future research should examine the stability of the pattern of significance of the current findings over time. Ideally, this work would be done using a more comprehensive measure of CU traits than the 6-item measure used in the current study, which exhibits only moderate internal consistency across a number of samples.

Third, because we only had one follow-up assessment (i.e., at age 3), we cannot speak to whether the association between arbitrary imitation and CU traits extends across later childhood, nor how CU traits and arbitrary imitation might be dynamically and reciprocally related over time. Of note, there is significant heterotypic continuity in how arbitrary imitation manifests across the life span, especially once children are verbal, meaning that future studies of arbitrary imitation and CU traits in older individuals would necessarily have to employ different methods to assess arbitrary imitation. For example, studies of older children and adults have explored both joint actions and movement (Marsh et al., 2009) and phonetic imitation during social conversation (Alan et al., 2013), which, like arbitrary imitation, might function to increase social connection and promote affiliation with others. Such methods have yet to be applied in relation to risk for, or amelioration of, CU traits but represent an intriguing and innovative target for future studies.

Finally, the observed relationship we report between arbitrary imitation and CU traits may have arisen because of parent–child dyadic processes that began earlier in infancy, which we did not assess. For example, parental modeling and attentional synchrony in infancy could have shaped tendencies to enact arbitrary imitation with potentially accumulating and reciprocal effects on the emergence of CU traits across development (D'Onofrio & Lahey, 2010). Moreover, research demonstrates increases in faithful imitation of arbitrary actions just after the first year of life, and that this form of imitation is associated with increased sociability, further providing support for examining these processes earlier in development (Hilbrink, 2013).

In sum, we applied a novel paradigm assessing imitation to provide compelling evidence linking lower arbitrary imitation, a core skill linked to social cooperation and affiliation across the life span, to the early development of CU traits. Our findings provide initial evidence for impairments in socio-affiliative mechanisms being critical for understanding risk for CU traits, which are pathways that have been hypothesized but rarely tested. The results suggest that socio-affiliative processes could be targeted in future personalized treatment and intervention strategies for children with CU traits and at risk for persistent and severe conduct problems across development (Waller & Wagner, 2019). More specifically, treatment strategies for decreasing CU traits beginning early in childhood could focus on social skills and empathy training (Wilkinson et al., 2016) and, drawing on treatment research for autism

spectrum disorders, reciprocal imitation training (Ingersoll et al., 2017).

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Appendix S1. Description of imitation tasks.
Table S1. Behaviors coded in imitation tasks.
Table S2. Longitudinal path models including ADHD outcomes.
Table S3. Genetic and environmental correlations explaining covariance between CU and Arbitrary Imitation.

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Key points

- Callous–unemotional traits differentiate patterns of homogeneity within child conduct problems and are associated with greater risk for later disruptive behavior disorders and antisocial behavior in adulthood.
- CU traits arise from a distinct set of developmental processes, and there is emerging evidence that impaired sensitivity to affiliative bonding and low social motivation may increase risk for CU traits by undermining the development of interpersonal processes.
- Imitation of arbitrary behaviors which have no apparent causal function promote social affiliation by signaling shared intentions and conformity to normative conventions. Despite the importance of imitation for the development maintenance of social relationships in human cultures, no study has tested whether lower arbitrary imitation is a specific precursor to CU traits in early childhood.
- This study shows that lower arbitrary imitation at age 2, but not imitation of goal-directed actions, was related to increases in CU traits from ages 2 to 3. In exploratory analyses which leveraged the study's twin design, we find that only genetic factors contributed to the covariance between arbitrary imitation and CU traits at age 3.
- The results suggest that socio-affiliative processes could be targeted in future personalized treatment and intervention strategies for children with CU traits and at risk for persistent and severe conduct problems across development.

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