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Conduct problems, IQ, and household chaos: a longitudinal multi-informant study

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Abstract

Background—We tested the hypothesis that household chaos would be associated with lower child IQ and more child conduct problems concurrently and longitudinally over two years while controlling for housing conditions, parent education/IQ, literacy environment, parental warmth/ negativity, and stressful events.

Methods—The sample included 302 families with same-sex twins (58% female) in Kindergarten/1st grade at the first assessment. Parents' and observers' ratings were gathered, with some collected over a two-year period.

Results—Chaos varied widely. There was substantial mother–father agreement and longitudinal stability. Chaos covaried with poorer housing conditions, lower parental education/IQ, poorer home literacy environment, higher stress, higher negativity and lower warmth. Chaos statistically predicted lower IQ and more conduct problems, beyond the effects of other home environment factors.

Conclusions—Even with other home environment factors controlled, higher levels of chaos were linked concurrently with lower child IQ, and concurrently and longitudinally with more child conduct problems. Parent self-reported chaos represents an important aspect of housing and family functioning, with respect to children's cognitive and behavioral functioning.

Keywords

IQ; behavior problems; environment; parenting

There is a growing literature that implicates household 'chaos' (e.g., noise, lack of family routines) as an important correlate and statistical predictor of children's and adolescents' social-emotional and cognitive development outcomes. However, household chaos operates

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Supporting information
Additional supporting information may be found in the online version of this article:
Appendix S1. Conduct problems, IQ, and household chaos: A longitudinal multi-informant study.
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within a broader context of interrelated family environment factors. There have been few longitudinal studies examining the statistical prediction of child IQ and conduct problems from chaos while controlling for other family environment attributes. Thus, the goal of the current study was to test whether chaos would be associated with lower child IQ and higher levels of child conduct problems in cross-sectional and longitudinal (over two years) analyses after controlling for other related family environment factors.

Household chaos

Families and their households vary widely in their structure and functioning. Over the past two decades, family researchers have begun studying the role of chaos in the family environment – including noise levels, crowding and 'traffic' (people coming and going all the time), lack of predictability and family routines – and its links with other aspects of family functioning as well as children's physical, cognitive, and social-emotional development. A landmark in this work was the establishment of the CHAOS scale (Chaos, Hubbub and Order Scale; Matheny, Wachs, Ludwig, & Phillips, 1995), which provided a foundation for brief, reliable parent ratings of chaos that had been validated using detailed observations of home environments. This questionnaire was a welcomed addition to the field, because it permitted the efficient collection of data based on parents' reports that could be applied to studies with much larger samples than would be possible using traditional observational methods.

The growing literature on chaos points to several consistent findings (for reviews, see Evans, 2006, and Wachs & Çorapçi, 2003). First, previous studies have indicated wide variation in parent-reported chaos regardless of socioeconomic status, and much of this variation appears to be valid and reliably reported by parents using the CHAOS scale (Dumas et al., 2005; Matheny et al., 1995). To extend this literature, our first aim was to estimate mother and father agreement on selfreported chaos across three annual assessments. Based on the literature, our hypothesis was that mother–father agreement would be moderate (correlations in the .4 to .6 range) and the within-parent stability correlations would be substantial (correlations in the .6 to .8 range).

The second major finding is that this wide range of chaos is correlated with other important parent and household characteristics such as parental stress and dysfunction (Evans et al., 1998), maternal depression (Pike, Iervolino, Eley, Price, & Plomin, 2006), lower parental positivity (Valiente, Lemery-Chalfant, & Reiser, 2007), and harsh reactive discipline (Dumas et al., 2005). However, these correlations typically are modest ($r < .3$). Thus, parents' reports of the levels of chaos in their households seem to represent an empirically distinct aspect of the home environment that is not simply redundant with other measures of household and family environment factors – though conceptually, these various family environment factors are interrelated.

Our second aim was to estimate associations between chaos and six key variables spanning structural/ physical and psychosocial aspects of the home environment that are known correlates of children's cognitive and social-emotional outcomes: parent education and verbal IQ, home literacy environment (e.g., books, reading habits), stress (e.g., number and impact of stressful life events), parent negativity and warmth toward child (e.g., hostility and rejection; affection and acceptance), and housing conditions (e.g., cleanliness, risks to safety). Our second hypothesis was that higher levels of chaos would be associated with less parental education and lower verbal IQ, less optimal literacy environment, more stress, more negativity, less warmth, and poorer housing conditions.

The third emerging finding from this literature is that parent-reported chaos statistically predicts lower child IQ and achievement scores (Asbury, Wachs, & Plomin, 2005; Dumas et

al., 2005), and higher levels of child conduct problems (e.g., opposition, aggression, delinquency; Coldwell, Pike, & Dunn, 2006; Dumas et al., 2005; Petrill, Pike, Price, & Plomin, 2004; Pike et al., 2006). Effect sizes have been in the .2 to .4 range and are fairly consistent across informants. However, these effects must be considered within the context of other, covarying home environment factors. Therefore, in the current study we included six family/household environment variables that have been shown to predict child IQ or conduct problems, in order to test whether chaos contributes independent statistical prediction of child IQ and conduct problem scores above and beyond the statistical effects of other family factors. In particular, the inclusion of observers' ratings of cluttered/dirty and potentially dangerous housing conditions is noteworthy, given that this aspect of the home environment typically has not been examined in studies that have used the CHAOS scale. Our third hypothesis was that chaos would provide independent statistical prediction of both lower child IQ scores and higher child conduct problem scores, even with these other statistical predictors controlled statistically.

Finally, we know little about the robustness of the link between changes in chaos and child IQ or conduct problems over time. Individual differences in child IQ and conduct problems in middle childhood are substantially stable (Heller, Baker, Henker, & Hinshaw, 1996), but there remains sufficient change over time to examine a potential role of shifts in chaos. Thus, our final aim was to conduct exploratory analyses of individual differences in chaos, child IQ and conduct problems over a two-year period in middle childhood.

In sum, the goal of the current study was to extend the literature on household chaos and children's developmental outcomes in middle childhood by: 1) examining longitudinal stability and mother–father agreement in parent-reported chaos across three annual assessments; 2) estimate associations between parent-reported chaos and six other family and home environment variables; 3) test whether parent-rated chaos provided independent statistical prediction of child IQ and conduct problem scores beyond the effects of these other environment variables; and 4) test whether effects were found longitudinally over two years.

Method

Participants

Participants included 302 families with healthy same-sex twins (59% female, 42% genetically identical, 94% two-parent homes, 92% Caucasian) in the Western Reserve Reading Project (Petrill, Deater-Deckard, Thompson, DeThorne, & Schatschneider, 2006). The sample of 302 families represented those with valid chaos scores in at least one of three annual assessments or 'waves'. Sample size varied from 279 to 302 in cross-sectional analyses due to missing data. For longitudinal analyses predicting wave 3 from wave 1 scores, sample size was reduced to 181 or 182 families, depending on the analysis.

There was widely varying levels of parent education (for mother/father): 10–13% high school or less, 22–23% some college or associates degree, 33–36% bachelor's degree, 26–28% some post-graduate education or degree, 4% not specified. Nearly all families were two-parent households (6% single mothers) and the majority was White (92%). The children were 6.10 years old on average (*SD* = .68, from 4.32 to 7.92 years) at the first assessment.

Procedure

The current study involved data from three annual in-home assessments or 'waves', with each home visit conducted by two research assistants and lasting about 2.5 hours. The data were collected at one site, but the study was conducted in compliance with regulations from Institutional Review Boards at all of the teams' institutions. Parents and children completed

informed consent or assent in which they were made aware of the observational and questionnaire/test procedures being used. The semistructured home visit allowed considerable time for interaction between the research assistants and the family, and for the research assistants to observe the home environment and parent–child interactions. Parent and child cognitive performance data were collected during the home visit; each child was tested separately and by a different research assistant from her or his co-twin. Mothers and fathers (when participating) completed questionnaires and returned them during the home visit or shortly thereafter by mail. Upon completion of a home visit, the two research assistants completed independent ratings of their observations of the home environment. Parents and children were compensated with an honorarium after each home visit to thank them for their time.

Measures

Variables were measured either in the first wave only or in all three waves, as indicated below. The variables collected only in the first wave included parental education and verbal IQ, parent-reported stressful life events, and observer-reported housing conditions. Variables collected in all three waves included parent-reported chaos, parent-reported home literacy environment, parentand observer-reported negativity and warmth, child general intelligence ('g'), and parent-rated child conduct problems (i.e., opposition, noncompliance, and aggression). We used composite scores (multiple indicators, often across three assessments, and sometimes across informants), to increase the reliability and predictive validity of the variables. Within each composite score, a valid score on one or more indicators was needed for a composite to be computed for any given child. For each set of variables described below, the multiple variables were standardized, averaged, and standardized again to yield composite *z*-scores. Details of data reduction are provided in online Appendix S1.

Chaos—In all three waves, parents completed a short version of the Chaos, Hubbub and Order Scale (CHAOS; Matheny et al., 1995) that was used in two studies in the UK: the Twins Early Development Study (Pike et al., 2006; $\alpha = .63$) and the Sisters and Brothers Study (Coldwell et al., 2006; $\alpha = .56$). The short version includes six items from the Matheny et al. questionnaire and utilized a 5-point Likert-type scale rather than the original instrument's binary (yes/no) scale. The six items are: 'I have a regular morning routine' (reverse scored), 'You can't hear yourself think in our home', 'It's a real zoo in our home', 'We are usually able to stay on top of things' (reverse scored), 'There is usually a television turned on somewhere in our home', and 'The atmosphere in our house is calm' (reverse scored).

Parent education and verbal IQ—In the first wave, parents reported their level of education on an 8-point scale (from no high school diploma or GED, to post-graduate degree completed) that corresponds with years of education (mother–father education, $r = .43$). Also in the first wave, mothers completed the oral vocabulary sub-test of the Stanford–Binet (Thorndike, Hagen, & Sattler, 1986).

Home literacy environment—In all three waves, parents completed the Home Literacy Environment questionnaire (Griffin & Morrison, 1997), which yields a total score representing overall levels of literacy materials and reading practices in the home. The scores were stable over time (mothers, $r = .57$ to $.66$; fathers, $r = .41$ to $.63$), and mother–father agreement was substantial (r's in the .6 to .7 range).

Housing conditions—In the first wave only, research assistants completed independent ratings of the home environment immediately after the home visit, using a modified version of the Post-Visit Inventory or PVI (Deater-Deckard, 2000). Two indicators were derived to

comprise a housing conditions composite score. *Dirt/clutter* was rated using two items (5-point Likert-type scales) regarding the areas inside and outside the home. We included four variables (two raters, two dirt/clutter items) in a principal components analysis and estimated the first component, which explained 76% of the variance (loadings .83 to .89). The averaged score across raters and items was $M = 1.45$ ($SD = .68$), indicating that the majority of the homes received scores in the 'clean to moderately dirty' (1–3 on the 5-point scale) range – although the entire range of possible scores was represented. *Health/ safety* concerns regarding the physical environment were rated using 15 binary indicators (e.g., absence of age-appropriate toys and safe play area, presence of adults/ teens loitering, presence of heavy traffic). These were summed to yield a multiple risk index, $M = 1.09$ risks, $SD = 1.34$, ranging from 0–9 risks, with observers' intra-class r (254) = .69.

Stressful events—In the first wave only, parents completed a brief stressful life events inventory (Deater-Deckard, Petrill, & Wilkerson, 2003) pertaining to the prior 12 months, including a rating of how much each event affected them using a 4-point Likert-type scale. Mothers reported $M = 3.20$ events ($SD = 2.64$, from 9–10 events), but reported being only modestly affected, $M = .18$ ($SD = .25$, from 0–2.40). Fathers reported $M = 3.82$ events ($SD = 2.67$, from 0–17 events), also reporting being only modestly affected, $M = .21$ ($SD = .26$, from 0 to 1.71). Mother-father agreement was moderate ($r = .39$ for number of events, and .30 for how affected).

Parent warmth/negativity—In the first wave only, eight items (four for mother, four for father) from the PVI were completed that pertained to each research assistants' perceptions of parental warmth toward their children during the home visit. These were rated on 5-point Likert-type scales: cold/unfriendly vs. warm/affectionate, hostile/ negative vs. warm/ positive, did not seem to know children well vs. knew children very well, and did not enjoy parenting vs. enjoyed parenting (correlations between items ranged from .68 to .82). The four items were averaged to yield a warmth score for mother, and for father. Inter-rater agreement between the two observers was acceptable (intra-class $r = .68$ and .70 for ratings of mother and father respectively). Therefore, the two observers' scores were averaged, $M = 4.08$ ($SD = .73$) for mother warmth, $M = 3.98$ ($SD = .86$) for father warmth. These scores indicated that although there was a wide range of observers' perceptions of parental warmth, most of the ratings were between 3–5 on the 5-point Likert-type scale, suggesting that the parents were seen as being moderately to substantially warm during the home visit. The observers rated mothers and fathers similarly ($r = .57$ to .68 depending on observer). In addition, in all three waves, parents reported their feelings of warmth toward each child using the 15-item warmth scale from the Parent Feelings Questionnaire (PFQ, Deater-Deckard, 2000). Longitudinal stability over three waves was substantial ($r = .57$ to .71), and parents reported similar warmth toward both children (intra-class $r = .73$ and .80 for mothers' and fathers' reports, respectively). Mothers' and fathers' ratings were averaged across children and over time to yield one mother-reported warmth z-score and one father-reported warmth z-score. These four indicators (self and observer reports of mother and father warmth/positivity) comprised the composite z-score used for analyses.

The same approach was used to assess parental negativity. In the first wave only, one observer-rated item from the PVI was used (5-point Likert-type scale from low to high) regarding mother and father harsh scolding or yelling toward the children during the visit; the two observers' agreement was moderate to substantial (inter-rater intra-class $r = .71$ for rating of mother, .54 for rating of father). Observers' reports were averaged, $M = 1.31$ ($SD = .62$) for mother, $M = 1.21$ (.44) for father. In addition, in all three waves, parents' self-reports were based on the 16-item negativity scale from the PFQ (longitudinal stability $r = .59$ to .83; similarity in parents' reports of negativity toward both twins intra-class $r = .73$ and .75 for mothers and fathers respectively). Mothers' and fathers' ratings were averaged

over time and across children. As with parent positivity, four indicators (self and observer reports of mother and father negativity) comprised the composite *z*-score for analyses.

Child IQ—In all three waves, child cognitive ability was assessed using the sum of area scores from the oral vocabulary, pattern analysis, digit span/memory for sentences, and quantitative reasoning sub-scales of the Stanford–Binet (Thorndike et al., 1986). Child IQ scores were very stable over time (r = .68 to .77).

Child conduct problems—In all three waves, parents completed the oppositional-defiant disorder, inattention, and hyper-impulsivity scales from the Disruptive Behavior Rating Scale (DBRS; Barkley & Murphy, 1998), and the externalizing syndrome scale of the Child Behavior Checklist (CBCL; Achenbach, 1991). Scores were stable over time (r = .52 to .79), and mother–father agreement was moderate to substantial (r = .39 to .62).

Results

We computed descriptive statistics on the entire sample of children (the dependence within sibling data does not influence estimates of means and variances). Child IQ scores approximated the population distribution, although there was some range restriction, n = 586 children, M = 101.34, SD = 12.15. There also was ample variation in children's conduct problem scores. Distributions were positively skewed, which is typical in community samples of this kind: CBCL externalizing, n = 595 children, M = 6.68, SD = 5.00; inattention, n = 604 children, M = 4.34, SD = 3.82; hyperactive-impulsivity, n = 604 children, M = 4.61, SD = 3.60; number of oppositional behaviors endorsed, n = 604 children, M = .46, SD = .35. All of the family environment composites were *z*-scores (M = 0, SD = 1).

Chaos was normally distributed across the entire possible range of scores for the 5-point scale (see Table 1 for descriptive statistics). Means were just below the middle of the scale, reflecting modest positive skew. There was ample variation, with standard deviations of about two-thirds of a point on the five-point scale. Table 1 also shows the correlations within and between parents' reports of chaos. Mother–father agreement and longitudinal stability both were substantial. In a principal components analysis, we estimated the first component using the three mother-rated and three father-rated chaos scores; it explained 77% of the variance (loadings from .85 to .89), so the six scores were averaged to yield a composite score, n = 302 families, M = 2.36, SD = .58.

In subsequent analyses, those that focused on chaos and its correlates or statistical predictors were conducted once for the entire sample of families (i.e., at the 'family level' of analysis). For those that focused on child IQ and conduct problems, analyses were conducted twice because these variables were child-specific and nested within families (i.e., at the 'child level' of analysis). In those instances, we estimated effects separately for two sub-samples of children, each including one child per family selected arbitrarily to test for internal replication. Analyses are labeled as 'family level' or 'child level' to make clear which approach was used.

Chaos and the family environment

Table 2 includes correlations between chaos and the other composite scores, estimated at the family level of analysis. Parental education/IQ, an enriched family literacy environment, poorer housing conditions, and more chaos all covaried. More chaos and poorer housing conditions also were associated with more parental negativity, less parental warmth, and more stressful events. Of the seven family/home environment variables considered, chaos and housing conditions were the only two that were significantly correlated with all other variables (average r = ±.23 for chaos and ±.25 for housing conditions).

Next, we estimated a multiple regression equation to examine variance in family chaos that was accounted for by the other home environment variables (excluding parental warmth and negativity which conceptually were not thought to operate as predictors of chaos). Statistical predictors included parent education/IQ, literacy environment, stressful events, and housing conditions. These accounted for 15% (adjusted R^2) of the variance in family chaos, F (4, 281) = 13.72, $p < .001$. More chaos was associated with lower parental education/IQ ($\beta = -.16$, $p < .05$), a poorer literacy environment ($\beta = -.21$, $p < .01$), and poorer housing conditions ($\beta = .15$, $p < .01$); stressful life events (.07) was not significant.

Chaos and child outcomes

Table 3 shows correlations with child IQ and conduct problem scores, estimated at the child level of analysis. Effect sizes were consistent across the two sub-samples. Higher child IQ was associated with higher parental education/IQ, home literacy environment, less parental stress, better housing conditions, and less chaos. Higher levels of child conduct problems were associated with more parental negativity and less warmth, more family stress, and more chaos.

Next, we estimated hierarchical regression equations predicting child IQ and conduct problems (Table 4) at the child level of analysis, separately for the two sub-samples. The first step included: parent education/IQ, literacy environment, negativity, warmth, stressful events, and poor housing conditions. Chaos was entered as a predictor in the second step. For all four estimated equations (two sub-samples by two child outcomes), the first step of the equation was significant. Higher child IQ was associated with higher parental education/IQ and an enriched literacy environment, and more conduct problems were associated with parental negativity and lower warmth. The inclusion of chaos in the second step also was significant for all four equations. Thus, after controlling for other family factors, more chaos provided independent statistical prediction of lower IQ scores and higher conduct problem scores, adding an additional 2–4% explained variance above and beyond the statistical prediction provided by other family variables.

Longitudinal analyses

Longitudinal analyses involved prediction of scores at wave 3, after controlling for those scores at wave 1. There was attrition over the two years, though it appeared to be random with respect to levels of chaos and conduct problems at wave 1, based on comparisons of the sample available for analysis to the sample of 107 families who had chaos and conduct problems scores at wave 1 but not at wave 3. In contrast, there was evidence that among the 101 families who had valid child IQ data at wave 1 only, their children had IQ scores that were lower by one-third of a standard deviation, M = 96.41 (12.98) for sub-sample 1, M = 96.19 (12.07) for sub-sample 2, compared to children with both waves included in the reported analyses, M = 101.58 (13.12) for sub-sample 1, and 102.21 (12.62) for sub-sample 2.

Chaos—To test the statistical prediction of variance in chaos over time we estimated a hierarchical regression equation at the family level, predicting wave 3 chaos (averaged mother–father rating) after controlling for chaos measured at wave 1 – the first step of the equation, F (1, 179) = 176.28, $p < .001$, adjusted $R2$ = .49, wave 1 chaos $\beta = .70$, $p < .001$. In step 2, the home environment predictors that were used in the previous cross-sectional analyses were included as predictors. This step accounted for an additional 5% of the variance, F (4, 175) = 5.12, $p < .001$, *adjusted R2* = .54, education/IQ $\beta = -.12$, $p < .01$, literacy environment $\beta = -.13$, $p < .05$, housing conditions $\beta = .03$, non-significant, and stressful events $\beta = .07$, nonsignificant. Thus, lower parental education/IQ and literacy

environment statistically predicted higher chaos at wave 3 after controlling for chaos at wave 1.

IQ and conduct problems—In child level analyses, we tested whether child IQ over two years (from wave 1 to 3) would be statistically predicted by chaos over the same two years. We estimated a hierarchical regression equation predicting wave 3 child IQ, separately for the two sub-samples. None of the home environment variables was a significant statistical predictor of wave three IQ after controlling for wave 1 IQ (See online Appendix S1 for details). We conducted the same longitudinal regression analysis for predicting child conduct problems at wave 3, and the results are shown in Table 5; this equation also included parent negativity and warmth, since these emerged as predictors of conduct problems in previous analyses. After wave 1 conduct problems were statistically controlled (Step 1), the equation included parent negativity and warmth composite scores (Step 2), wave 1 chaos (Step 3), then wave 3 chaos (Step 4). In both sub-samples, the 4th step of the equation was significant, suggesting that change in chaos covaried with change in child conduct problems over a two-year period.

Discussion

Household chaos has been implicated in children's and adolescent's cognitive and social emotional development (Dumas et al., 2005; Evans, 2006; Petrill et al., 2004; Pike et al., 2006; Wachs & Çorapçi, 2003), but there is much to learn about how chaos operates within the broader context of family environment factors and whether chaos is predictive of child outcomes above and beyond other family context variables (e.g., parental education, home literacy, housing conditions, parenting warmth and negativity) concurrently and over time. The current study was novel in its examination of the longitudinal stability of between-family differences (over a two-year period) and the stability of mother–father agreement in their ratings of their own households. Stability correlations for mothers' and fathers' ratings were substantial (ranging from .70 to .89), as were the correlations between parents' ratings at each wave (.62 to .70). Such stability over time and agreement between informants suggests that the levels of chaos in the home are not only consistent over time but are highly salient to mothers and fathers.

Chaos and the family environment

Parents' subjective reports of chaos have been shown to be correlated with other aspects of the parenting environment including poorer maternal mental health, less parental positivity and harsher discipline, and more crowded living conditions (Dumas et al., 2005; Pike et al., 2006; Valiente et al., 2007). In the current study, we examined various parenting and home environment factors assessed via parent reports as well as assessments and observers' ratings. We found that households that were more chaotic had parents who were less educated and had lower IQ scores, provided less optimal literacy environments, showed less warmth and more negativity toward their children, reported more stressful events, and lived in poorer housing conditions.

Of the seven home environment factors that we examined, only chaos and poor housing conditions were significantly associated with all of the other variables, suggesting that chaos and poor housing conditions represented a 'core' aspect of household functioning – at least empirically. Unfortunately, we were not able to ascertain whether this remained true over time, because the observers' ratings of housing conditions and parental warmth and negativity were gathered only at wave 1. It remains to be seen whether shifts in parents' reports of chaos correspond closely with shifts in observers' reports of other characteristics such as housing conditions and parental warmth and hostility. It also remains to be seen

whether chaos mediates the effects of these other home environment factors on children's developmental outcomes, although visual inspection of the coefficients in Table 4 prior to (Step 1) and following (Step 2) inclusion of chaos in the equations suggests only a small mediating effect.

Chaos and child outcomes

Chaos is a key aspect of family functioning that is associated with children's developmental outcomes in important ways. Parent-reported chaos has been linked with multiple aspects of child development such as poorer cognitive performance and scholastic achievement, and more conduct problems (Asbury et al., 2005; Coldwell et al., 2006; Dumas et al., 2005; Petrill et al., 2004; Pike et al., 2006), but other co-varying family and parenting environment factors also have been implicated. In the current study, chaos accounted for additional variance in child IQ and conduct problems, even after other home environment predictors were controlled statistically. These findings suggest that although parent-rated chaos is closely related conceptually to other family environment factors, parents' perceptions of chaos are empirically distinct from other environmental factors when it comes to statistically predicting variance in child IQ and conduct problems. The statistical predictive effects of parent-rated chaos do not appear to be simply redundant with the effects of other home environment factors.

Longitudinal analysis of chaos

We were able to assess variation in chaos scores over time, and the findings suggest that at least some of the variation over time was predictable. Although ratings of chaos were very stable (r = .7 to .8 from year to year), this still meant that one-third to one-half of variance in chaos at any point in time remained unexplained even after prior chaos was controlled statistically. Two pieces of evidence suggested that at least some of this unexplained variance was systematic and not random measurement error. The first piece of evidence was that the longitudinal variation in chaos was significantly associated with other home environment factors. Longitudinal effects were found for less parental education, lower parental IQ, and less enriched literacy environments, even after controlling for initial chaos score at wave 1. In contrast, chaos was not predicted longitudinally from stressful life events, parental warmth and negativity, or housing conditions after controlling for chaos at wave 1.

The second piece of evidence was that longitudinal variation in chaos was associated with longitudinal variation in child conduct problems (but not child IQ) over a two-year period. To our knowledge, the current study is the first to demonstrate a potential link between change in chaos and change in conduct problems. This longitudinal analysis was a more stringent correlational test of a potential causal relationship between chaos and child behavior problems, though it rests firmly on the foundation of previous studies that showed moderate-sized concurrent effects between higher chaos and child conduct problems (e.g., Dumas et al., 2005; Pike et al., 2006). Note, however, that there was evidence of selective attrition over the two-year period, at least with respect to child IQ scores.

The potential influence of child behavior on chaos also should be considered. It may be that parents in households with a child who is showing escalation in aggressive conduct problems find it increasingly difficult to maintain order in the home. Yet even with the inclusion of longitudinal data, the current study's correlational design prevented testing alternative causal models regarding parent and child effects. In addition, although the data for each twin were analyzed separately, the findings based on this sample of families with twins may not generalize to other types of families. The sample was not representative of US families with school-age children, given that the vast majority was Caucasian two-parent

households, and parental education was above the national average (i.e., over half had a college degree). Furthermore, the magnitudes of significant effects were typically modest – a pattern that could be due in part to the study being based on a 'low risk' community sample of families, and the use of an abbreviated version of the CHAOS scale. Finally, although we attempted to empirically address some of the measurement issues surrounding the assessment of chaos in the home, reliance on parents' reports for much of this information was a limitation to the extent that such ratings are biased. Similarly, our observations in the home were only 'snapshots', and those data may have included method variance arising from parents' reactions to the home visit and presence of research assistants. These caveats aside, the findings implicate meaningful and predictable variation in, and potential consequences of, household chaos concurrently and over a two-year period.

Conclusions

Chaos varies widely between families and is stable over time, and provides some unique statistical prediction of children's IQ scores and conduct problems. There are three important implications. First, maintaining a non-chaotic home environment is important to children's healthy cognitive and social-emotional development (Evans, 2006; Wachs & Çorapçi, 2003). The lack of such structure may be influencing these outcomes in ways that further promulgate the risks of poverty, lack of parental education, harsh reactive parenting, and family distress and conflict. Second, the home environment factors that we measured are conceptually and empirically inter-related, but are by no means redundant. Parents' reports of chaos provide invaluable additional information about family processes that may be critical to understanding the etiology of problems in cognitive and social-emotional development. Researchers who study family environments should consider including parent-reported chaos and brief objective measures of housing conditions whenever possible. Third, those who work with distressed families and children would do well to assist parents with the establishment and maintenance of household routines in quiet and calm settings, through education and instrumental support (Coldwell et al., 2006).

Key points

- A chaotic home environment is detrimental to healthy cognitive and social-emotional development in childhood and adolescence.
- In the current longitudinal study, we examined parents' reports of household chaos along with parent and observer ratings of other aspects of the home environment, and the statistical prediction of child IQ and conduct problems over a two-year period.
- Parents' reports of household chaos were related to poorer housing conditions and literacy environments, lower parent education and verbal IQ, greater stress, less parental warmth, and more parental negativity. Even with these other factors considered, more chaos statistically predicted more child conduct problems and lower IQ scores, as well as changes in conduct problems over two years.
- Prevention and intervention efforts with parents should emphasize and support the establishment and maintenance of a quiet, calm, predictable home environment.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Means (SD) and correlations between measures of CHAOS in three waves for mothers' and fathers' ratings

		Father		
		Wave 1 (*n* = 156)	**Wave 2 (*n* = 125)**	**Wave 3 (*n* = 79)**
Mother:	*M (SD)*	2.46 (.62)	2.35 (.59)	2.32 (.57)
Wave 1 (*n* = 286)	2.36 (.65)	.62	.70	.72
Wave 2 (*n* = 233)	2.29 (.60)	.79	.67	.73
Wave 3 (*n* = 191)	2.32 (.57)	.70	.80	.70

Note: Correlations on diagonal represent mother-father agreement. Correlations below diagonal are for mothers, and above diagonal are for fathers. All correlations significant, $p < .001$, two tailed.

Table 2

Correlations between CHAOS and other environmental measures

	1	2	3	4	5	6
1. Education/IQ						
2. Literacy environment	.37***					
3. Negativity	.05	−.09				
4. Warmth	−.03	.09	−.46***			
5. Stressful events	−.07	−.19**	.26***	−.04		
6. Poor housing	−.22***	−.28***	.21***	−.31***	.23***	
7. CHAOS	−.27***	−.32***	.21***	−.15*	.15*	.26***

Note: n varied from 288 to 302,

* $p < .05$,

** $p < .01$,

*** $p < .001$ (two-tailed).

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Table 3

Correlations between CHAOS, family environment variables, and child IQ (*n* = 279–293) and Conduct Problems (*n* = 288–302), for two sub-samples ('1' and '2')

	IQ		Conduct problems	
	1	**2**	**1**	**2**
Education/IQ	.26***	.21***	.08	.00
Literacy environment	.27***	.31***	−.05	−.08
Negativity	−.06	−.11	.51***	.55***
Warmth	.02	.08	−.38***	−.34***
Stressful events	−.14*	−.19**	.20**	.26***
Poor housing	−.16**	−.22***	.10	.12*
CHAOS	−.33***	−.33***	.24***	.29***

Note:

* $p < .05$,

** $p < .01$,

*** $p < .001$ (two-tailed).

Table 4

Standardized regression coefficients and model statistics from two-step hierarchical regression equations

	IQ				Conduct Problems			
	Sub-sample 1		Sub-sample 2		Sub-sample 1		Sub-sample 2	
	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2
Education/IQ	.22**	.18**	.13*	.09	.07	.10	−.02	.02
Literacy Env	.14*	.09	.21**	.16**	−.02	.02	−.01	.03
Negativity	−.02	.02	−.01	.03	.39***	.36***	.47***	.43***
Warmth	.01	−.01	.06	.06	−.21***	−.21***	−.13*	−.13*
Stressful events	−.06	−.06	−.11	−.10	.10	.10	.14**	.13*
Poor housing	−.13	−.10	−.12	−.10	−.08	−.10	−.06	−.09
CHAOS	–	−.22***	–	−.20**	–	.18**	–	.20***
Adjusted R^2 (%)	12	16	14	17	29	31	32	35
F change	7.44	12.74	8.25	11.25	19.94	10.70	23.19	13.79
df	6,272	1,271	6,272	1,271	6,279	1,278	6,279	1,278
p-value	<.001	<.001	<.001	<.001	<.001	<.01	<.001	<.001

Note:

* $p < .05$,

** $p < .01$,

*** $p < .001$ (two-tailed).

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Table 5

Longitudinal prediction of conduct problems at wave 3: Standardized regression coefficients and model statistics from four-step hierarchical regression equations

	Sub-sample 1				Sub-sample 2			
	F	**df**	**AdjR²**	**β**	**F**	**df**	**AdjR²**	**β**
Step 1: Conduct probs (wave 1)	145.56	1,180	.44***	.67***	156.62	1,180	.46***	.68***
Step 2: Negativity	11.43	2,178	.50***	.16*	19.05	2,178	.55***	.07
Warmth				−.17**				−.29***
Step 3: Chaos (wave 1)	.01	1,177	.50***	.01	.05	1,177	.55***	.01
Step 4: Chaos (wave 3)	6.16	1,176	.51***	.18*	5.29	1,176	.56***	.16*

Note:

* $p < .05$,

** $p < .01$,

*** $p < .001$ (two-tailed).