Longitudinal associations among family environment, neural cognitive control, and social competence among adolescents

Jungmeen Kim-Spoon⁎, Dominique Maciejewski, Jacob Lee, Kirby Deater-Deckard, Brooks King-Casas

⁎ Corresponding author at: Department of Psychology (MC 0436), Virginia Tech, Blacksburg, Virginia, 24061, USA.
E-mail address: jungmeen@vt.edu (J. Kim-Spoon).

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ABSTRACT

During adolescence, prefrontal cortex regions, important in cognitive control, undergo maturation to adapt to changing environmental demands. Ways through which social-ecological factors contribute to adolescent neural cognitive control have not been thoroughly examined. We hypothesize that household chaos is a context that may modulate the associations among parental control, adolescent neural cognitive control, and developmental changes in social competence. The sample involved 167 adolescents (ages 13–14 at Time 1, 53% male). Parental control and household chaos were measured using adolescents’ questionnaire data, and cognitive control was assessed via behavioral performance and brain imaging at Time 1. Adolescent social competence was reported by adolescents at Time 1 and at Time 2 (one year later). Structural equation modeling analyses indicated that higher parental control predicted better neural cognitive control only among adolescents living in low-chaos households. Higher household chaos predicted better neural cognitive control only among adolescents living in high-chaos households. Household chaos may undermine the positive association of parental control with adolescent neural cognitive control and exacerbate the detrimental association of poor neural cognitive control with disrupted social competence development.

The developmental period of adolescence is characterized by dramatic changes in the brain (Casey et al., 2008). In particular, prefrontal cortex regions, important in cognitive control (CC), have been shown to undergo maturation, including increased myelination and experience-dependent synaptogenesis and pruning (Paus, 2005) as well as strengthening of connections within prefrontal circuitry to adapt to changing environmental demands (Liston et al., 2006) throughout adolescence and into early adulthood. Neurodevelopmental models of adolescent motivated behavior (Casey et al., 2008; Ernst et al., 2006) suggest that subcortical “emotional/motivational” regions develop earlier in adolescence than prefrontal “cognitive control” regions, explaining why adolescence is a period when self-control becomes particularly difficult.

Self-control refers to the ability to inhibit certain emotions, thoughts, or actions and to feel, think, or act in alternative, more appropriate ways in the pursuit of long-term goals (Baumeister et al., 2007; Casey, 2015). The social environment is thought to have an important influence on the development of self-control during adolescence (Casey, 2015). We incorporate a bioecological model (Bronfenbrenner and Morris, 1998) as a theoretical basis for examining how socio-ecological factors are associated with CC and social competence in adolescence. The bioecological model defines “proximal processes” as interactions between the organism and the environment that serve as the primary mechanisms influencing human development, and emphasizes that the influence of such processes varies systematically as a function of the environmental context. In the present study, we examined the role of household chaos as a context that modulates the associations among parental control, adolescent neural CC, and developmental changes in social competence.

Within the bioecological model, ‘chaotic systems’—characterized by frenetic activity, lack of structure, and unpredictability in everyday activities—are regarded as a major source of interruption of proximal processes that engender competence (Bronfenbrenner and Evans, 2000). Past research has demonstrated that the level of chaos, defined as confusion, clutter, and ambient noise in the home, is an important aspect of family dynamics that interferes with optimal parenting...
practices and could subsequently impact developmental outcomes (Evans and Wachs, 2010 for review). There is an increasing body of evidence documenting household chaos as a contextual factor that alters the effects of parenting. For example, during early to middle childhood, the association between poor quality parent-child relationships (e.g., low positivity, harsh discipline) and children’s behavior problems is exacerbated in the context of high household chaos (Asbury et al., 2003; Coldwell et al., 2006). In addition, during adolescence, reactive and harsh parenting styles predict more callous-unemotional traits in high but not low chaos environments (Kahn et al., 2016). These findings suggest that household chaos may function as a moderator between parenting and children’s adjustment. According to the bioecological model (Bronfenbrenner and Morris, 1998), higher parental control may be a positive proximal process, which is associated with higher adolescent self-control. Yet this association may be disrupted by the context characterized by high household chaos.

Within neuroscience literature, prior research has shown that positive parenting behaviors (e.g., warmth) and positive parent-child relationships (e.g., high emotional support and low conflict) are related to longitudinal changes in prefrontal brain structure (e.g., accelerated thinning in the anterior cingulate and orbitofrontal cortices; Whittle et al., 2014) as well as reward-related neural activity during risk taking (e.g., decreased activation in ventral striatum; Qu et al., 2015). In contrast, negative family relationships (e.g., high conflict and low cohesion) seem to impede development in the prefrontal regions which subserve CC (e.g., increased activation in ventrolateral prefrontal cortex; McCormick et al., 2016). To date, however, no empirical study has examined the effects of parental control on prefrontal functioning related to CC. Therefore, we sought to address this gap by examining one of the parental monitoring features that seems to be critical for self-control development: parental control, which represents the active supervision and establishment of clear expectations and boundaries for youth (Stattin and Kerr, 2000).

The importance of parental control in the development of self-control is emphasized by the self-control theory (Gottfredson and Hirschi, 1990). According to this theory, high self-control is fostered by effective socialization by parents (e.g., teaching their children to think about the long-term consequences of their acts) and low control is produced by the absence of nurturance, discipline, or training. For the effective socialization, parents must monitor their children’s behaviors; recognize deviant behaviors when they occur; and punish such behaviors (Gottfredson and Hirschi, 1990). Thus, parents’ adequate control over children’s behaviors is critical for optimal self-control development. Extant literature suggests that higher parental control is related to higher self-control among their adolescent children (Bowers et al., 2011; Farley and Kim-Spoon, 2017; Ng-Knight et al., 2016; but see Finkenauer et al., 2005). Parental control may promote adolescent self-control by increasing adolescents’ awareness of being monitored, thus making them more conscious of their behaviors as well as possible consequences of their behaviors.

Researchers have paid increasing attention to the role of impaired CC as a risk factor in the development of psychopathology and risk taking (see Crone et al., 2016 for review), but we do not know whether and how CC is associated with positive adaptation. Throughout adolescence, competence is expected to improve as young people mature and learn across multiple domains of adaptation in basic capabilities and coordinated execution of actions (Masten, 2007). Success in social relationships is one of the age-salient developmental tasks during the adolescent period (Masten, 2007), characterized by increased importance and complexity of peer relationships and an improved understanding of others (Blakemore, 2008). The literature suggests that self-control develops in the context of social relationships, and those who demonstrate more self-control maintain higher quality social relationships (Farley and Kim-Spoon, 2014 for review). For example, children and adolescents who are better able to behaviorally self-regulate are also more socially competent (McKown et al., 2009). Similarly, young adults with better emotion regulation abilities tend to be more sensitive to others and engage in more prosocial activities; consequently, they receive greater positive nominations from peers (Lopes et al., 2005). Finally, in a recent longitudinal study spanning middle childhood through middle adolescence, higher levels of executive functions (measured by inhibitory control, attention, and working memory) reduced the likelihood of experiencing problems in peer relationships later on (Holmes et al., 2016). According to the bioecological model, person (i.e., the characteristics of the organism) can directly shape proximal processes. It follows that high self-control would facilitate forming positive social relationships, thus promoting high social competence. Yet this association may be disrupted by the context characterized by high household chaos.

In the current study, we examined socio-ecological factors that are associated with the neural CC system in adolescence. We focused on how parenting behavior and home environment may be related to the neural CC system which in turn is related to changes in social competence. Specifically, we examined the role of household chaos as a contextual factor that modulates (1) the association between parental control and the neural CC system, and (2) the association between the neural CC system and the development of social competence. Given that brain development during adolescence is expected to be influenced by both biological factors, such as puberty (Blakemore et al., 2010; Crone and Dahl, 2012), as well as experience-dependent plasticity that varies with environmental contexts, we also examined the effects of pubertal development on CC.

1. Methods

1.1. Participants

Participants were 167 adolescents (53% male) aged 13–14 years at Time 1 (M = 14.13, SD = 0.54) or 14–15 years at Time 2 (M = 15.05, SD = 0.54). About 80% were White, 13% were African American, and 7% were in other racial groups. The median of family annual income ranged from $35,000 to $49,999 at both time points. The sample was representative of the region of the state for household income and race/ethnicity. At Time 1, 157 adolescents participated in the study. At Time 2 (approximately one year later), 17 adolescents did not return for the following reasons: ineligibility for tasks (n = 2), declined participation (n = 7), and lost contact (n = 8). Ten additional adolescents were invited to participate at Time 2, leading to the final sample of 167 adolescents. Multiple logistic regression analyses indicated that attrition was not significantly predicted by demographic (age, income, race, sex) and most study variables (household chaos, parental control, pubertal development, neural and behavioral CC, all ps > 0.215). However, adolescents that did not return for Time 2 had lower social competence at Time 1, compared to adolescents that did return (p = 0.028). Adolescents were excluded from participation if they had a history of head injury resulting in loss of consciousness for more than 10 min, claustrophobia, orthodontia impairing image acquisition, or contraindications to magnetic resonance imaging.

1.2. Procedure

Participants were recruited by diverse advertisement methods including flyers, recruitment letters, and e-mail distributions. Data collection took place at the university offices where adolescents and their primary caregivers were interviewed by trained research assistants. All adolescents provided written assent and their parents provided written permission for a protocol approved by university’s institutional review board.
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