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Infant Attachment Security and Timing of Puberty:

Testing an Evolutionary Hypothesis

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Abstract

Life-history theories of the early programming of human reproductive strategy stipulate that early rearing experience, including that reflected in infant-parent attachment security, regulates psychological, behavioral and reproductive development. We test the hypothesis that *infant* attachment insecurity (at age 15 months) predicts earlier pubertal maturation (assessed via annual physical exams from age 9½-15½ years and self-reported age of menarche), using data gathered on 373 White females enrolled in the NICHD Study of Early Child Care and Youth Development. Results revealed that insecure infants initiated *and* completed pubertal development and had menarche earlier than secure infants, even after accounting for maternal age of menarche. Results support a conditional-adaptational view of individual differences in attachment security while raising questions about biological mechanisms responsible for the attachment effects discerned.

Keywords: attachment, puberty, reproductive strategy, menarche, evolution

Attachment in Infancy and Timing of Puberty:

Testing an Evolutionary Hypothesis

Puberty is a central event in human development, defining reproductive maturity. The fact that individual differences in pubertal timing are heritable does not preclude the possibility that developmental experiences also influence this life-history characteristic (Ellis, 2004). Indeed, rodent research shows that the early rearing environment regulates pubertal, sexual and reproductive development through epigenetic processes (Cameron, Del Corpo, Diorio, Mackallister, Sharma, & Meaney, 2008; Cameron, Fish, & Meaney, 2008; Cameron, Champagne, Parent, Fish & Osaki-Kuroda, 2005; Champagne, Weaver, Diorio, Dymov, Szyf, & Meaney, 2006). Here we test the evolutionary-developmental hypothesis that security of infant-mother attachment predicts and perhaps programs pubertal development in human females, too.

Although evolutionary theory figured centrally in the development of attachment theory (Bowlby, 1969), most attachment research over the past 40 years has neglected this intellectual heritage, guided as it is by “mental-health thinking” (Simpson & Belsky, 2008). Thus, attachment security is widely considered to reflect “optimal” development, fostering empathy and prosocial behavior, self-regulation and the establishment of close, trusting interpersonal relationships. Building on evolutionary critiques of such mental-health thinking about attachment (Hinde & Stevenson-Hinde, 1984; Lamb, Thompson, Gardner, Charnov & Estes, 1984), Belsky, Steinberg and Draper (1991; Belsky, 1997) advanced a life-history theory of socialization by recasting traditional developmental thinking, including attachment theory, in conditional-adaptational, reproductive-strategy terms. The early family environment, including the infant-parent attachment relationship, they argued, conveys to the child the risks and uncertainties that she is likely to encounter in her own life time. Such information adaptively regulates psychological, behavioral and reproductive development, either towards a mutually-beneficial orientation to interpersonal relations or an opportunistic, advantage-taking one. These in turn affect mating behavior, pair bonding and parental investment, promoting early vs. later sexual debut, unstable vs. stable intimate partner relationships and a quantity vs. quality approach to children and parenting. These divergent developmental trajectories are theorized to fit the organism to the environment in ways that enhance reproductive success—or at least did so in the environments of evolutionary adaptation.

The fact that many of these reproductive-strategy-oriented predictions could themselves be derived from traditional, non-evolutionary accounts of human development (e.g., attachment, social-learning, life-course theories) made an additional, "uncanny" prediction by Belsky et al. (1991; Belsky, 1997) critically important, distinguishing it from all prevailing theories of development; namely, that early family experiences, including those reflected in security of the infant-parent attachment relationship, would influence and thus predict the timing of pubertal development by contributing to slower vs. faster development. Whereas insecure and unsupportive family relationships would accelerate pubertal development, thereby enabling females in particular to initiate mating and reproduction earlier—considered advantageous in environments in which survival and thereby reproduction could be compromised--the opposite would be the case for secure and supportive relationships.

A comprehensive review of the determinants of female pubertal development provides qualified support for this pubertal-timing prediction (Ellis, 2004), as does more recent research (Belsky, Steinberg, Houts, Friedman, DeHart, et al., 2007; Ellis & Essex, 2007; Tither & Ellis, 2008). Nevertheless, questions remain, most notably whether apparent effects of family relationship processes on pubertal development are genetically mediated (Comings, Muhleman, Johnson & MacMurray, 2002; Rowe, 2002) and whether *early* attachment security itself predicts pubertal timing. Although rodent studies document the programming of reproductive strategy by maternal (licking-and-grooming) behavior extremely early in life (Cameron et al., 2005), all human work linking rearing experiences to pubertal timing relies on measurements made substantially after infancy. Tested here is the proposition that females with insecure *infant*-mother attachment histories mature earlier than those with secure attachment histories, while taking into account mother's age of menarche in attempt to discount the well-established heritability of pubertal timing (Ellis, 2004). Because attachment security reflects the influence of distal and proximate contextual factors like SES and quality of maternal care (Belsky & Fearon, 2008), these are neither conceptualized as alternative explanatory factors nor statistically controlled in this inquiry. Such influences on attachment and, thereby perhaps, pubertal development should not be regarded then as "third variables" which need to be accounted for before evaluating attachment effects.

Method

Participants

To test the evolutionary hypothesis under consideration, we draw on data from 373 White females enrolled in the multi-site NICHD Study of Early Child and Youth Development (NICHD Early Child Care Research Network [ECCRN], 2005) who participated in any of the study's assessments of pubertal status (see below). Minority children were also excluded because small numbers precluded hypothesis testing within these sub-samples; males were excluded because evidence indicates that family experience does not regulate their pubertal development (Belsky et al., 2007). On average, analysis-sample mothers were 29.6 years of age at study enrollment, had completed 14.8 years of education and were living with a male partner/spouse on

90.7% of measurement occasions across the child's first eight years of life. Family income-to-needs ratio, averaged across the same time period, was higher than the U.S. government-determined poverty line by a factor of 4.23. No significant differences existed in terms of mother's age or education, family income-to-needs or, most critically, proportion with secure vs. insecure attachments between 373 White-females included in the analysis and 129 White-females who had neither pubertal onset nor completion data.

Procedures and Measures

Children were followed from birth to age 15. Complete details about all procedures and measures are documented at http://secc.rti.org.

Control variable: Maternal age of menarche.

Mother's report of her own age of menarche was used to (partly) control for genetic effects on children's timing of puberty.

Primary predictor: Infant-mother attachment security.

At 15 months of age, infants were videotaped in the Strange Situation, a separation-reunion procedure designed to evoke attachment behavior (Ainsworth et al., 1978). When stressed this way, secure infants establish unambiguous psychological contact with their mothers upon reunion, either across a distance (e.g., smiling, vocalizing) or via physical contact (e.g., approaching, reaching), finding comfort and solace in mothers' arms if distressed. Insecure infants avoid such psychological and physical contact, physically resist contact or combine approach with avoidance behavior. All videotapes were double scored by highly reliable coders unaware of children's rearing experiences (NICHD ECCRN, 1997).

Primary outcomes: Onset and Completion of Puberty and Age of Menarche.

Pubertal development was assessed via annual physical exams using Tanner criteria (Marshall & Tanner, 1969, 1970), following instructions from the American Academy of Pediatrics Manual, *Assessment of Sexual Maturity Stages in Girls* (Herman-Giddens & Bourdony, 1995), augmented with breast bud palpation, when girls averaged 9.56 (SD = 0.13), 10.60 (SD = 0.16), 11.57 (SD = 0.14), 12.57 (SD = 0.14), 13.55 (SD = 0.12), 14.57 (SD = 0.15) and 15.55 (SD = 0.14) years of age. Exams were conducted by trained nurses/physicians blind to attachment history until girls reached Tanner Stage 5 on the clinical ratings of breast *and* pubic hair *and* reported their first menstruation (see Belsky et al., 2007, for additional details). These assessments yielded Tanner Stage (TS) scores (1-5) each year for (a) breast and (b) pubic hair. To estimate pubertal onset (see below), TS scores were recoded to indicate, at each age of measurement, whether the child showed any evidence of pubertal development (TS > 1 vs. TS = 1) on breast *or* pubic hair development; to estimate pubertal completion they were recoded to indicate whether the child had completed pubertal development (TS = 5 vs. TS < 5) on breast *and* pubic hair development.

Results

To first estimate pubertal onset and completion, we used latent transition analysis (LTA; Lanza & Collins, 2008; Muthen & Muthen, 1998-2007), a longitudinal extension of latent class analysis, for identifying underlying subgroups in the population while allowing individual membership in identified classes (e.g., no vs. some pubertal development) to change over time. LTA handles multiple indicators (i.e., breast, pubic-hair) to define class membership (e.g., pubertal onset or not) and can estimate group membership for cases with missing data. LTA analyses, run using MPlus (version 5.2: Muthen & Muthen, 1998 – 2007), uses maximum likelihood estimation under the assumption of data missing at random. Pubertal onset and completion were estimated for 327 (87.7%) of the girls in the analysis sample; pubertal onset only was estimated for 43 (11.5%) girls; and, pubertal completion only was estimated for 3 (0.8%) girls. Girls with onset only data were more likely to experience early puberty (79%) than girls with both onset and completion data (55%). Nonetheless, girls missing onset or completion data did not differ significantly from girls with complete data in terms of mother's age or education, family income-to-needs or proportion with secure vs. insecure attachments. Because analysis of the combination of pubertal onset and completion required both pieces of information, those results may under-represent girls who started puberty early. Evidence of validity of the pubertal-onset and completion estimates comes from data showing that taller and heavier girls initiated and completed puberty earlier than smaller children (available on request), as did girls who experienced menarche earlier (onset: r [349] = .55, $p < .0001$; completion: r [320] = .45, $p < .0001$). Estimates indicated that all girls initiated pubertal development by 13½ years and that none had completed it by 10½ years.

To determine whether pubertal onset and/or completion were related to infant attachment security, we dichotomized pubertal onset and pubertal completion so that early onset was defined as occurring prior to 10½ years and early completion was defined as reaching TS 5 before 13½ years (see Figure 1). Logistic regression using attachment security (0 = insecure; 1 = secure) as the primary predictor was run without and then with maternal age of menarche controlled (see Table 1). Attachment security significantly predicted both pubertal onset and completion. Having an insecure attachment at age 15 months increased the odds of experiencing pubertal onset before age 10½ years by 1.60 (95% CI: 1.01 to 2.52), though this finding became marginally significant ($p = .06$) when maternal age of menarche was controlled. Having an insecure attachment increased the odds of experiencing pubertal completion before age 13½ by 1.98 (95%

CI: 1.21 to 3.23), a result which remained virtually unchanged with maternal age of menarche controlled, OR = 1.95 (95% CI: 1.19 to 3.20).

OLS regression analysis confirmed the prediction that insecure girls would experience earlier age of menarche, reporting their first menstruation 3.4 months (95% CI: 0.8 to 5.9 months) earlier than girls with secure attachments without maternal menarcheal age controlled, t (474, 1) = 2.60, p = .0095; Secure: M = 12.49 years, SD = 1.14; Insecure: M = 12.21 years, SD = 1.14, and 2.6 months earlier with it controlled (95% CI: 0.2 to 5.0 months), t(458, 1) = 2.10, p = 0.0366; Insecure: 12.26 (95% CI: 12.10 to 12.42); Secure: 12.48 (95% CI: 12.35 to 12.60).

Finally, we examined the effect of attachment insecurity on the *combination* of early pubertal onset *and* early completion using multinomial logistic regression after creating a categorical variable indicating the four possible combinations of pubertal onset (early vs. later) and pubertal completion (early vs. later). This nominal variable was the dependent variable and attachment insecurity was the independent variable; “later onset, later completion” served as the comparison group. The effect of attachment security proved significant with and without maternal age of menarche controlled (see Table 2 and Figure 2). Having an insecure attachment at age 15 months increased the odds of being in the “Early Onset, Early Completion” group, relative to the “Later Onset, Later Completion” group, by a factor of 2.36 (95% CI: 1.31 to 4.28) without maternal menarcheal age controlled and 2.33 (95% CI: 1.27 to 4.28) with it controlled.

Discussion

Here we tested and found support for the theory-distinguishing, developmental-evolutionary hypothesis that the quality of the early rearing environment, *as reflected in the security of the infant-mother attachment relationship*, predicts and perhaps programs the timing of pubertal development in humans and, more specifically, that females with insecure attachments *in infancy* mature earlier than those with secure attachments, as revealed by both verbal reports of age of menarche and annual physical assessments of breast and pubic-hair development. Experimental efforts to promote security, perhaps by enhancing maternal sensitivity, are needed to determine whether the documented attachment effects are truly causal. We did not evaluate whether attachment mediated the effect of maternal sensitivity on pubertal timing because prior NICHD Study work indicated that although early sensitivity predicted attachment security (NICHD ECCRN, 1997), it did not predict pubertal timing (Belsky et al., 2007).

The apparent accelerating effect of attachment insecurity discerned herein confirms a unique prediction of an evolutionary theory of socialization (Belsky, 1997; Belsky, Steinberg & Draper, 1991) and thus necessitates a rethinking of the functional significance of secure and insecure attachments which figure so prominently in the study of human development (Cassidy & Shaver, 2008). Rather than regarding security as “optimal” and insecurity as a form of compromised development, theory and now evidence support the view that both should be considered part and parcel of nascent reproductive strategies which encompass a suite of correlated physical, psychological and behavioral characteristics, including social orientation, pubertal timing, sexual behavior, pair bonding and parenting (Simpson & Belsky, 2008). Certainly consistent with this interpretation is evidence that earlier pubertal development, found here to be related to insecure attachment in infancy, contributes to earlier sexual debut and younger age at first pregnancy (Ellis, 2004).

A developmental profile involving attachment security, prosocial orientation, delayed maturation, deferred sexual debut, stable pair bonds and high levels of parental investment should not be considered inherently better or more natural than a contrasting profile, even if the former remains more valued in the western world. As Cameron and associates (2005, p.846) recently observed, “the idea that any form of phenotypic variation in and of itself is necessarily positive or negative is an anathema to biology.” In contexts in which risk and uncertainty are high—or perceived to be so—maturing early, apparently stimulated by early insecurity, reduces the risk of the individual dying before procreating. In more supportive contexts, security and deferred maturation provide the individual more time to benefit from available physical and psychological resources before reproducing, thereby enhancing offspring viability.

The data linking early insecurity with accelerated pubertal development raise questions about mechanisms: Through what biological processes might early attachment regulate pubertal development? Given extensive evidence that quality of rearing influences attachment security (Bakermans-Kranenburg et al., 2003; De Wolff & van Ijzendoorn, 1997), recent rodent work would seem informative (Cameron, Del Corpo et al., 2008; Cameron et al., 2008; Champagne et al., 2006). Cross-fostering studies show that parental investment in the female rat affects offspring development through epigenetic processes involving the methylation of genes regulating the hypothalamic-pituitary-adrenal and hypothalamic-pituitary-ovarian systems. Critically, maternal licking and grooming of the newborn pup affects estrogen receptor α gene expression, which regulates neuroendocrine function and sexual behaviour, including pubertal timing (Cameron et al., 2008). With so many biological systems conserved across mammalian species, there would seem good reason to suspect that related processes operate in humans, thereby accounting for the discerned effects of attachment on pubertal timing, though this remains to be established.

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Conflict of Interest

The authors have no competing financial interests in relation to the work described.

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Table 1. Timing of pubertal onset and completion.

	Pubertal Onset				Pubertal Completion			
			Prob. of Group Membership [a]				Prob. of Group Membership	
Age in Years	N	%	Mean	SD	N	%	Mean	SD
≤ 9.5	73	19.7	0.91	0.08				
9.5 - 10.5	140	37.8	0.78	0.24				
10.5 - 11.5	97	26.2	0.88	0.15	4	1.2	0.97	0.07
11.5 - 12.5	56	15.1	0.88	0.18	34	10.3	0.83	0.23
12.5 - 13.5	4	1.1	1.00	0.00	70	21.2	0.88	0.15
13.5 - 14.5					131	39.7	0.71	0.28
14.5 - 15.5					72	21.8	0.90	0.11
> 15.5					19	5.8	0.87	0.14

[a] Probability of girls being assigned to each age group in the Latent Transition Analysis

Table 2. Effects of attachment insecurity on pubertal development (with/without maternal menarcheal age controlled)[a]

	Pubertal Onset < 10.5 years					Pubertal Completion < 13.5 years				
PREDICTOR VARIABLES	B		OR	95% CI		B		OR	95% CI	
Intercept	0.16					-0.97	****			
Insecure Attachment	0.47	*	1.60	1.01	2.52	0.68	**	1.98	1.21	3.23
Omnibus χ^2:	χ^2(N = 344, 1) = 4.15					χ^2(N = 307, 1) = 7.39				
	p = .04					p = .007				
Intercept	3.57	***				1.96	*			
Maternal Age of Menarche	-0.26	**	0.77	0.66	0.90	-0.23	*	0.79	0.66	0.95
Insecure Attachment	0.45	+	1.57	0.99	2.49	0.67	**	1.95	1.19	3.20
Omnibus χ^2:	χ^2(N = 344, 2) = 15.57					χ^2(N = 307, 2) = 14.00				
	p = .0004					p = .0009				

[a] B: unstandardized regression coefficient; OR: odds ratio; CI: confidence interval

+ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

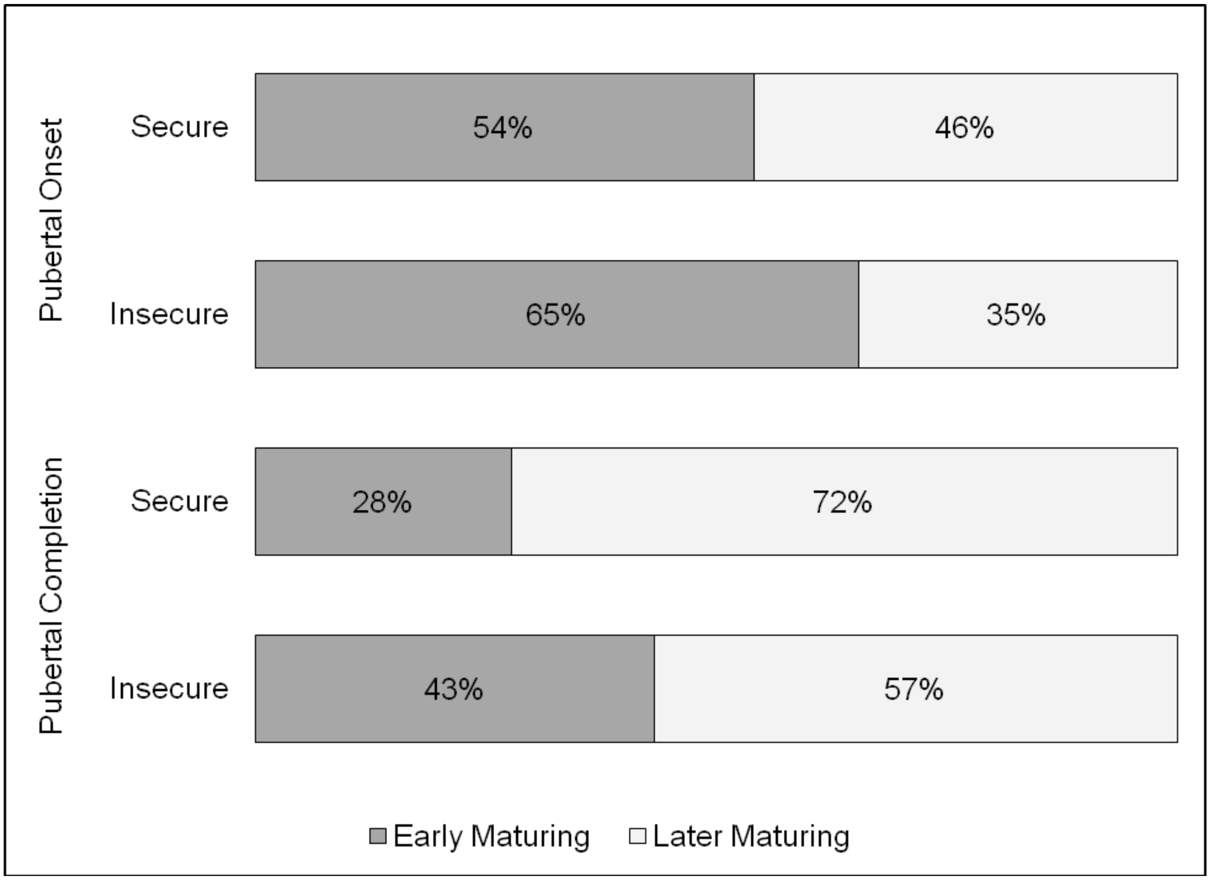
Table 3. Effects of attachment insecurity on pubertal-onset-*and*-completion profiles (with/without maternal menarcheal age controlled)[a]

	Without Maternal Age of Menarche controlled					With Maternal Age of Menarche controlled				
	B		RRR	95% CI		B		RRR	95% CI	
Early Onset, Early Completion										
Intercept	-0.69	***				4.73	**			
Maternal Age of Menarche						-0.43	***	0.65	0.52	0.82
Insecure Attachment	0.86	**	2.36	1.31	4.28	0.85	**	2.33	1.27	4.28
Early Onset, Late Completion										
Intercept	-0.37	*				2.00				
Maternal Age of Menarche						-0.18	+	0.83	0.68	1.02
Insecure Attachment	0.24		1.27	0.70	2.32	0.22		1.25	0.68	2.29
Late Onset, Early Completion										
Intercept	-2.03	***				-3.25				
Maternal Age of Menarche						0.09		1.10	0.80	1.51
Insecure Attachment	0.62		1.85	0.68	5.01	0.63		1.89	0.69	5.12
Omnibus χ^2:	χ^2(N = 304, 3) = 8.77 p = .03					χ^2(N = 304, 6) = 26.38 p = .0002				

[a] The "Late Onset, Late Completion" is the comparison group. B: unstandardized regression coefficient; CI: confidence interval; RRR = Relative Risk Ratio.

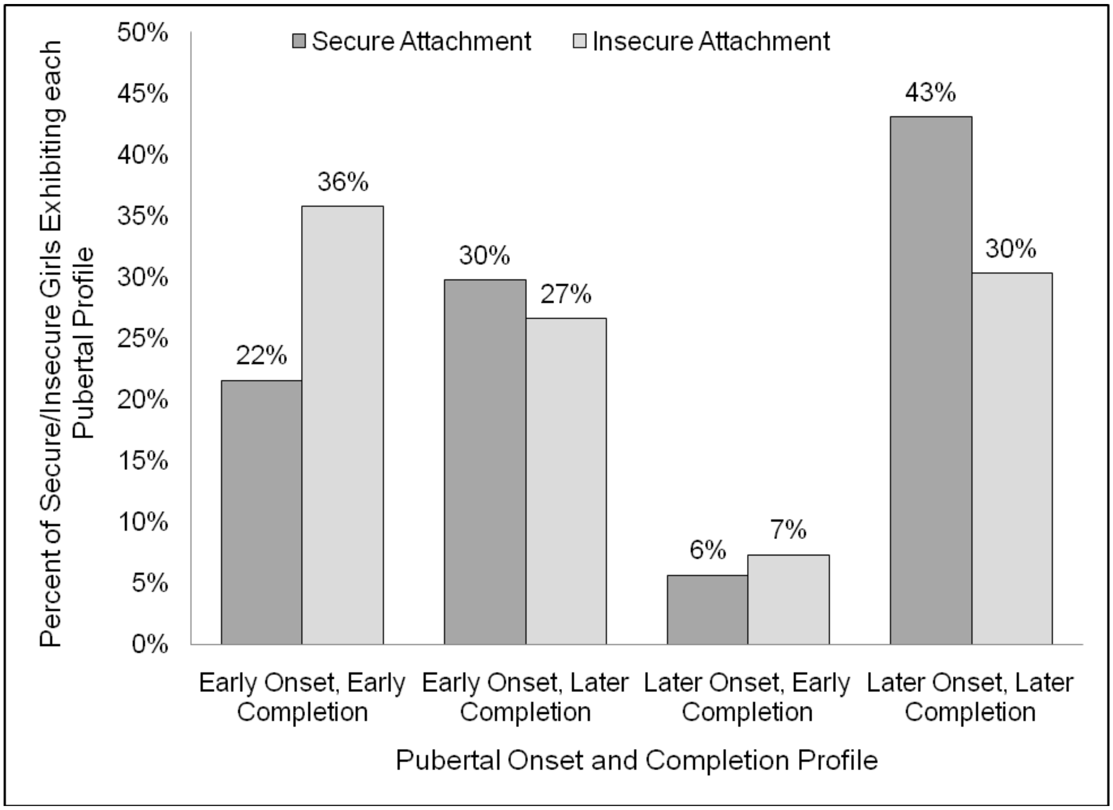
+ p < .10; * p < .05; ** p < .01; *** p < .001

FIGURE 1. Attachment security and timing of pubertal onset and completion.[a]



[a] Early onset: pubertal onset <10½ years; early completion: Tanner Stage 5 <13½ years.

Figure 2. Attachment security and pubertal-onset-and-completion profiles.[a]



[a] Early onset: pubertal onset <10½ years; early completion: Tanner Stage 5 <13½ years.