

Adolescents' sensitivity to children's supernatural thinking: A preparation for parenthood?

Carlos Hernández Blasi¹ and David F. Bjorklund²

¹ Universitat Jaume I and ² Florida Atlantic University

Abstract

Background: Young children often use magical explanations to account for ordinary phenomena (e.g., “The sun’s not out today because it is mad”). We labeled these explanations supernatural thinking. Previous research reports that *supernatural thinking* attributed to preschool-age children evokes both positive affect and perceptions of helplessness from both adults and older (14-17 years old) but not younger (10-13 years old) adolescents. In this study, we asked if cues of cognitive immaturity are more influential in affecting adolescents’ judgments of children than physical cues (faces). **Method:** 245 adolescents aged between 10 and 17 rated pairs of children who physically and/or cognitively resembled either a 4- to 7-year-old or an 8- to 10-year-old child in three between-subject conditions (Consistent, Inconsistent, Faces-Only) for 14 traits classified into four trait dimensions (Positive Affect, Negative Affect, Intelligence, Helplessness). **Results:** For both younger and older adolescents, cognitive cues had a greater influence on judgments than facial cues. However, only the older adolescents demonstrated a positive bias for children expressing immature supernatural thinking. **Conclusions:** Adopting an evolutionary developmental perspective, we interpreted this outcome in late (but not early) adolescence as preparation for potential parenthood.

Keywords: Cognitive immaturity, adolescence, parenthood, evolutionary developmental psychology.

Resumen

Receptividad de los adolescentes al pensamiento sobrenatural de los niños: ¿una preparación para la paternidad? Antecedentes: los niños pequeños emplean a menudo explicaciones mágicas para referirse a fenómenos cotidianos (por ejemplo, “El sol no sale hoy porque está enfadado”). Nosotros etiquetamos estas explicaciones como *pensamiento sobrenatural*. Investigaciones anteriores muestran que el *pensamiento sobrenatural* atribuido a niños en edad preescolar evoca afecto positivo y percepción de desamparo en adultos y adolescentes mayores (14-17 años) pero no en adolescentes jóvenes (10-13 años). En este estudio nos preguntamos si las señales de inmadurez cognitiva son más influyentes en los juicios de los adolescentes que las señales físicas (caras). **Método:** 245 adolescentes de 10 a 17 años evaluaron pares de niños que emulaban físicamente y/o cognitivamente a niños de 4 a 7 años o niños de 8 a 10 años en tres condiciones (Consistente, Inconsistente, Solo-Caras) respecto a 14 rasgos clasificados en cuatro dimensiones (Afecto Positivo, Afecto Negativo, Inteligencia, Desamparo). **Resultados:** tanto en adolescentes jóvenes como en mayores, las señales cognitivas tuvieron mayor influencia que las señales faciales. Sin embargo, solo los adolescentes mayores mostraron un sesgo positivo hacia niños que expresaban pensamientos sobrenaturales. **Conclusión:** adoptando una perspectiva evolucionista del desarrollo, interpretamos este resultado en la adolescencia tardía (no temprana) como preparación para la paternidad.

Palabras clave: inmadurez cognitiva, adolescencia, paternidad, psicología evolucionista del desarrollo.

Humans are unique among mammals in a number of ways. One of the more distinctive human features is their prolonged period of immaturity and dependence on others before reaching a sufficient competence for survival. In fact, in all human societies parents must provide their offspring with food and care for about a decade, if not more (Bogin, 1994).

Typically in traditional societies “the problem of child care” has been solved by the use of *alloparents*, people other than the genetic parents who provide care for children (Lancy, 2015). One

particularly important class of alloparents is adolescents. For example, Bogin (1994) reports that in different types of traditional societies (hunter/gatherers, horticulturalists) adolescence is a time when parenting skills are learned and practiced before reproduction takes place. Bogin argued that the significant differences found in the rates of offspring survival until adulthood among human traditional societies, chimpanzees, and social carnivores such as lions (50%, 35%, and 12% respectively), as well as between first born and next born in other species (e.g., Altmann, 1980), supports the hypothesis that adolescence in humans evolved to provide individuals with the time required to acquire the complex social skills needed to become competent parents.

Goetz, Keltner, and Simon-Thomas (2010) proposed that to guarantee the care needed for the survival of vulnerable offspring, several adaptations were shaped over our species’ evolutionary history: (a) an effective response to neotenous cues and distress

vocalizations; (b) specific tactile behaviors such as skin-to-skin contact; (c) attachment-related behaviors; and (d) the possibility to experience compassionate emotion. In this context, offsprings' signals providing cues to adults regarding their maturity, health, and the degree of urgency of their needs, along with adults' positive attitude toward the children emitting these signals, become important. These cues can be physical (e.g., facial features described by Lorenz, 1943), behavioral (e.g., clumsy movements, smiling, Bowlby, 1969), or vocal (e.g., infants' crying as cues to health, Soltis, 2004).

In recent years, we and our colleagues have investigated the effects on adults' and adolescents' judgments of children for cues of *cognitive immaturity*, analogous to the cues of physical immaturity originally proposed by Lorenz (Bjorklund, Hernández Blasi, & Periss, 2010; Hernández Blasi, Bjorklund, & Ruiz Soler, 2015, 2017; Periss, Hernández Blasi, & Bjorklund, 2012). More specifically, we have investigated the influence that some children's verbalized immature explanations of ordinary phenomena (e.g., why clouds block the sun; why some mountain have big and small peaks) have on adults' and adolescents' perception of them. We have found that some forms of immature cognition, such as those described by Piaget (1926) typifying the preoperational period (e.g., *animism*, "The sun's not out today because it's mad"; *finalism*, "The big peak is for long walks, and the small peak is for short walks"), have positive effects on adults' and older adolescents' (14 to 17 years old) perception of children, but not on younger adolescents (10 to 13 years old). In contrast, other forms of immature cognition (e.g., overestimating one's performance, "I can remember all 20 words!"; having difficulty inhibiting responses, "I couldn't avoid peeking in the box!"), had negative effects on adults' and both younger and older adolescents' judgments of the children professing them. We labeled the former type of immature cognition *supernatural thinking* (because it seems to share a supernatural or magical explanation of a natural phenomenon), and the latter type of immature cognition *natural thinking*. We have also found that the effects of children's supernatural thinking on adults' judgments prevail over the effect of facial cues when presented together (Hernández Blasi et al., 2015, 2017).

We suggested (Bjorklund et al., 2010; Periss et al., 2012) that the reason why children's immature supernatural thinking provokes positive reactions (and immature natural thinking does not) might have to do with the fact that some forms of magical causation involved in this type of thinking are characteristic of adults (see Subbotsky, 2014), increasing sympathy and/or empathy toward children who verbalize them. In contrast, immature natural thinking is perceived by adults as a "cognitive error" or mistakes, and therefore is not seen as something endearing in children, provoking negative affect. Moreover, the fact that this pattern is found in older but not younger adolescents is consistent with the preparation of older adolescents for their near future potential role as parents.

One unexplored issue is adolescents' reactions to young children's supernatural thinking when simultaneously presented with physical-appearance cues, i.e., faces. Although one might expect adolescents to display the same pattern as adults (i.e., cognitive cues prevailing over physical cues), such a conclusion may not be warranted. For instance, some research (Fullard & Reiling, 1976) reports that the first significant bias towards "baby-like" faces begins in early adolescence, making tenable that the impact of physical cues will be stronger than the effect of cognitive cues not only during early but also late adolescence, a reversal of

the adult pattern. Alternatively, if as other research has found (e.g., Borgi et al., 2014), a positive sensitivity toward "baby-like" faces is already present in childhood, one might expect that the novelty provided by cognitive cues would be more informative for younger adolescents than physical cues in terms of immaturity status, making their reaction in favor of supernatural-thinking cues over physical cues even stronger than found in adults.

The main objective of this study was to determine if the advantage provided by children's cognitive over facial cues on adults' reactions toward children, documented and replicated for adults (Hernández Blasi et al., 2015, 2017), is also present in adolescence; and if so, if the effect varies for younger (10 to 13 years old) and older (14 to 17 years old) adolescents, consistent with patterns of judgments for natural and supernatural vignettes reported by Periss et al. (2012). No prediction about sex differences was made, given the inconsistencies found in our previous studies regarding this variable.

Method

Participants

The sample comprised 245 10- to 17-year-old adolescents, recruited from several public and private schools in Castellón, Spain. They represented a broad range of backgrounds and socioeconomic levels. We divided participants into two groups: younger adolescents, ages 10 to 13 years ($n = 115$, 51 boys; $M = 12.0$ years, $SD = 1.3$), and older adolescents, ages 14 to 17 years ($n = 130$, 69 boys; $M = 16.3$ years, $SD = 0.8$).

Instruments

The methodology and questionnaires were based on Hernández Blasi et al. (2015). Questionnaires were booklets composed of four double-sided pages, with a cover page where simple instructions were provided, and age, gender, and educational level of the participant was recorded. In the rest of pages, four pair-comparisons were presented successively so that, for each pair, participants could see simultaneously two children's pictures in high quality resolution located on their left side, and a listing of 14 traits or short statements about these children on their right side. Participants were assigned to three between-subjects conditions: Consistent, Inconsistent, and Faces-Only. In the first two conditions, questionnaires were composed of four pair-comparisons that included both a vignette and a photograph of a child's face. Two of these pairs included a vignette attributed to a child expressing immature *supernatural thinking* (e.g., *animism*, "The sun's not out today because it's mad") and a vignette attributed to a child expressing mature cognition (e.g., "The sun's not out today because clouds are blocking it"). The other two pairs included vignettes attributed to a child expressing immature *natural thinking* (e.g., *overestimation*, "I can remember all 20 cards!") and a vignette expressing a mature version of the same thought (e.g., "I can remember 6 or 7 cards").

In the Consistent condition (39 younger adolescents, 44 older adolescents), each immature vignette was matched with a photo of a child's face manipulated to resemble approximately a 4- to 7-year-old child, whereas each mature vignette was matched with a photo of the same child manipulated to resemble approximately an 8- to 10-year-old child. In the Inconsistent condition (37 younger adolescents, 41 older adolescents), each immature vignette was

matched with the photo of the mature child's face, whereas each mature vignette was matched with the photo of the immature child's face. In the Faces-Only condition (39 younger adolescents, 45 older adolescents), only immature vs. mature photographs of the same child were depicted. For each participant, two of the pairs were boys and two were girls. The procedure for morphing and selecting the photos of the children are described in detail in Hernández Blasi et al. (2015).

For every pair-comparison in each condition, adolescents decided which of the two children illustrated better a series of 14 traits, reflecting a wide range of characteristics potentially relevant in interactions with young children. Based on principal-component analyses of our previous studies for Spanish samples (Hernández Blasi et al., 2017; Periss et al., 2012), we organized these traits into four main groups: Positive Affect (*Cute, Friendly, Nice, Likeable*), Negative Affect (*Sneaky, Likely to lie, Feel more angry with, Feel more irritated with*), Intelligence (*Smart, Intelligent*), and Helpless (*Helpless, Feel more protective towards, Feel like helping*). (The item *Curious* did not load highly on any factor and was not included in subsequent analyses).

Procedure

Questionnaires were administered in small groups in quiet rooms by school personnel under researchers' supervision and with both the parents' and adolescents' consent. The different questionnaire versions of each condition were assigned at random to the participants.

Data analysis

Participants' choices were coded as 1 when they selected the child represented by the immature vignettes and 0 when they selected the child represented by the mature vignettes. In the Faces-Only condition responses were coded as 1 when participants selected the immature face and 0 when they selected the mature face. Thus, mean scores greater than 0.5 indicate that participants selected the immature vignettes (in the Faces+Vignettes conditions) or the immature faces (in the Faces-Only condition) more often, whereas scores less than 0.5 indicate that participants selected the mature vignettes (in the Faces+Vignettes conditions) or the mature faces (in the Faces-Only condition) more often. Initial analyses (two-tailed, single-sample *t* tests) indicated whether immature or mature children were selected significantly different than expected by chance (.50) for each age × trait × condition × vignette-type cell (*p* < .05, adjusted for multiple contrasts). To assess further the pattern for the various age groups, conditions, and traits, we computed a series of ANOVAs, first for the Faces-Only condition, and then for contrasting patterns between the Consistent and Inconsistent conditions.

Results

Table 1 presents the mean scores by age (Younger Adolescents, Older Adolescents), trait dimension (Positive Affect, Negative Affect, Intelligence, Helpless), and condition (Consistent, Inconsistent, Faces-Only), separately for Supernatural and Natural

Table 1
Proportion of participants selecting the immature face (Faces-Only condition) or the child expressing immature cognition (other conditions) by trait dimension, condition, vignette type, and age group (standard deviations in parenthesis)

		Positive affect		Negative affect		Intelligence		Helpless	
		Super Natural	Natural						
Faces-Only (n = 39)	Younger adolescents (10-13 years)	.67 ^a (.15)		.44 (.29)		.50 (.31)		.44 (.26)	
	(n = 45)	.66 ^a (.21)		.55 (.26)		.49 (.23)		.43 (.26)	
	(n = 66)	.68 ^a (.21)		.57 (.26)		.51 (.26)		.47 (.29)	
Consistent (n = 39)	Younger adolescents (10-13 years)	.58 (.29)	.57 (.21)	.65 ^a (.27)	.57 (.22)	.13 ^b (.24)	.36 ^b (.22)	.67 ^a (.29)	.49 (.24)
	(n = 44)	.71 ^a (.24)	.43 (.26)	.54 (.32)	.77 ^a (.22)	.10 ^b (.20)	.35 ^b (.31)	.76 ^a (.26)	.46 (.27)
	(n = 60)	.72 ^a (.27)	.43 (.25)	.56 (.29)	.76 ^a (.22)	.17 ^b (.27)	.38 (.32)	.76 ^a (.31)	.45 (.30)
Inconsistent (n = 37)	Younger adolescents (10-13 years)	.44 (.26)	.26 ^b (.22)	.65 ^a (.23)	.73 ^a (.23)	.14 ^b (.22)	.33 ^b (.22)	.67 ^a (.30)	.55 (.26)
	(n = 41)	.62 ^a (.31)	.31 ^b (.21)	.46 (.35)	.63 ^a (.30)	.10 ^b (.21)	.37 ^b (.28)	.85 ^a (.26)	.52 (.29)
	(n = 55)	.59 (.29)	.31 ^b (.21)	.48 (.31)	.72 ^a (.26)	.17 ^b (.22)	.29 ^b (.27)	.79 ^a (.29)	.53 (.31)
Vignettes-Only (n = 132)	Younger adolescents (10-13 years) (Periss et al., 2012)	.51 (.29)	.40 ^b (.29)	.64 ^a (.30)	.65 ^a (.32)	.17 ^b (.25)	.28 ^b (.41)	.73 ^a (.30)	.46 ^b (.35)
	(n = 302)	.65 ^a (.31)	.34 ^b (.31)	.57 ^a (.34)	.71 ^a (.34)	.11 ^b (.27)	.33 ^b (.39)	.80 ^a (.31)	.50 (.40)
	(n = 151)	.68 ^a (.27)	.28 ^b (.24)	.53 (.28)	.81 ^a (.21)	.11 ^b (.20)	.36 ^b (.34)	.77 ^a (.24)	.28 ^b (.26)

Note: ^a selecting an immature child significantly greater than expected by chance; ^b selecting a mature child significantly greater than expected by chance; *p* = .000-.006, excepting for *, where respectively *p* = .02 and .01; *p* = .002, for Bjorklund et al. (2010) and Periss et al. (2012); *p* < .001, for Hernández Blasi et al. (2015); ¹Data organized on the basis of a different factor analyses from Bjorklund et al. (2010) (see note in Hernández Blasi et al., 2015, p. 519)

vignette-types. Table 1 also presents mean values for Spanish adult samples from both Bjorklund et al. (2010) and Hernández Blasi et al. (2015), and the Spanish adolescent sample from Periss et al. (2012).

Faces-Only Condition

Both younger and older adolescents selected the immature child significantly greater than chance for the Positive-Affect trait dimension and exhibited no bias towards either child for the Negative-Affect, Intelligence, and Helpless traits.

Consistent and Inconsistent Conditions

Supernatural vignettes. For both the Consistent and Inconsistent conditions, older adolescents selected the immature child more frequently for the Positive-Affect trait and showed no bias towards either the mature or immature child for the Negative-Affect trait. Conversely, younger adolescents selected the immature child more often for the Negative-Affect trait and showed no bias for the Positive-Affect trait. For the Intelligence and Helpless traits, both groups selected significantly more often the mature child for Intelligence and the immature child for the Helpless trait.

Natural vignettes. For the Inconsistent condition, both the younger and older adolescents performed comparably on the Positive-Affect and the Negative-Affect dimensions, with subjects selecting more often the mature child for Positive-Affect items and the immature child for Negative-Affect items. In contrast, in the Consistent condition both the younger and older adolescents failed to exhibit a bias towards either the mature or immature child on the Positive-Affect trait. For the Negative-Affect trait in the Consistent condition, older adolescents selected more often the immature child, but younger adolescents showed no bias towards either the mature or immature child.

Contrasting Consistent, Inconsistent, and Faces-Only Conditions

A 2 (age) \times 2 (gender of participant) \times 2 (photo gender) \times 4 (trait) ANOVA for the Faces-Only condition, with repeated measures on the Photo gender and Trait factors, produced a significant main effect for Trait, $F(2.56, 189.37) = 9.39, p = .000, \eta_p^2 = .11$ (Positive Affect, $M = .67 >$ Negative Affect, $M = .50 =$ Intelligence, $M = .49 =$ Helpless, $M = .44$), and Photo gender, $F(1, 74) = 9.25, p = .003, \eta_p^2 = .11$ (Photos of Boys, $M = .54 >$ Photos of Girls, $M = .50$), as well as a significant Trait \times Photo gender interaction, $F(2.49, 184.53) = 6.98, p = .000, \eta_p^2 = .09$, and a significant Trait \times Gender of participant interaction, $F(3, 74) = 4.25, p = .006, \eta_p^2 = .05$. Subsequent inspection of these interactions indicated a significant Photo gender effect on the Positive-Affect (Photos of Boys, $M = .73 >$ Photos of Girls, $M = .60, p = .000$) and Intelligence (Photos of Boys, $M = .57 >$ Photos of Girls, $M = .43, p = .000$), but not on the Negative-Affect and Helpless traits. A significant effect of Gender of participant was found on the Intelligence dimension (Males, $M = .57 >$ Females, $M = .41, p = .004$).

For the Consistent and Inconsistent conditions, a 2 (age) \times 2 (condition) \times 2 (gender of participant) \times 2 (vignette type) \times 4 (trait) ANOVA, with repeated measures on vignette type and trait was performed. The analysis produced a significant main effect for Trait, $F(2.55, 356.94) = 103.78, p = .000, \eta_p^2 = .43$

(Negative Affect, $M = .63 =$ Helpless, $M = .62 >$ Positive Affect, $M = .49 >$ Intelligence, $M = .23$), Vignette type, $F(1, 140) = 9.96, p = .002, \eta_p^2 = .07$ (Supernatural, $M = .50 >$ Natural, $M = .48$), Condition, $F(1, 140) = 7.50, p = .007, \eta_p^2 = .05$ (Consistent, $M = .51 >$ Inconsistent, $M = .48$), and the following significant interactions: Trait \times Vignette type, $F(2.55, 356.46) = 58.30, p = .000, \eta_p^2 = .29$; Trait \times Condition, $F(2.55, 356.94) = 6.65, p = .001, \eta_p^2 = .05$; Gender of participant \times Age, $F(1, 140) = 5.22, p = .024, \eta_p^2 = .04$; Trait \times Vignette type \times Age, $F(2.55, 356.46) = 8.86, p = .000, \eta_p^2 = .06$; and Trait \times Condition \times Age, $F(2.55, 356.95) = 3.92, p = .013, \eta_p^2 = .03$.

Subsequent inspection of these interactions revealed three noticeable differences between the performance of the younger and older adolescents: (1) there was a slight effect of Gender of participant on global performance for younger adolescents, with females selecting the vignettes associated with the immature child more often than males (Females, $M = .51 >$ Males, $M = .41, p = .004$), but not for older adolescents (Males, $M = .50 =$ Females, $M = .49$); (2) whereas there were no differences for the Consistent condition between younger and older adolescents' performance on any dimension (collapsed over vignettes type), there were differences for the Inconsistent condition, namely on Positive-Affect (Older Adolescents, $M = .46 >$ Younger Adolescents, $M = .35, p = .018$), and Negative-Affect (Younger Adolescents, $M = .70 >$ Older Adolescents, $M = .55, p = .003$) dimensions, but not on the Intelligence and Helpless dimensions; and (3) for the Supernatural vignettes there were significant differences between younger and older adolescents (collapsed across the Consistent and Inconsistent conditions) for the Positive-Affect (Older Adolescents, $M = .66 >$ Younger Adolescents, $M = .51, p = .001$), Negative-Affect (Younger Adolescents, $M = .65 >$ Older Adolescents, $M = .50, p = .002$), and Helpless (Older Adolescents, $M = .80 >$ Younger Adolescents, $M = .67, p = .004$) dimensions, but not for the Intelligence dimension. There were no significant age differences for the Natural vignettes.

Discussion

There were two major findings from our study: First, hypothetical children's cognitive cues had an overall greater impact on adolescents' judgments than facial cues. Namely, in 13 of the 16 outcomes, scores in the Consistent and the Inconsistent conditions were comparable and equivalent to those found by Periss et al. (2012) in a Vignettes-Only condition, for the same two age groups of adolescents studied here (see Table 1). This is quite likely the most noteworthy finding in this study, because it highlights again the dominance of children's cognitive cues over physical cues in determining humans' (this time adolescents') reactions toward the preschool-age children emitting them.

Second, we found a developmental pattern similar to that reported by Periss et al. (2012), with older adolescents displaying the typical adult patterns for both the Natural and Supernatural vignettes, whereas the younger adolescents showed a different pattern. For the Supernatural vignettes, younger adolescents displayed a negative-affect bias toward the immature children and no bias toward either the mature or immature children for Positive Affect. In contrast, older adolescents replicated the adult pattern reported in Bjorklund et al. (2010) and Hernández Blasi et al. (2015), specifically a positive-affect bias toward the immature children and

no bias toward either the mature or immature children for negative-affect items. For the Natural vignettes, there were some differences between conditions. Participants in the Inconsistent condition produced mainly the same pattern found for the Vignettes-Only condition in Periss et al. (2012), with both younger and older adolescents exhibiting a positive-affect bias towards the mature children and a negative-affect bias towards the immature children. Participants in the Consistent condition exhibited a different pattern, with both younger and older adolescents showing no positive-affect bias toward either the mature or immature children, whereas older adolescents exhibited a negative-affect bias towards the immature child, but younger adolescents showed no negative-affect bias towards either the mature or immature children. The difference in positivity bias for immature supernatural thinking and the negativity bias for immature natural thinking between the younger and older adolescents can be seen in Figure 1, which shows the average difference between Positive- and Negative-Affect scores. Results from adults from Hernández Blasi et al. (2015) are shown for comparison purposes.

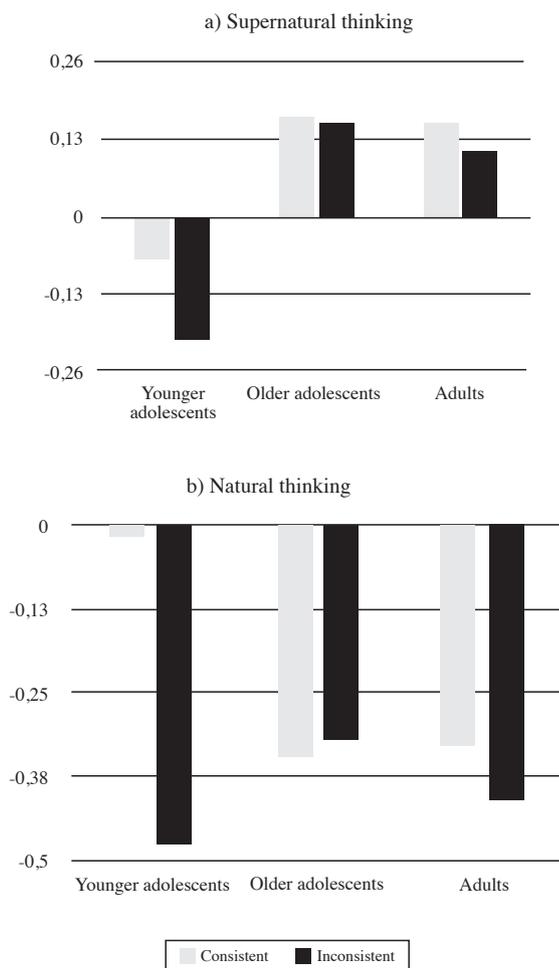


Figure 1. Mean difference between Positive-Affect and Negative-Affect scores for supernatural (a) and natural thinking (b) vignettes depending on whether they were or were not consistently matched with mature/immature children's faces. Positive values indicate greater positive than negative affect (bias toward mature thinking); negative values indicate greater negative than positive affect (bias toward immature thinking). Adult data from Hernández Blasi et al. (2015)

This differential pattern between conditions suggests, first, that the addition of an inconsistently matched child's face to a vignette reflecting natural cognition had no additional effect on adolescents' reactions towards children, with participants apparently paying more attention to the cognitive cues than to the contradictory physical cues that were simultaneously presented. Second, the pattern of results suggests that the addition of a consistently matched child's face to a vignette reflecting natural cognition does have an interaction effect on adolescents' reactions, apparently reducing a negative-affect bias during early adolescence toward children who verbalize immature cognition, as well as reducing a positive-affect bias during both early and later adolescence towards mature children who verbalize cognitively competent cognition. This is the first evidence in our studies of an interaction between cognitive and physical cues, suggesting that, at least regarding natural thinking during early adolescence, children are actually judged as a whole, with physical cues modulating the effects typically obtained when only cognitive cues are available. We currently do not have a satisfactory explanation for this finding, either from a developmental or an evolutionary perspective, making it worthy of replication and further study.

How might one explain the differential reaction of older versus younger adolescents regarding the supernatural immaturity cues found in this study? One possibility is that supernatural immature reasoning evolved (jointly with other cognitive or/and non-cognitive cues not yet identified) to be a particularly significant cue of children's maturational status for older adolescents and adults, given their potential role as a parents and/or close caretakers, compared to younger adolescents (Periss et al., 2012). During early childhood language presumably becomes a more distinctive, powerful, and functionally efficient way for children to convey critical information about themselves to their potential caregivers (albeit often implicitly), in comparison to both physical appearance and vocal cues, which are much more salient and informative during infancy. This interpretation is consistent with some theories within evolutionary biology (e.g., Dawkins & Guilford, 1991) that stress the importance that proper signaling between and within species has for survival and development.

The feasibility of this interpretation should be grounded on further research providing convergent evidence. We do not have yet data available, for example, about the sensitivity of both children younger than the ones studied here and adults in the post-childbearing years towards young children's supernatural thinking, nor about how this sensitivity to young children's supernatural thinking cues varies depending on the timing at puberty, and hence the real possibility of becoming a parent. In absence of further research, this interpretation remains speculative, with other potential explanations to our data open. For example, younger adolescences might have identified themselves as closer in cognitive terms to children verbalizing mature thinking, and therefore perceived as more negative those immature children whom they do not resemble anymore, but still are not so removed from them, developmentally speaking, at least in contrast to older adolescents.

No developmental trend was found on the effects of viewing children's faces on either the younger or older adolescents' reactions. In the Faces-Only condition, both groups of adolescents reacted similarly when only faces were provided, namely, the immature faces produced significantly higher ratings for the Positive-Affect items, whereas there was no bias demonstrated towards either

child for the Negative-Affect, Intelligence, or Helpless dimensions. These results are equivalent to those reported for adults in previous studies (Hernández Blasi et al., 2015, 2017), suggesting that a positive bias towards immature preschool children's faces is present at 10 years of age, 2 years earlier than described by Fullard and Reiling (1976) for "baby-like" faces in their study. Faces of children seem to be an early, pervasive, and powerful cue of children's status in both infancy and early childhood (Franklin & Volk, 2017), although in the latter case: 1) their effects are less critical for provoking positive reactions of both adolescents and adults than some forms of verbalized information (immature supernatural thinking); 2) they seem to interact with other forms of verbalized utterances (natural thinking in younger adolescents); and, 3) contrary to what has typically been found in infancy (e.g., Glocker et al., 2009), they do not seem to be enough by themselves to influence decisions on children's helplessness status, nor, for adults, on negative-affect and intelligence trait attributions.

Some significant gender and photo gender interactions were found for the Faces-Only condition, but again, similar to the only gender effect found on the Faces+Vignettes condition, and to some of the gender effects found in previous studies (e.g., Bjorklund et al., 2010), they are minor, do not change the general pattern of results, and are often difficult to interpret (e.g., male adolescents rating children with immature faces more intelligent, $M = .57$, whereas female adolescents rating children with mature faces more intelligent, $M = .41$).

Results from this study indicate that, from early to late adolescence, an increased sensitivity toward preschoolers' expressions of supernatural thinking develops, increasing both positive affect and helplessness feelings toward them, and therefore the chance that corresponding caregiving behaviors occur. This effect is seen regardless if the faces of these children are available. Immature physical appearance by itself generates a positive-affect reaction in adolescents regardless of their age, but does not seem to be enough to make adult-like judgments on Helpless, Intelligence, and Negative-Affect traits. However, when combined with preschool children's expressions of immature natural thinking, physical appearance seems to have the power of moderating negative-affect reactions towards the children uttering them, at least during early adolescence. Overall this research reinforces the significance of supernatural thinking as a psychological marker of children's maturity status during early childhood, beginning in late adolescence.

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References

- Altmann, J. (1980). *Baboon mothers and infants*. Cambridge, MA: Harvard University Press.
- Bjorklund D. F., Hernández Blasi, C., & Periss, V. A. (2010). Lorenz revisited: The adaptive nature of cognitive immaturity. *Human Nature, 21*, 371-392. doi:10.1007/s12110-010-9099-8
- Bogin, B. (1994). Adolescence in evolutionary perspective. *Acta Paediatrica, 83*(s406), 29-35. doi:10.1111/j.1651-2227.1994.tb13418.x
- Borgi, M., Cogliati-Dezza, I., Brelsford, V., Meints, K., & Cirulli, F. (2014). Baby schema in human and animal faces induces cuteness perception and gaze allocation in children. *Frontiers in Psychology, 5*, 411. doi:10.3389/fpsyg.2014.00411
- Bowlby, J. (1969). *Attachment and loss: Vol. 1. Attachment*. New York: Basic Books.
- Dawkins, M. S., & Guilford, T. C. (1991). The corruption of honest signalling. *Animal Behaviour, 41*, 865-873. doi:10.1016/S0003-3472(05)80353-7
- Fullard, W., & Reiling, A. M. (1976). An investigation of Lorenz's "babyiness." *Child Development, 47*, 1191-1193. doi:10.2307/1128462
- Franklin, P., & Volk, A. A. (2017). A review of infants' and children's facial cues' influence on adults' perceptions and behaviors. *Evolutionary Behavioral Sciences*. Advance online publication. http://dx.doi:10.1037/ebs0000108
- Glocker, M. L., Langleben, D. D., Ruparel, K., Loughead, J. W., Gur, R. C., & Sachser, N. (2009). Baby schema in infant faces induces cuteness perception and motivation for caretaking in adults. *Ethology, 115*, 257-263. doi:10.1111/j.1439-0310.2008.01603.x
- Goetz, J. L., Keltner, D., & Simon-Thomas, E. (2010). Compassion: An evolutionary analysis and empirical review. *Psychological Bulletin, 136*, 351-374. doi:10.1037/a0018807
- Hernández Blasi, C., Bjorklund, D. F., & Ruiz Soler, M. (2015). Cognitive cues are more compelling than facial cues in determining adults' reactions towards young children. *Evolutionary Psychology, 13*, 511-530. doi:10.1177/147470491501300212
- Hernández Blasi, C., Bjorklund, D. F., & Ruiz Soler, M. (2017). Children's supernatural thinking as a signalling behaviour in early childhood. *British Journal of Psychology, 108*, 467-485. doi:10.1111/bjop.12211
- Lancy, D. F. (2015). *The anthropology of childhood: Cherubs, chattel, changelings* (2nd ed.). Cambridge, UK: Cambridge University Press.
- Lorenz, K. (1943). Die angeborenen Formen möglicher Erfahrung (The innate forms of experience). *Zeitschrift für Tierpsychologie, 5*, 235-409. doi:10.1111/j.1439-0310.1943.tb00655.x
- Periss, V., Hernández Blasi, C., & Bjorklund, D. F. (2012). Cognitive "babyiness": Developmental differences in the power of young children's supernatural thinking to influence positive and negative affect. *Developmental Psychology, 48*, 1203-1214. doi:10.1037/a0026979
- Piaget, J. (1926). *Judgment and reasoning in the child*. New York: Harcourt, Brace Jovanovich.
- Soltis, J. (2004). The signal functions of early infant crying. *Behavioral and Brain Sciences, 27*, 443-458. doi:10.1017/S0140525X0400010X
- Subbotsky, E. (2014). The belief in magic in the age of science. *SAGE Open, 4*, 1-17. doi:10.1177/2158244014521433