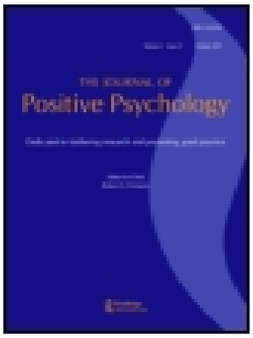

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Overoptimism about future knowledge: Early arrogance?

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ABSTRACT
Three studies explored whether young children (5–7 years) have more optimistic views of their future knowledge than older children (8–12 years) and adults. In Study 1, younger children were more likely than older children and adults to expect greater knowledge in both young and mature protagonists. Both groups of children saw knowledge rising at a faster rate into adulthood than adult participants did. All ages judged moral knowledge as much easier to acquire than other types of knowledge, such as artifacts. In Study 2, all children saw their own future knowledge in especially optimistic terms in comparison to ratings by adults, and the older children exhibited a self-enhancement bias. Study 3 found an overall preference for the acquisition of positively valenced future knowledge, particularly for the 8- to 12-year olds and in the domain of morality, suggesting pragmatic underpinnings for these judgments.

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Optimism; humility; development; cognition; moral knowledge; self-enhancement; intuitive beliefs

Young children tend to see their futures in rosy terms. They see their deficiencies as vanishing over the years and believe that, when they grow up, they will be smarter, more athletic, and more attractive than their peers (Lockhart, Chang, & Story, 2002). These beliefs gradually decline with age and level off during adolescence when the future is seen in more realistic terms. This result is robust across cultures (Lockhart, Nakashima, Inagaki, & Keil, 2008) and is found in several related lines of work (Diesendruck & Lindenbaum, 2009; Droege & Stipek, 1993). This optimism may arise from a cognitive protective mechanism that distorts the future so that young children will continue to try to succeed even when faced with the omnipresent failures of youth (Bjorklund & Green, 1992).

Childhood overoptimism occurs for physical traits (e.g. height), for physical/behavioral traits (e.g. gross motor coordination), and for psychological traits (e.g. shyness). These are relatively stable attributes of individuals that might be viewed as essential characteristics of a person's identity. Here, we ask if overoptimism extends to knowledge, which is constantly expanding (subject to constraints of memory), and is not a fixed essence. Do younger children see an excessively optimistic future in which they have extraordinary amounts of knowledge?

We predict a youthful overoptimism for knowledge for several reasons. If overoptimism helps maintain motivation in the face of present failures, that function would apply not just to skills and attributes, but also to learning more about the world. In addition since young children are more optimistic about the growth of malleable characteristics such as neatness and kindness (Lockhart et al., 2008), future knowledge, which is also highly malleable, may also be regarded overoptimistically early on.

Children might also be overoptimistic about future knowledge because they have difficulty calibrating their own and others' present knowledge. For example, young children often think that they have always known something that they just recently learned (Taylor, Esbensen, & Bennett, 1994). Children also display a 'meta-ignorance' about their lack of knowledge when they have partial but critically incomplete knowledge (Rohwer, Kloo, & Perner, 2012). More broadly, because greater ignorance often causes larger errors in knowledge overestimation (Dunning, 2011), younger children may be especially prone to misestimate the extent of adults' knowledge. Finally, if children sometimes think of adults as close to omniscient (Piaget, 1929), they may be particularly likely to inflate the end state.

At the same time, young children might not be completely unbridled optimists about their knowledge futures. They do not think that adults are completely omniscient as they see incompetent adults as less likely sources of legitimate information than competent ones (Harris, 2012; Sabbagh & Baldwin, 2001). Even preschoolers are aware that different adults have different areas of expertise in domains such as physical mechanics and biology

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(Lutz & Keil, 2002). Thus, young children are capable of seeing adults as having limits to their knowledge. As epistemic critics, they might be more discerning about knowledge than they are about traits such as athleticism or cheerfulness.

Young children might also adjust their estimates of future knowledge as a function of the kind of knowledge involved, especially for domains that seem to arise less from experience and more from raw intuition. Thus, young children might believe moral knowledge comes more from a good heart than from cognitive sophistication (Danovitch & Keil, 2007; Haidt, 2001) and thereby not expect to see a major change in moral expertise with age. Indeed, they might see moral understanding as high at all ages, especially when rating one's own future moral knowledge.

The potential for a youthful overoptimism about future knowledge bears on the question of whether young children can show intellectual humility (IH). Knowledge overoptimism might reflect a possible lack of IH in that it shows a disregard of plausible constraints on what one can reasonably know. However, such overoptimism in children may not result in the conceit and pretentiousness often associated with a lack of IH (Roberts & Wood, 2003). Young children may be overexuberant about what they can and will know, and may at times even be boastful about their abilities, e.g. 'I know everything about dinosaurs!' (Lockhart et al., 2015); but they may lack the self-reflective and social comparison skills required for feelings of sustained arrogance. Indeed, such potential differences support recent suggestions that a great deal more empirical work is needed to understand the psychological underpinnings of IH (Samuelson, Church, Jarvinen, & Paulus, 2012). For these reasons, if young children do show a clear knowledge overoptimism, that effect in turn helps lay a groundwork for discussions of the extent to which a lack of IH also requires more explicit manifestations of intellectual arrogance.

Here, we describe three studies on childhood overoptimism for knowledge. First, we ask if overoptimism is found in ratings of future knowledge of others, using a method analogous to that used in prior studies showing overoptimism for traits. Based on those prior studies, we predict that younger children will rate a protagonist's future knowledge at a higher level than older children and adults. We also predict that younger children will expect a sharper rate of knowledge growth over development in those areas that are generally judged as more complex by adults, such as artifacts. Younger children might foresee more modest changes in ratings of moral knowledge if it is seen as reflecting something about one's essential nature or 'coming from the heart' (Lockhart, Keil, & Aw, 2013).

Study 2 asks if overoptimism about one's own past and future knowledge mirrors those effects for judgments about others. Here, we predict overoptimism, but we also expect an influence of the first person perspective. We predict overall higher ratings of knowledge because of the general tendency to overestimate one's own ability relative to others (e.g. Guenther & Alicke, 2010).

Finally, Study 3 asks if the affective valence of knowledge influences overoptimism. Young children believe positive physical and psychological traits will stay positive and that negative traits will change to the positive over development (Lockhart et al., 2002, 2008). This bias for positivity could lead to opposing predictions about the acquisition of knowledge that varies in valence. One prediction focuses on the total amount of knowledge mastered, which might lead to a tendency to think that a future self would achieve vast mastery even of highly negative things that might cause distress, such as knowing all the ways one could get food poisoning. An alternative prediction concerns knowledge of things that increase happiness, which could make one overoptimistic about future knowledge that is only pleasant, such as all the ways to make food taste delicious. Thus, overoptimism either could be about all future knowledge or only about knowledge that enhances one's well-being. Because children may weigh valence more than the ways positive knowledge often entails its negative counterparts, they may have reduced optimism about negative knowledge. Overoptimism favoring the acquisition of positively valenced knowledge might also arise from pragmatic considerations, as a person might not want to learn negative information and would devote less time to acquiring it. Given that a full mastery of linguistic pragmatics (which includes abilities to factor in emotional connotations of messages) extends well past childhood (e.g. Bosco, Angeleri, Colle, Sacco, & Bara, 2013), a discounting of negative future knowledge may emerge late rather than being an early bias.

Study 1 – Do children show overoptimism for future knowledge in others?

Study 1 asked if young children's overoptimism for psychological and physical characteristics extends to future states of knowledge.

Method

Participants

Thirty-four 5- to 7-year olds (M_{age} = 6:5; age range = 5:0–7:11, 21 females) and twenty-nine 8- to 10-year-olds (M_{age} = 9:5; age range = 8:0–10:11, 17 females) participated. Children were recruited from elementary schools in Connecticut and were tested individually for 20 min. Additionally, 21 adults (M_{age} = 19.1, age range = 18–22, 11 females), recruited from an undergraduate college

population, participated in the same study. The child sample was approximately 75% white, 13% African-American or black, 6% Asian American, and 6% other. The adult sample was 60% white, 6% African-American or black, 20% Asian, and 14% other.

Stimuli

Participants received 10 knowledge items to evaluate for both 5- and 35-year-old protagonists. Two items each were about knowledge of: complex artifacts (e.g. How much do you think John knows about all the inside parts that make up helicopters and how they work to make helicopters fly?), biological processes (e.g. How much do you think Tony knows about all the parts that make up trees and leaves and how they work to make leaves change color in the fall?), natural phenomena (e.g. How much do you think Bill knows about all the parts that make up thunder and lightning storms and how these parts make thunder and lighting storms happen?), psychological phenomena (e.g. How much do you think Daniel knows about why some children are better liked than others and have more friends?), and moral knowledge (e.g. How much do you think Mary knows about when it's wrong to take other people's things without asking and why that's wrong?). We also included one child-centered knowledge item (How much do you think John knows about the cartoon shows on Saturday morning television and the characters in those shows?) and one adult-centered knowledge item (How much do you think Ann knows about how to start a car and drive it on the highway?). These last two items were included as checks on response biases.

For each of the 24 items, participants were told about a gender-matched individual aged either 5 or 35 and asked how much that person would know about a knowledge item. All knowledge items were about 20 words long and were presented in random order. All knowledge items were phrased in terms of 'why' and 'how' wording that emphasized the knowledge as being about deeper causal structures.

Procedure

Prior to testing, participants were trained on a scale rating the degree of a person's knowledge. The training was based on scales used in prior research (e.g. Mills & Keil, 2004). The scale was from 1 (*Not much at all*) to 5 (*Almost everything*) and each interval depicted a head with a brain bubble inside ranging from (1) a very small amount of the brain bubble filled to (5) a brain bubble completely filled. Four of the youngest children were dropped and replaced for either failing the training or failing to complete the task.

After training, children were told that they would hear about other children and adults and would be asked to rate how much they knew using the scale. For each item, a drawing provided memory support for the item being queried. The drawings were simple line drawings of the items that did not reveal any of the complexity of the system involved.

The pencil-and-paper version for adults included a set of written instructions with the accompanying examples and pictures from the experimenter script. The procedure was otherwise the same.

Results

Scoring

Participants' ratings for the two item types within each of the five domains were summed and averaged resulting in five scores for each protagonist (5 v. 35 years) ranging from 1 (*Not much at all)* to 5 (*Almost everything*). For both the 5- and 35-year-old protagonists, these scores were then collapsed across the five domains and averaged to produce a total knowledge score again ranging from 1 to 5. We also calculated a difference score by subtracting the knowledge estimates for 5-year-old protagonists from those for 35-year-old protagonists both overall and within each domain. These difference scores were a measure of the amount of knowledge increase that participants saw as occurring between the 5- and 35-year-old protagonists.

Optimism for others' future knowledge

A repeated measures ANOVA with the total scores for the 5- and 35-year-old protagonists' knowledge (Protagonist Age) as the within-subjects factor and age (Age Group) as the between-subjects factor revealed a significant effect of protagonist age, $F(1, 81) = 761.63$, $p < .001$, $\eta^2 = .904$. Participants believed the 35-year-old character would have significantly more extensive total knowledge than the 5-year-old character would, *35 year old character M* (3.74, SD = .719) > *5 year old character M* (1.90, SD = .431).

The youngest children were the most optimistic about how much knowledge the protagonists would possess overall, $F(2, 81) = 36.06$, $p < .001$, $\eta^2 = .471$; 5–7 *M* (3.19, SD = .429) > 8–10 *M* (2.69, SD = .314) > Adult *M* (2.38, SD = .267), *Bonferroni*, $p < .02$. An Age Group × Protagonist Age interaction ($F(2, 81) = 18.59$, $p < .001$, $\eta^2 = .315$) revealed that the youngest age group was more optimistic than the older children and adults for the amount of knowledge both the 5- and 35-year-old protagonists would possess; the 8–10-year olds only differed from the adults in their estimations of the 35-year-old protagonist's knowledge: *5-year-old protagonist*: 5–7 *M* (2.16, SD = .476) > 8–10 *M* (1.66, SD = .280) = Adult *M* (1.79, SD = .275); *35-year-old protagonist*: 5–7 *M* (4.22, SD = .540) > 8–10 *M* (3.72, SD = .558) > Adult *M* (2.97, SD = .468), *Bonferroni*, $p < .01$.

A one way ANOVA with the total difference score as the dependent variable and age group as the fixed factor

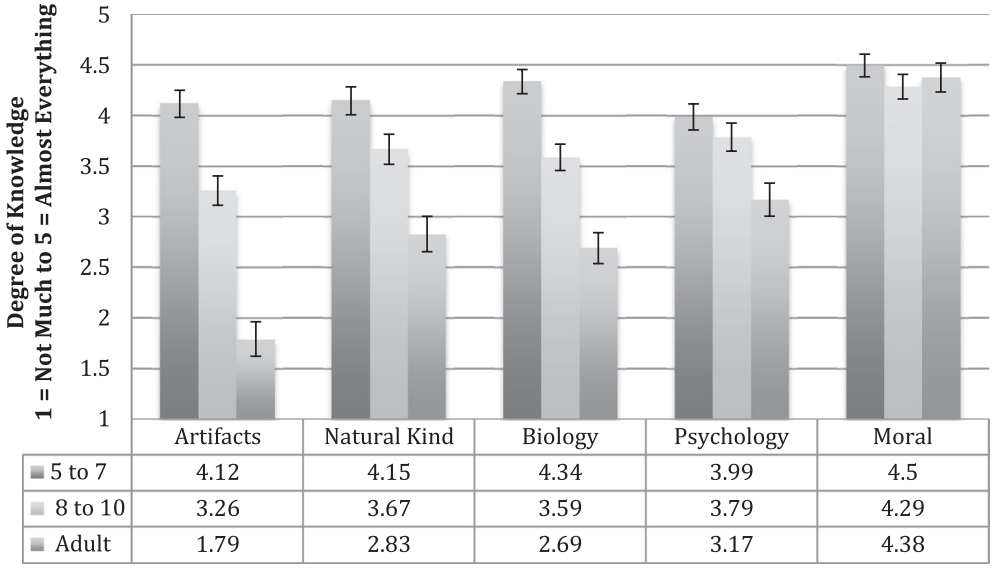

Figure 1. Means of others' knowledge at age 35 by domain and age group.

showed that both groups of children expected greater knowledge acquisition from ages 5 to 35 than adults did, *Difference 35–5*: $F(2, 81) = 18.59$, $p < .001$, $\eta^2 = .315$; 5–7 *M* (2.06, SD = .547), 8–10 *M* (2.06, SD = .620) > Adult *M* (1.17, SD = .558), *Bonferroni*, $p < .05$.

Domain differences for judgments of future knowledge

A repeated measures ANOVA with the ratings of the 35-year-old protagonists' knowledge in the five domains (Domain) as the within subjects factor and age (Age Group) as the between subjects variable revealed a significant effect of domain, $F(4, 324) = 56.01$, $p < .001$, $\eta^2 = .409$. Future moral knowledge was judged overall as the easiest to acquire and knowledge of artifacts was perceived as the most difficult, *Moral M* (4.40, SD = .653) > *Psychology M* (3.71, SD = .811), *Biology M* (3.67, SD = .952), *Natural Kind M* (3.65, SD = .947) > *Artifacts M* (3.24, SD = 1.20), *Bonferroni*, $p < .001$.

A significant Domain × Age interaction ($F(8, 324) = 14.00$, $p < .001$, $\eta^2 = .257$) found that both groups of children were more optimistic than the adults about future knowledge in all domains except morality, on which they did not differ. The youngest children were more optimistic than the older children only about mechanical and biological knowledge (See Figure 1).

A repeated measures ANOVA of domain difference scores as the within-subjects variable (Domain 35–5) and age as the between-subjects factor (Age Group) revealed domain differences in growth of knowledge, $F(4, 324) = 17.82$, $p < .001$, $\eta^2 = .180$. As we predicted, moral knowledge showed the least growth between ages 5 and 35, *Moral M* (1.23, SD = 1.09) < *Psychology M* (1.69, SD = 1.08), *Artifact M* (1.96, SD = 1.06) < *Natural Kind M* (2.15, SD = .904), *Biology M* (2.17, SD = .897), *Bonferroni*, $p < .05$.

Manipulation check

One-way analyses of the difference scores for the cartoon and car check questions produced the predicted results. With increasing age, participants expected the 5-year-old protagonist to know progressively more about cartoons than the 35-year-old protagonist, $F(2, 81) = 10.02$, $p < .001$. The mean difference score (Cartoon 35-5) for 5–7-year olds ($M = -.68$, SD = 2.40) was significantly lower than the difference score for 8–10-year olds ($M = -2.41$, SD = 1.70), which did not differ from that of adults ($M = -2.76$, SD = 1.14). As shown by the negative means, no age group thought the 35-year old would know more than the 5-year old about cartoons. In contrast, all age groups believed the 35-year old would have more knowledge than the 5-year old about how to drive a car (*Car 35 –5 diff. score*: 5–7 *M* (3.74, SD = .511) = 8–10 *M* (3.59, SD = .733) = Adult *M* (3.57, SD = .676), one-sample ts (33, 28, 20) > 26.36, $p < .001$, test value = 0). There was no significant change in the difference scores across ages for the car item, $F(2, 81) = .606$, $p > .548$.

Discussion

As predicted, the youngest children were overoptimistic, believing 5- and 35-year olds would know more than older children and adults judged they would. Moreover, the manipulation check demonstrated that young children were not slavishly bound to seeing adults as always knowing more – they judged that adults might know the same or less than children about cartoon shows. Children saw a sharper rise in knowledge with increasing age than adults

did. Finally, all participants judged future moral knowledge as being greater than knowledge in other domains and saw growth in moral knowledge as more modest over development.

Study 2 – Does overoptimism about one's own future knowledge show a different pattern?

Study 1 showed childhood optimism for future knowledge, with children estimating larger future gains even as they rated initial knowledge equally high or higher. However, actual judgments about one's own past, present, and future knowledge might differ from judgments of others' knowledge. When considering the self, one might inflate one's knowledge higher, especially in the moral domain which could be seen as indicating a 'good person' more than knowing a great deal of content. Study 2 therefore asked participants to rate their *own* knowledge. We predicted that young children would again be the most optimistic in rating their future knowledge, and we expected all participants to show self-enhancement in rating their own future knowledge over that of others, particularly moral knowledge.

Methods

Participants

Forty-six 5- to 7-year olds (M_{age} = 6 :4; range = 5:1–7:7, 30 females) and thirty-five 8- to 10-year olds (M_{age} = 9:1; range = 8:0–10:7, 18 females) participated. Children were recruited from schools and museums in Connecticut and were tested individually in sessions lasing 20 min. Additionally, 26 adults younger than 25 years old (M_{age} = 22:6; range = 18–24, 11 females) participated in the same study on Amazon's Mechanical Turk. The child participants were 88% white, 6% black or African-American, 5% Asian, and 1% Other. Eleven percent of the children were of Hispanic or Latino ethnicity and self-identified as white. The adults were 67% white, 14% Asian, and 6% black or African-American. Hispanics constituted 11% of the sample and all self- identified as white.

Stimuli

Using the same stimuli from Study 1, participants were asked to judge how much they know/knew at age 5 and how much they would know at age 35.

Procedure

Prior to testing, participants were trained on the same 1 (*Not much at all*) to 5 (*Almost everything*) rating scale used in Study 1.

After training, children were told that they would be asked to judge how much they knew (or know) when they were five years old and how much they would know when they were 35 years old. The rest of procedure was identical to that used in Study 1. Nine 5- to 7-year olds, four 8- to 10-year olds, and nine adults were dropped and replaced either for failing the training or failing to complete the task.[1]

Results

Scoring

Responses were scored the same way as in Study 1.

Optimism for own future knowledge

A repeated measures ANOVA with ratings of total knowledge at ages 5 and 35 (Age of Self) as the within-subjects variables and age (Age Group) as the between-subjects factor found that participants believed they would possess significantly more total knowledge at age 35 than at age 5, $F(1, 104) = 990.24$, $p < .001$, $\eta^2 = .905$; *Knowledge at 35 M* (4.02, SD = .572) > *Knowledge at 5 M* (2.17, SD = .532).

As predicted, the youngest age group was the most optimistic about how much knowledge they would possess overall, $F(2, 104) = 54.14$, $p < .001$, $\eta^2 = .510$; 5–7 *M* (3.38, SD = .364) > 8–10 *M* (3.15, SD = .310) > Adult *M* (2.56, SD = .215), *Bonferroni*, $p < .01$. A significant Age of Self x Age Group interaction ($F(2, 104) = 12.56$, $p < .001$, $\eta^2 <= .195$) revealed that for one's own knowledge at age 5, the youngest age group was more optimistic than the older children and adults, who did not differ from one another, *Knowledge at 5*: 5–7 *M* (2.49, SD = .524) > 8–10 *M* (2.02, SD = .416), Adult *M* (1.79, SD = .321), *Bonferroni*, $p < .001$. For ratings of one's own knowledge at 35 years, both groups of children were significantly more optimistic than adults, *Knowledge at 35*: 5–7 *M* (4.23, SD = .462), 8–10 *M* (4.27, SD = .391) > Adult *M* (3.32, SD = .356), *Bonferroni*, $p < .001$.

A one way ANOVA with total difference scores as the dependent variable and age group as the fixed factor showed that the 8- to 10-year-old children expected greater knowledge acquisition from ages 5 to 35 than the younger children and adults did, *Total Difference 35–5*, $F(2, 104) = 12.56$, $p < .001$, $\eta^2 = .195$; 8–10 *M* (2.25, SD = .516) > 5–7 *M* (1.74, SD = .668), Adult *M* (1.53, SD = .524), *Bonferroni*, $p < .05$.

Domain differences in judgments of own future knowledge

A repeated measures ANOVA with the ratings of own knowledge at age 35 in the five domains (Domain) as the within-subjects factor and age (Age Group) as the between-subjects variable found a significant effect of domain, $F(4, 416) = 56.83$, $p < .001$, $\eta^2 = .353$. Moral knowledge was judged as easiest to acquire and knowledge

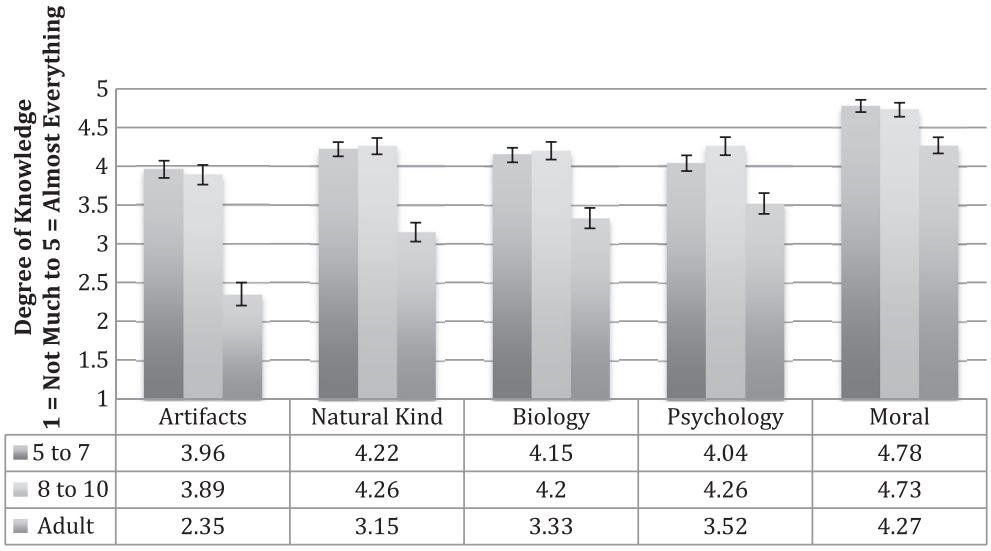

Figure 2. Means of own knowledge at age 35 by domain and age group.

of artifacts was rated the most difficult, *Moral M* (4.64, SD = .570) > *Psychology M* (3.99, SD = .738), *Biology M* (3.97, SD = .759), *Natural Kind M* (3.97, SD = .774) > *Artifacts M* (3.54, SD = 1.01), *Bonferroni*, $p < .05$.

A significant Domain × Age Group interaction ($F(8, 416) = 6.02$, $p < .001$, $\eta^2 = .104$) revealed that both groups of children had similar ratings of future own knowledge and were more optimistic than the adults in all domains except morality, on which the ages did not differ (see Figure 2).

A repeated measures ANOVA of domain difference scores as the within-subjects variable (Domain 35–5) and age as the between-subjects factor (Age group) showed significant domain differences in growth of knowledge, $F(4, 416) = 46.25$, $p < .001$, $\eta^2 = .308$. Knowledge in the moral domain showed a more modest increase between ages 5 and 35 than other domains, *Moral M* (.972, SD = .936) < *Psychology M* (1.90, SD = .973), *Natural Kind M* (2.02, SD = .915), *Biology M* (2.17, SD = .888), *Artifacts M* (2.21, SD = .944), *Bonferroni*, $p < .001$). An Age × Domain 35–5 interaction ($F(8, 416) = 5.64$, $p < .001$, $\eta^2 = .098$) revealed that both groups of children did not differ from adults in their expectations for growth of moral knowledge, but they did expect more knowledge growth in the domain of artifacts, *Artifacts*: 5–7 *M* (2.41, SD = .878), 8–10 *M* (2.64, SD = .753) > Adult *M* (1.25, SD = .570); *Moral*: 5–7: .804 (.946) = 8–10: 1.20 (.833) = Adults: .962 (1.02), *Bonferroni*, $p < .05$.

Self-enhancement in judgments of one's own knowledge (Study 2) v. others' knowledge (Study 1)

In order to investigate differences between ratings of one's own v. others' knowledge at age 5, an ANOVA was conducted with total knowledge ratings at age 5 as the dependent variable and age groups and knowledge type (Others' knowledge (Study 1) v. Own knowledge (Study 2)) as fixed factors. The comparison of the adult sample in Study 2 with the college population in Study 1 seemed reasonable because (1) the Mechanical Turk adult population was selected from a United States-only population and was age restricted to a range analogous to college students (greater than 18 and less than 25, mean = 22:6) and (2) most Mechanical Turk participants in this age range are either college students or recent college students and perform similarly to college students (Paolacci & Chandler, 2014). Likewise, a comparison of the child participants in the first two studies seemed warranted since they were drawn from similar age and demographic groups in Connecticut.

A main effect of knowledge type revealed that participants were significantly more optimistic when rating their own knowledge at age 5 than when rating the knowledge of others, $F(1, 185) = 155.97$, $p < .001$, $\eta^2 = .457$, *Own at 5 M* (2.17, SD = .533) > *Others at 5 M* (1.39, SD = .397). This self-enhancement for knowledge at age 5 was true for all age groups (all *ts* (78, 62, 45) > −7.78, $p < .001$, see Figure 3).

A similar ANOVA examining differences between ratings of one's own and others' knowledge at age 35 showed that overall, participants were more optimistic when rating their own knowledge at age 35 than when rating others' knowledge, $F(1, 185) = 21.68$, $p < .001$, $\eta^2 = .105$; *Own at 35 M* (4.02, SD = .573) > *Others at 35 M* (3.71, SD = .829). A significant Age Group × Knowledge type interaction ($F(2, 185) = 8.69$, $p < .001$, $\eta^2 = .086$) revealed that the 8- to 10-year olds and adults, but not the 5- to 7-year olds, were significantly more optimistic when judging themselves (8–10, Adults, all *ts* (62, 45) > −4.15, $p < .001$; 5–7 year olds, $t(78) = .485$, $p = .629$, see Figure 3).

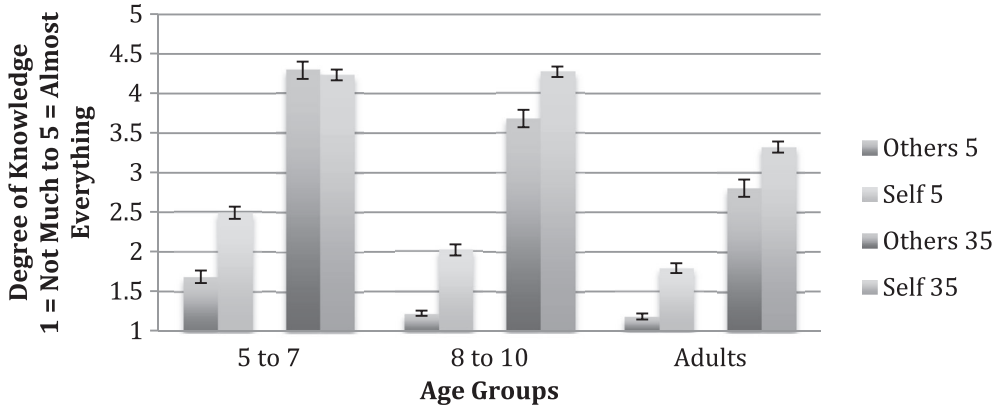

Figure 3. Others (Study 1) vs. self (Study 2) total knowledge at 5 and 35 years.

Discussion

Study 2 replicated the youthful overoptimism effect in Study 1 as well as the domain differences, with especially high estimates and slow growth rates for moral knowledge. A self-enhancement effect was seen in all age groups for ratings of one's own v. others' 5-year-old knowledge. The older participants also showed self-enhancement for one's own future knowledge at age 35. The 5- to 7-year-old group may have not shown self-enhancement at age 35 because of ceiling effects in the rating scale. Because the 5- to 7-year olds did show self-enhancement at age 5, the ceiling effect explanation seems more likely than a lack of self-enhancement presenting just for age 35.

Study 3 – Does the valence of future knowledge matter?

Study 3 explored which of two dimensions is driving overoptimism about future knowledge: a general bias towards the future self's increased competence, or a bias towards only those increased competences that bring about pleasant experiences. In prior studies examining childhood overoptimism for traits (e.g. Lockhart et al., 2002), it was difficult to tease these dimensions apart because it was likely that expressing the positive dimension of a trait, such as being more athletic, was associated not only with greater competence but also with more positive experiences as a result of having that trait. In contrast, expanded future knowledge could easily represent both greater competence and greater anxiety. Greater knowledge about possible complications of common diseases could predict higher anxiety, while less knowledge could predict complacency. In tasks looking at traits, younger children are more likely to see positive characteristics remaining stable over time (Heyman & Giles, 2004; Lockhart et al., 2002) and are more likely to make positive personality attributions on the basis of limited information, often ignoring negative data (Boseovski, 2010). Preferring positively valenced trait information, young children might expect a greater growth of positive knowledge over development, believing it is easier to acquire and also more stable over time (Lockhart et al., 2002). Alternatively, only older participants may consider the pragmatics of not wanting to learn negative information.

Methods

Participants

Ninety-one 5- to 7-year olds (M_{age} = 6:4; range = 5:0–7:9, 39 males) and ninety-one 8- to 12-year olds (M_{age} = 10:4; range = 8:0–12:10, 51 males), participated. Children were recruited from schools and museums in Connecticut and were tested individually for approximately 20 min. The child sample was 77% white, 8% African-American or black, 4% Asian, and 11% other. Fifteen percent of the children were Hispanic or Latino and self-identified as white. Additionally, a restricted age range of 80 adults (M_{age}: 22:7: range 18–29, 48 males) also participated in the same study on Amazon's Mechanical Turk. The adults were 85% white, 10% African-American or black, and 5% Asian. Hispanics comprised 14% of the sample and all self-identified as white. Approximately equal numbers at each age were assigned to either the positive or negative valenced conditions (*Positive/Negative*: 5–7: 45/46; 8–12: 45/46 Adult: 40/40).

Stimuli

Participants evaluated 10 future knowledge items, two each from the five domains used in the previous studies. To test the generality of previous results, the specific items in each domain were new. In one condition participants in each age group received all positively valenced items; in the other condition, participants received all negatively valenced ones. An example pair is as follows:

Positive Sam_1 is 35 years old and grown up. How much do you think he knows about why and how new lakes and rivers might form, creating a home where many animals and plants can grow and live?

Negative Sam_2 is 35 years old and grown up. How much do you think he knows about why and how lakes and rivers might dry up and disappear, leaving a desert where no plants or animals can live or survive?

As in the earlier studies, all knowledge items were about 20 words long. The items were randomly ordered and were presented in terms of 'why' and 'how' phrasing that emphasized knowledge of deeper causal structures.

Procedure

Prior to testing, participants were trained on the same rating scale used in the first two studies. Nine 5- to 7-year olds, two 8- to 12-year olds, and 10 adults were dropped and replaced for failing the training or failing to complete the task.[2] As in Studies 1 and 2, a line drawing of each item was used to maintain attention and to provide memory support. Following each item, participants were asked to rate how much they thought a character who was '35 years old and all grown up' would know using the visual scale.

The MTurk version for adults included a set of written instructions with the accompanying examples and pictures. The procedure was otherwise the same.

Results

Scoring and analysis

Responses were scored in the same manner as in Studies 1 and 2. Repeated measures ANOVA with the ratings of the 35-year-old protagonists' knowledge in the five domains (Domain) as the within-subjects factor and age (Age Group) and valence (Positive/Negative) as the between-subjects variable was conducted.

Optimism for future knowledge

Overall, the youngest children were more optimistic than the older children and adults about how much knowledge a 35-year old would possess, $F(2, 256) = 36.10$, $p < .001$, $\eta^2 = .220$; *5–7 M* (3.56, SD = .547) > 8–12 *M* (3.22, SD = .620) > Adult *M* (2.86, SD = .449), *Bonferroni*, $p < .001$.

Domain differences in future knowledge

As in the first two studies, participants rated 35-year-old characters as knowing more about moral knowledge items than other domains, such as artifacts, $F(4, 1024) = 23.10$, $p < .001$, $\eta^2 = .083$; *Moral M* (3.48, SD = .894) > *Natural Kind M* (3.22, SD = .845), *Psychology M* (3.17, SD = .874) > *Artifacts M* (2.93, SD = .928), *Bonferroni*, $p < .01$; *Moral* > *Biology M* (3.33, SD = .905), $p = .06$.

A Domain × Age interaction ($F(8, 1024) = 6.78$, $p < .001$, $\eta^2 = .050$) revealed that the 5- to 7-year olds were more optimistic than the adults across all domains. The 8- to 12-year olds were only more optimistic than adults in their ratings of natural kind and biological knowledge (*Artifacts*: 5–7 *M* (3.54, SD = .883) > 8–12 *M* (2.75, SD = .893), Adult *M* (2.44, SD = .581); *Natural Kind*: 5–7 *M* (3.37, SD = .871), 8–12 *M* (3.35, SD = .884) > Adult *M* (2.91, SD = .676); *Biology*: 5–7 *M* (3.70, SD = .816), 8–12 *M* (3.46, SD = .965) > Adult *M* (2.75, SD = .606); *Psychology*: 5–7 *M* (3.47, SD = 1.01) = 8–12 *M* (3.13, SD = .784), 8–12 *M* = Adult *M* (2.88, SD = .681); 5–7 > Adult; *Moral*: 5–7 *M* (3.71, SD = .898) = 8–12 *M* (3.40, SD = .984), 5–7 > Adult *M* (3.31, SD = .723), 8–12 = Adult, *Bonferroni*, $p < .05$).

Influence of valence on future knowledge

Positively valenced items were rated overall as more likely to be known at age 35 than negatively valenced ones, $F(1, 256) = 4.76$, $p = .03$, $\eta^2 = .018$, *Positive Valence M* (3.30, SD = .554) > *Negative Valence M* (3.15, SD = .663). Further analysis by age group revealed that 8- to 12-year olds were the only age group to predict a significant difference in overall positive v. negative knowledge at age 35 ($F(1, 89) = 6.38$, $p = .013$, $\eta^2 = .067$, See Figure 4.)

A significant Valence × Domain interaction ($F(4, 1024) = 4.82$, $p = .001$, $\eta^2 = .018$) found the difference between positively and negatively valenced items only reached significance in the moral domain (*Moral*: Positive *M* (3.69, SD = .740) > Negative *M* (3.28. SD = .987): *Artifacts*: Positive *M* (3.04, SD = .905) = Negative *M* (2.82, SD = .941); *Natural Kind*: Positive *M* (3.23, SD = .783) = Negative *M* (3.22, SD = .904); *Biology*: Positive *M* (3.42, SD = .891) = Negative *M* (3.24, SD = .913); *Psychology*: Positive *M* (3.14, SD = .882) = Negative *M* (3.21, SD = .867), *Bonferroni*, $p < .05$).

Discussion

The overoptimism effect found in the youngest children is not influenced by valence, with 5- to 7-year olds expecting high future mastery of both negatively and positively valenced knowledge. The overall valence effect occurred primarily in the 8- to 12-year-old group. Spontaneous comments made by older children suggested that the developmental change arose from the emergence of a pragmatic inference that people would not want to learn negative things. These pragmatic considerations might be minimized later in development as one begins to understand that it is often hard to know the positive dimensions of systems without also knowing their negatives. The pragmatic desire to avoid acquiring negative moral knowledge (i.e. how and why people play unfairly and cheat in games),

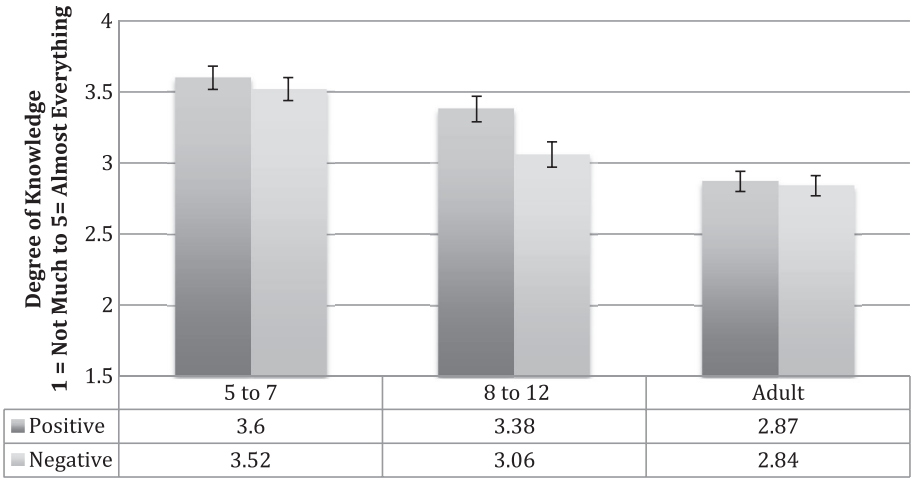

Figure 4. Knowledge at 35 by valence and age group.

however, seems to be maintained by even the oldest participants, hence the valence effect for moral knowledge.

General discussion

Younger children's rosier views of the future extend beyond physical and psychological traits to predictions about depth of understanding. Children may not see adults as omniscient, but they do see them as knowing much more and understanding the world in far better depth than adults themselves believe they do. Eight- to 10-year olds see their own future knowledge in especially rosy terms, predicting steeper knowledge trajectories between 5 and 35 years even though they also rate their own five-year-old knowledge as higher than peers' five-year-old knowledge. Although the youngest children showed such self-enhancement in judging their own knowledge at age 5, ceiling effects may have limited their self-enhancement of knowledge judgments at age 35 as well as the trajectory of their own knowledge growth. In addition, participants at all ages tended to think that people would have an easier time acquiring moral knowledge than knowledge in the sciences or technology. Moreover, the rise in moral understanding with increasing age, although significant, was less than that of other domains, largely because participants rated it high at all ages.

Although there was a significant effect of valence, it was primarily seen in the 8-to 12-year-old age group and in the moral domain. Spontaneous comments from some of the older children revealed that they seemed to be swayed by the pragmatic consideration of not wanting to know or learn negative things, particularly in the moral realm. In contrast, the youngest children did not seem to make such pragmatic inferences. The valence effect disappears in the adults except in the moral domain, perhaps because adults begin to believe that having a deep understanding of one valence in a domain usually entails a good understanding of the other.

These three studies show that overoptimism extends to judgments about the amount of knowledge and understanding that one will acquire in the future, thereby going beyond views of aptitude to inferences about the complexity and richness of future knowledge. These studies therefore both compliment and extend prior work showing overoptimism effects for traits (Diesendruck & Lindenbaum, 2009; Droege & Stipek, 1993; Lockhart et al., 2002, 2008, 2013). Future knowledge might well have been treated differently as it reflects not so much a trait or a skill, but something that is acquired through exposure and motivation and which may be transient as memory fades. For example, many adults acknowledge having once known a foreign language in high school but having largely forgotten it 10 years later. In addition, knowledge is more intangible and depersonalized than traits, which are more closely linked to an individual's personality. Younger children may be less aware of memory decline (e.g. Dufresne & Kobasigawa, 1989) and therefore especially prone to envision a continuously expanding knowledge future.

The domain effects were expected and found across all studies, with the most striking difference for moral knowledge. All age groups in all studies saw smaller or minimal developmental shifts in moral understanding and generally rated moral knowledge as higher at all ages. The age differences argue against a simple ceiling effect, but moral understanding certainly was judged as easier to achieve, perhaps reflecting other findings that people of all ages see moral understanding and expertise as coming more from the heart rather than analytical thought (Danovitch & Keil, 2007; Haidt, 2001).

The self-other differences conformed to the literature on self-enhancement effects and the tendency to think

one is above average. Even with overoptimism effects for both self and others, additional self-enhancement effects still occurred for all children in judging their 5-year-old selves and for the 8- to 10-year olds in judging their 35-year-old selves. Overoptimism is not so strong as to overcome especially high views of one's own present and future abilities, as was apparent in the self-enhancement results.

The effects of valence were unexpected. Younger children might have shown the strongest positive valence effect if a desire for a rosy future meant only knowing good things or things that made one happy. But even the youngest children saw general knowledge competence as a more likely future accomplishment than simply knowing positive things. Around 8–12 years of age, however, children seem to consider the motivational factors that could lead one to avoid learning negative things. Then, as they become still older, these practical factors may be discounted by the assumption that one cannot fully know the positive facets of a phenomenon without also knowing the negative.

Does overoptimism reflect children's beliefs that they can achieve unusually complex and deep understandings of the world around them, or do they simply think that the world is much simpler than it really is and is therefore easy to learn about? We suspect that deflating the complexity of future knowledge is not the primary driver of the effect for several reasons. First, given that overoptimism holds in other studies for such traits as future height or skin complexion where effort is irrelevant (Lockhart et al., 2002, 2008), it does not seem that perceived ease invariably mediates the effect. Second, the consistently rated most difficult domain in our studies, artifacts, also showed one of the largest predicted rises in knowledge with age. If a reduction of perceived complexity was responsible, less overoptimism should occur in the domain viewed as most complex to master. Finally, some children who were very overoptimistic about future knowledge also stated that achieving knowledge often takes tremendous effort and hard work. Thus, while optimistic about the outcome, those children did not trivialize the path to such knowledge.

How can young children have such heavily inflated views of their own knowledge if they also defer more to others (e.g. Harris, 2012)? Although young children do rate their present or recent knowledge higher than older participants rate their former selves, they also envision a steep rise in future knowledge, thus illustrating that they think they still have much to learn. They could, therefore, inflate their current knowledge greatly while also happily deferring to others to learn still more. Overoptimism might actually be linked to a form of deference, namely the belief that one is especially likely to learn a great deal from others. One limitation of these studies is that they only focused on learning over a very long time period of 30 years. Thus, knowledge overoptimism may be driven by an especially idealized view of the adult end state and not of shorter term learning potential. Alternatively, if the overoptimism is playing a motivational role, it might well apply to beliefs about what one could learn over a shorter duration, such as a single year.

Youthful overoptimism may be a mixed blessing. It leads to inflated views of one's knowledge, but this overoptimism does not seem to lead to disdain for others – probably because even though future knowledge is rated highest for oneself, there is still a great deal of overoptimism for peers as well. A non-judgmental overoptimism may motivate learning. If one sees great mastery in one's future, one might be more willing to expend more effort to get there. This effect is supported by related work on 'mindsets' in which children who view the brain as similar to a muscle that can always be grown through practice are more resilient when faced with difficult learning tasks (Yeager & Dweck, 2012). The challenge is not being disappointed when one matures and has not met one's own expectations. Humans may be predisposed to conveniently forget much of their youthful overoptimism and therefore might not notice the discrepancy.

Notes

1. Because many of the child participants in Study 2 were recruited at science and children's museums during the summer months, noise and interruptions resulted in higher drop out/incompletion rates than in Study 1.
2. Because many of the child participants in Study 3 were recruited at science and children's museums during the summer months, noise and interruptions resulted in higher drop out/incompletion rates than in Study 1.

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