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The Developmental Origins of a Disposition Toward Empathy: Genetic and Environmental Contributions

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The authors investigated the development of a disposition toward empathy and its genetic and environmental origins. Young twins' (N = 409 pairs) cognitive (hypothesis testing) and affective (empathic concern) empathy and prosocial behavior in response to simulated pain by mothers and examiners were observed at multiple time points. Children's mean level of empathy and prosociality increased from 14 to 36 months. Positive concurrent and longitudinal correlations indicated that empathy was a relatively stable disposition, generalizing across ages, across its affective and cognitive components, and across mother and examiner. Multivariate genetic analyses showed that genetic effects increased, and that shared environmental effects decreased, with age. Genetic effects contributed to both change and continuity in children's empathy, whereas shared environmental effects contributed to stability and nonshared environmental effects contributed to change. Empathy was associated with prosocial behavior, and this relationship was mainly due to environmental effects.

Keywords: empathy, genetic versus environmental effects, prosocial behavior

Compassion is a dimension of morality that emphasizes concern for the well-being of others in distress. It is an important aspect of interpersonal responsibility and ethical behavior. Empathy and prosociality are essential to the expression of compassion. Developmentally, empathy is present in the first years of life (Zahn-Waxler, Radke-Yarrow, Wagner, & Chapman, 1992) and may play a role in facilitating caring actions reflecting concern for the well-being of others (Eisenberg & Fabes, 1998; Hoffman, 1975). Such actions include helping, providing physical comfort or reassurance, sharing, and sympathizing. Theorists with different approaches (Batson, in press; Eisenberg et al., 1987; de Waal, 2008) characterize empathy as an ideal candidate mechanism to underlie caring behaviors in response to another's pain, need, or distress.

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In this study, we propose that empathy is an enduring disposition, which is relatively stable across time and consistent across contexts and across its cognitive and affective aspects. Empathy includes both cognitive and affective components (Decety & Jackson, 2004; Preston & de Waal, 2002; de Vignemont & Singer, 2006). The cognitive aspect of empathy entails an ability to effectively comprehend a distressing situation and to recognize another's emotions and assume that person's perspective. In young children, it appears in the form of hypothesis testing or inquisitiveness, whereby the child actively tries to understand the other's problem. The affective aspect of empathy requires an individual to experience a vicarious emotional response to others' expressed emotions. In young children, it is seen in emotional expressions of concern for the victim. Both cognitive and affective components are aspects of the same complex construct of empathy, and they are not conceived as independent. For example, Hoffman (1988) referred to empathy as a vicarious affective response that relies on a developed cognitive sense of others.

Our research examined the development of empathy as a stable disposition in the second and third years of life. We assessed both cognitive and affective components of empathy, as well as prosocial behaviors that reflect children's concern for the well-being of others. We addressed the development of empathy and prosocial behavior in boys and girls. Using data from monozygotic and dizygotic twins observed at multiple time points over the second and third years of life, we examined the genetic and environmental contributions to empathic development and to the relationship between empathy and prosocial behavior.

Empathy as a Stable Disposition

Children's empathic responding to others has been linked to several stable personality or temperament traits, such as behavioral inhibition (Young, Fox, & Zahn-Waxler, 1999), positive affectivity (Volbrecht, Lemery-Chalfant, Aksan, Zahn-Waxler, & Goldsmith, 2007), effortful control (Valiente et al., 2004), and concentration and impulse control (Rothbart, Ahadi, & Hershey, 1994). On the basis of longitudinal research, empathy has been conceptualized as part of a broader altruistic or prosocial personality disposition, the roots of which can be found in childhood (Eisenberg et al., 1999). The first goal of this study was to investigate empathy as a stable disposition beginning in the first years of life.

A trait approach to empathy suggests that there is an underlying common empathy disposition that is manifest in both the cognitive (hypothesis testing) and affective (empathic concern) aspects of empathy. Indeed, hypothesis testing and empathic concern are positively correlated (Gill & Calkins, 2003; Young et al., 1999; Zahn-Waxler, Schiro, Robinson, Emde, & Schmitz, 2001; but see Volbrecht et al., 2007). In addition, empathy viewed as a trait entails a degree of continuity across time, as evidenced by longitudinal stability in children's empathy (van der Mark, van IJzendoorn, & Bakermans-Kranenburg, 2002; Volbrecht et al., 2007; Zahn-Waxler, Robinson, & Emde, 1992; Zahn-Waxler et al., 2001). Finally, cross-situational consistency is another important feature of an empathy trait. Indeed, children's empathic concern and hypothesis testing toward an unfamiliar examiner correlate with the same behavior performed toward the mother (Moreno, Klute, & Robinson, in press; Robinson, Zahn-Waxler, & Emde, 2001; Young et al., 1999; but see van der Mark et al., 2002, for empathic concern in Dutch girls) and in response to hearing another child cry (Gill & Calkins, 2003).

On the basis of these considerations, we expected hypothesis testing and empathic concern, toward both mothers and an unfamiliar examiner, to correlate with each other and to load on a common empathy factor at all ages. We also expected this empathy factor to show considerable continuity across time. Taken together, these expectations imply that there is a general underlying empathy factor.

The presence of an underlying empathy factor does not preclude the important influence of situational constraints, and although we expected some consistency in children's behaviors toward their mother and an unfamiliar examiner, such consistency would not be expected to be perfect, because children's dispositions may be manifest differently across contexts (see Mischel & Shoda, 1995). For example, some children may tend to react empathetically to their mother's pain but not to that of an unfamiliar examiner. Similarly, the affective and cognitive aspects of empathy may develop at different rates reflecting partially nonoverlapping brain regions (Singer, 2006), which may be reflected in some children's empathy being more focused on empathic concern and other children's empathy being focused on hypothesis testing. We were interested in the development of specific aspects of empathy (e.g., empathic concern) as well.

Genetic and Environmental Influences on Empathy

The view of empathy as a stable individual differences disposition raises the issue of the sources for these individual differences. The second goal of this study was to investigate the relative genetic and environmental contributions to individual differences in empathy.

Only two studies have addressed directly the issue of the origins of individual differences in children's observed empathy in the first years of life using a genetically informative design. These studies have relied on the twin research design, which allows differentiation between genetic and environmental influences as it compares monozygotic (MZ) twins, who share all of their genes, with dizygotic (DZ) twins, who share on average half of their genes. Assuming that twins of both types share their environments (e.g., the family environment) to the same extent, higher similarity in MZ versus DZ twins indicates genetic influence. An estimate of *heritability* (the proportion of individual differences in the study population under specific conditions that is due to genetic variability) is computed. Twin similarity that is beyond this genetic effect can be attributed to the *shared environment* (environmental influences shared by twins), whereas differences between twins that are not due to genetic differences are ascribed to *nonshared environment* or to measurement error (Plomin, DeFries, McClearn, & McGuffin, 2001).

Volbrecht et al. (2007) estimated the heritability of empathic concern of children aged 19–25 months toward their mother at .30 (although a model with no heritability had a better fit to the data) and that of hypothesis testing at .40. A preliminary study based on a partial sample (60%) of the present study also found moderate genetic effects on empathic concern and hypothesis testing (Zahn-Waxler et al., 2001). Both studies also found evidence of both shared and nonshared environmental influences. We thus expected empathy to be influenced by both genetic and environmental effects.

Empathy is viewed as a broad disposition that generalizes across its cognitive and affective components and across situations. Therefore, at each age, we investigated the genetic and environmental contributions to a common factor (e.g., Rijsdijk & Sham, 2002) of empathy, which encompasses both hypothesis testing and empathic concern toward both the children's mother and an unfamiliar examiner. However, children's responses are not expected to correlate perfectly across contexts and across modalities of empathy. In addition to stability and consistency in children's overall behavior, meaningful variations in how individuals respond to specific contexts may exist (Mischel & Shoda, 1995). Therefore, in addition to general genetic and environment effects relevant to a common factor of empathy, we also investigated the genetic and environmental effects unique to specific instances of empathy.

The Development of Genetic and Environmental Influences on Empathy

As noted, the idea of an empathy disposition entails substantial longitudinal stability. This stability can be the result of stable genetic influences, stable environmental effects, or both (Knafo & Plomin, 2006b). The third goal of this study is to estimate the genetic and environmental contributions to stability in empathy across time. Genetics and the environment can also contribute to change with time. Because children's empathic abilities undergo changes in the first few years of life, it is important to study the contributions to change and stability. Previous research suggests that genetic effects contribute to continuity, but additional new genetic effects accounting for change also emerged as children grew up (Knafo & Plomin, 2006b; Plomin et al., 1993; Zahn-Waxler et al., 2001). Shared environmental effects can also account for both continuity and change. Zahn-Waxler et al. (2001) reported overall continuity in the shared environment effects accounting for children's empathy. Finally, nonshared environmental influences typically contribute to change rather than continuity (Knafo & Plomin, 2006b; Zahn-Waxler et al., 2001). Our longitudinal genetic design enables us to observe the dynamics of genetic and environmental effects in the children's earliest years of life.

Empathy and Prosocial Behavior

Empathy has been described as the motivating impetus behind prosocial behavior in humans and other animals (de Waal, 2008). The cognitive and affective understanding of the suffering of others that empathy entails is characterized by a negative experience and can lead to behavioral efforts to alleviate the distress of the other. In this sense, prosocial behaviors, the intention of which is to promote the welfare of others (Eisenberg & Fabes, 1998), can be seen as a potential outcome of empathy. Investigating the relationship between prosocial behavior and empathy is the fourth goal of this article.

Research on children shows positive relationships between empathy toward a person in distress and prosocial behavior toward that person (e.g., Eisenberg & Fabes, 1998; Young et al., 1999; Zahn-Waxler, Radke-Yarrow, et al., 1992). In addition to the relationship between the empathy experienced at a certain moment and the desire to help the victim, research on children aged 5 to 13 found relationships between children's overall tendency for empathy and their prosocial behavior (e.g., Barnett & Thompson, 1985; Roberts & Strayer, 1996). We expected that, even at younger ages, more empathic children would be more likely to behave prosocially than less empathic children.

As is the case with empathy, there is evidence of moderate genetic influences on individual differences in children's prosocial behavior (Hur & Rushton, 2007; Knafo & Plomin, 2006a, 2006b; Scourfield, John, Martin, & McGuffin, 2004; Zahn-Waxler et al., 2001). Because empathy and prosocial behavior are positively related at the phenotypic level, and because they are both expected to be heritable to a certain extent, we sought to estimate the extent to which this relationship is due to genetic factors that affect both prosocial behavior and empathy. If, for example, the core affective basis of prosocial behavior is the empathy we feel toward others (de Waal, 2008), then genetic effects responsible for affective dispositions implicated in empathy may be responsible for the ensuing prosocial behavior. Similarly, the shared environment may be responsible for this relationship, because the environmental correlates of prosocial behavior and empathy overlap substantially (e.g., parental warmth and sensitivity to children's needs; Hastings, Zahn-Waxler, & McShane, 2006). We examined each of these possibilities.

The Present Study

In this study, we follow up on our earlier work (Zahn-Waxler et al., 2001) with a substantially increased twin sample. An important change from previous work is the focus on empathy as an individual-differences disposition, which characterizes responses to others' distress across contexts, cognitive and affective processes, and time. This focus on overall empathy, and the increased sample size, enabled us to separate the genetic and environmental components common to different aspects of empathy, from those unique to hypothesis testing and empathic concern in different contexts.

We investigated the development of empathy from infancy to early childhood. We did this separately for cognitive and affective components of empathy, considering also the target of children's empathy. In light of previous studies, we expected an increase in empathy with age (Volbrecht et al., 2007; Zahn-Waxler, Radke-Yarrow, et al., 1992; but see van der Mark et al., 2002) and higher empathy toward the mother than toward an examiner (van der Mark et al., 2002; Robinson, Zahn-Waxler, & Emde, 2001; Young et al., 1999; but see Zahn-Waxler, Radke-Yarrow, et al., 1992).

In summary, we had four main goals. First, we investigated empathy as an individual differences variable, focusing on consistency between the affective and cognitive aspects of empathy, between targets, and on continuity across time. Second, we investigated genetic and environmental contributions to individual differences in empathy, both those common to a common empathy factor and those unique to affective empathy or cognitive empathy toward the mother and the examiner. Third, we estimated the contribution of genetic and environmental influences to change and continuity in children's empathy. Finally, we examined the relationship between prosocial behavior and children's empathy and estimated the genetic and environmental contributions to this relationship.

Method

Participants

Twins were recruited from monthly reports of births from the Division of Vital Statistics of the Colorado Department of Health. Twins were selected preferentially for higher birth weight and birth weights appropriate for gestational age. No twins with birth weights less than 1,700 g or with gestational ages less than 34 weeks were selected. More than half of the parents contacted agreed to participate in the study. Over 90% of the sample was White; other participating families were primarily Hispanic, and 1% was African American. Participating parents were slightly older (30 years vs. 28 years, on average) and somewhat more educated (14.5 years vs. 12.5 years) than the average of parents of newborns in Colorado. This study was part of a larger longitudinal, genetically informed investigation of continuity and change in the development of cognition, emotion, and temperament in twins. (See Robinson, McGrath, & Corley, 2001, for greater detail about sampling and design).

Twin zygosity was determined by comparing twins' physical attributes with a modified version of the Nichols and Bilbro (1966) questionnaire, based on having 85% agreement from four or more raters and reliance on twins' sharing 11 highly informative short tandem repeat polymorphisms (Rhea, Gross, Haberstick, & Corley, 2006).

Assessments were made at 14, 20, 24 and 36 months. The original sample included 230 monozygotic (MZ) pairs and 179 dizygotic (DZ) pairs and their families, who participated in at least one of these ages. For the present study, data were available for 391 pairs at 14 months (96% of the total sample), 353 pairs at 20 months (86%), 355 pairs at 24 months (87%), and 341 pairs at 36 months (83%), an adequate retention rate. No differences in twins' sex or zygosity, or in their empathy and prosocial behavior, were observed between families who dropped out of the study after 14 months (the largest drop in participation rate) and those who participated at a later age. At each age, the vast majority of the families (80–84%) participated in both the lab and home visits; a small proportion participated only in the lab visit (2–3%), and a substantial minority (12–17%) participated only in the home visit. To increase reliability of measures and analytic power, we combined data from the lab and home visits.

Procedure

At each measurement point, two female examiners visited the twins and their mothers at home of the participants. One to 3 weeks later, the twin pair was brought to the laboratory by their mother. Visits were scheduled at a time when the children were likely to be at their best, usually after naps or meals. Each visit was completed in less than 3 hr.

Simulation procedures were used to probe for children's empathic capabilities. Four empathy probes at each age are examined in this report. At different points during each visit, the mother and examiner simulated distress according to specified scripts. Emphasis was placed on inserting these events naturally in the context of ongoing activities and in situations in which the other twin was not present. During the home visit, the examiner pretended to close her finger in the suitcase containing testing materials. The mother was instructed to pretend to hurt her knee as she got up from the floor. During the laboratory visit, the mother was instructed to catch her finger in a clipboard and the examiner bumped into a chair, both expressing pain. In all simulations, the mothers (and examiners) were instructed to accompany the simulated injury with rubbing of the injured body part, vocalizing pain at low-to-moderate volume, and a pained facial expression over a 30-s period with a gradual subsiding of the distress for an additional 30 s. Direct eye contact was always avoided to prevent the subtle induction of a response from the child.

These empathy probes are a widely used procedure for assessing children's empathy (e.g., Gill & Calkins, 2003; Moreno et al., in press; van der Mark et al., 2002; Volbrecht et al., 2007; Young et al., 1999; Zahn-Waxler, Radke-Yarrow, et al., 1992; Zahn-Waxler, Robinson, & Emde, 1992). Simulations were scored for credibility. Virtually all of the examiners' simulations were rated as credible, whereas 95% of mothers' simulations were so rated. The high credibility rates reflected the fact that mothers and examiners had received specific training in how to carry out these procedures.

Measures

Children's reactions to the empathy probes were videotaped, and all scoring and reliability coding was done from these tapes. Video cameras zoomed in on the children's upper bodies during these simulations so that hands and faces were clearly visible for coding. Observers used multiple passes to ascertain and clarify children's various emotional responses. The codes for the components are based on previous research (Zahn-Waxler, Radke-Yarrow, et al., 1992), with some extensions and adaptations. Each twin in a dyad was assigned to a different observer to keep coders uninformed of the child's zygosity and unbiased by the other twin's responses. Interobserver reliability was checked periodically, typically once every 6 months, although checks occurred more frequently when new observers were trained. Reliabilities were estimated from independent scoring of 236 distress simulations. Observer reliabilities for empathic concern and hypothesis testing were computed as polychoric correlations (used for ordinal scales) and were .87 and .79, respectively. Reliability for prosocial behavior was computed as a tetrachoric correlation (used for dichotomous scales) and was .91.

Empathic concern. Expressions of apparent concern for the victim, including facial, vocal, or gestural–postural expressions were rated on a 4-point scale on which 1 = *absent*, 2 = *slight* (fleeting or slight change of expression that includes brow furrow), 3 = *moderate* (sustained sobering of expression that includes brow furrow), 4 = *substantial* (sustained sadness expressed in cooing or sympathetic vocal tones or sympathy face in which eyebrows are drawn down and brow drawn up over the nose). Children's responses in the distress simulations at the lab and home correlated positively (across ages, for mothers, $r = .24$ on average; for examiners, $r = .16$) and were averaged to increase reliability and reduce the number of analyses.

Hypothesis testing. Behaviors in which the child explores and/or attempts to comprehend distress were rated on a 4-point scale on which 1 = *none*, 2 = *simple nonverbal* (e.g., looking from injury to victim's face) *or verbal* (e.g., a single utterance, "Hurt?"), 3 = *combinations of nonverbal and verbal exploration* (e.g., looking at the injury and its cause and inquiring "Owie?"), and 4 = *repeated, sophisticated attempts to comprehend the problem* (e.g., asking, "Does it hurt? Did you pinch it?" or looking behind or underneath the injury to ascertain cause). Scores from the lab and home simulations correlated (across ages, for mothers, $r = .26$ on average; for examiners, $r = .41$) and were averaged to reduce the number of analyses.

Prosocial behavior. Efforts to help or comfort the mother or examiner (e.g., attempts to comfort and distract the victim, getting a bandage, patting the victim, sharing or offering a toy, or defending the victim by hitting the offending object, such as the clipboard) were noted as prosocial acts. At each age, prosocial behavior was coded if it occurred at least once, either in the lab situation or in the home situation. The scores of children participating only at home or at the lab were based on this single visit.

Results

Descriptive Statistics for the Empathy Scores

All frequency and mean comparisons and correlational analyses were performed with SPSS software, Version 14.0. Because twin scores are not independent of each other, the scores of only one twin per pair, randomly chosen, were used in the descriptive analyses and in the within-twin correlations (similar results were obtained with data from the other twin in each pair). Preliminary analyses showed that MZ and DZ twins did not differ in hypothesis testing or empathic concern. In addition, no significant interaction was found between zygosity and age, sex, distress victim (mother/examiner), or aspect of empathy (hypothesis testing or empathic concern) in affecting empathy levels. We therefore dropped the zygosity variable from the mean comparison analyses.

Table 1 presents the means and standard deviations of scores for the two aspects of empathy (hypothesis testing and empathic concern) toward mothers and examiners at ages 14, 20, 24, and 36 months, separately for girls and boys. Two repeated measures three-way analyses of variance (ANOVAs; 4 [age group] × 2 [sexes] × 2 [distress victims]) were conducted, one for hypothesis testing and one for empathic concern. In the analysis model for each dependent measure, the overall tests for the three-way interactions were not significant, $F\text{s} < 1$.

Age effects. There were marked increases in empathy with age for both hypothesis testing, $F(3, 290) = 143.40$, $p < .001$; and empathic concern, $F(3, 290) = 41.05$, $p < .001$. We plotted these increases (see Figure 1, upper panel) using estimated marginal means and their 95% confidence intervals. (The lower panel of Figure 1 shows empathy levels plotted separately for boys and girls and for mothers and examiners.) The increase in empathic concern took place mainly from age 14 months to 20 months, whereas hypothesis testing increased steadily through age 36 months.

Mother versus examiner. Hypothesis testing was more pronounced toward mothers than toward examiners, $F(1, 290) = 71.52$, $p < .001$. Significant interactions between age and distress victim suggest that this difference between mother and examiner varied with age, $F(3, 290) = 23.37$, $p < .001$. In post hoc repeated contrasts, hypothesis testing was more prevalent toward the examiner at 14 months, $t(290) = -2.79$, $p < .01$; but more prevalent for mothers at 20 months, $t(290) = 3.95$, $p < .001$; 24 months, $t(290) = 7.61$, $p < .001$; and 36 months, $t(290) = 6.17$, $p < .001$. Overall, empathic concern was slightly higher for the examiner at most ages, $F(1, 290) = 10.30$, $p < .001$ (at 14 months, $t[290] = -4.91$, $p < .001$; at 24 months, $t[290] = -1.52$, *ns*; at 36 months, $t[290] = -2.20$, $p < .05$); but higher empathic concern toward mothers was found at 20 months, $t(290) = 1.69$, *ns* (followed by a slight decrease in empathic concern toward mothers at later ages; see Figure 1B), resulting in a significant interaction between age and distress victim, $F(3, 290) = 7.86$, $p < .001$.

Sex differences. Girls scored higher than boys on empathic concern, $F(1, 290) = 6.37$, $p < .05$. This sex difference was stable and did not interact with age, $F(3, 870) = 1.08$, *ns*; or with the distress victim, $F(1, 290) = 0.30$, *ns*. Although there was not a main effect of sex on hypothesis testing, there was a Sex × Age interaction, $F(3, 870) = 3.77$, $p < .05$. Girls tended to score higher in hypothesis testing at younger ages than boys (although these effects were not significant; at 14 months, $t[290] = 0.84$; at 20 months, $t[290] = 0.70$; at 24 months, $t[290] = 0.65$; all *ns*), whereas boys scored somewhat higher than girls by 36 months, $t(290) = -2.13$, $p < .05$ (this difference favoring boys at 36 months was not replicated when the analyses were conducted with the other twin). The sex of the child also interacted with the distress victim, $F(1, 290) = 7.77$, $p < .01$. Both girls, $t(141) = 8.07$, $p < .001$; and boys, $t(149) = 3.96$, $p < .001$, showed more hypothesis testing toward their mother than the examiner, but this difference was stronger for girls ($D = 1.36$ vs. 0.65, respectively).

Table 1
Means (and Standard Deviations) for Empathy of Children Toward the Mother or the Examiner

Children and age (months)	Empathic concern		Hypothesis testing	
	Examiner	Mother	Examiner	Mother
Boys				
14	2.26 (0.49)	2.10 (0.56)	2.27 (0.49)	2.15 (0.47)
20	2.48 (0.55)	2.52 (0.67)	2.34 (0.51)	2.40 (0.63)
24	2.51 (0.50)	2.41 (0.58)	2.56 (0.56)	2.79 (0.68)
36	2.61 (0.51)	2.52 (0.62)	2.74 (0.66)	3.00 (0.75)
Girls				
14	2.38 (0.54)	2.18 (0.66)	2.27 (0.47)	2.24 (0.49)
20	2.56 (0.52)	2.64 (0.66)	2.32 (0.50)	2.50 (0.58)
24	2.59 (0.51)	2.58 (0.57)	2.53 (0.52)	2.90 (0.63)
36	2.62 (0.50)	2.53 (0.60)	2.56 (0.61)	2.92 (0.69)

Evidence for Empathy as a Stable Disposition

An examination of the correlations between children's empathy toward their mother and the examiner enabled us to investigate the stability of children's empathic tendencies. Table 2 presents the correlations between children's empathic concern and hypothesis testing toward the mother and the examiner. For empathic concern, the correlation between behavior toward the mother and toward the examiner averaged .36 across the four age groups and was lowest at 36 months (.26). Mother–examiner hypothesis testing correlations averaged .43 across ages and also were lowest at 36 months (.25).

The affective component (empathic concern) and the cognitive component (hypothesis testing) of empathy also correlated positively as predicted. Correlations for empathy toward the examiner averaged .32 across ages and were lowest at 36 months (.27). Correlations for the mother averaged .48 and were lowest at 36 months (.40). The overall picture is that of stability in empathy toward the examiner and the mother, across the affective and cognitive components of empathy, and a stability that declines at 36 months. These results are consistent with the hypothesized general latent empathy factor that is common to empathic concern and hypothesis testing and toward mother and examiner, described later.

The longitudinal correlations between children's empathy at the different ages appear in Table 3. All correlations between adjacent measurement points were positive and significant, indicating some continuity in children's empathy. The average correlation from 14 to 20 months and from 20 to 24 months was .29. Correlation across the 12-month gap from 24 to 36 months averaged .21. Even correlations from 14 to 36 months tended to be positive, averaging .15, although they were not significant for empathic concern (see Table 3).

As a direct test of the idea of empathy as a dispositional variable, we ran a principal components analysis, separately at each age. At all ages, a single factor emerged, on which all four empathy indicators (empathic concern and hypothesis testing toward the mother and the examiner) loaded, with loadings ranging from .58 to .80. This single factor accounted for a substantial proportion of the variance at all ages (at 14 months, 51%; at 20 months, 55%; at 24 months, 51%; at 36 months, 42%).

We further tested longitudinal stability with structural equation modeling (SEM), using the AMOS statistical package (Arbuckle, 1997). At each age, hypothesis testing and empathic concern

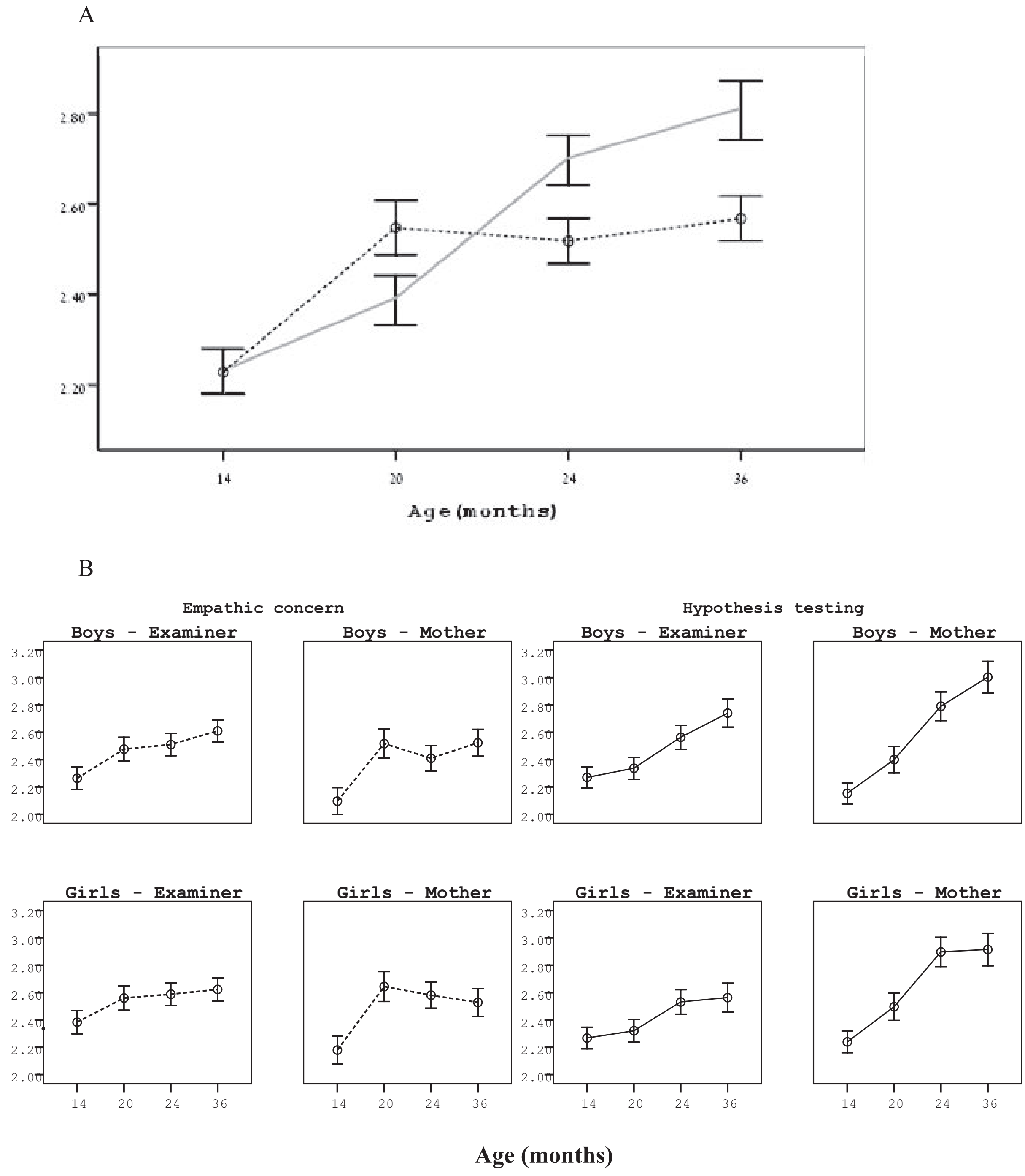

Figure 1. Means (and 95% confidence intervals) of empathic concern (dashed line) and hypothesis testing (solid line) scores across ages. (A) Empathic concern and hypothesis testing across children's gender and mothers/examiners. (B) Results presented separately for girls and boys and for mothers and examiners.

toward the mother and the examiner were modeled as loading on a single empathy factor. We permitted correlated errors between empathic concern toward the mother and the examiner and between empathic concern and hypothesis testing toward the mother. The analysis showed that all the indicators loaded significantly on their hypothesized age-specific latent factors ($p < .001$), with standardized loadings ranging from .15 to .86. The overall fit of the model with age-specific factors, allowing for the correlated errors, was good: The comparative fit index was .96, and the root mean square error of approximation (RMSEA) was .04. These results support empathy as an age-specific disposition. In addition, the longitudinal stability of the common empathy factor was high,

Table 2
Correlations Between Empathic Concern and Hypothesis Testing Toward the Mother and the Examiner

Age and aspect of empathy toward mother/examiner	Empathic concern: Examiner	Empathic concern: Mother	Hypothesis testing: Examiner
14 months			
Empathic concern: Mother	.31**		
Hypothesis testing: Examiner	.33**	.21**	
Hypothesis testing: Mother	.17**	.49**	.51**
20 months			
Empathic concern: Mother	.46**		
Hypothesis testing: Examiner	.38**	.28**	
Hypothesis testing: Mother	.24**	.50**	.54**
24 months			
Empathic concern: Mother	.39**		
Hypothesis testing: Examiner	.28**	.23**	
Hypothesis testing: Mother	.21**	.52**	.40**
36 months			
Empathic concern: Mother	.26**		
Hypothesis testing: Examiner	.27**	.08	
Hypothesis testing: Mother	.10	.40**	.25**

** $p < .01$.

with the empathy factor at each age predicting a substantial proportion of the variance at the following measurement ages: At 14 to 20 months, $\beta = 0.76$, $t = 8.16$, $p < .001$, $R^2 = .58$; at 20 to 24 months, $\beta = 0.75$, $t = 5.89$, $p < .001$, $R^2 = .57$; at 24 to 36 months, $\beta = 0.57$, $t = 7.47$, $p < .001$, $R^2 = .32$.

Genetic and Environmental Influences on Empathy

To examine genetic and environmental influences on empathy at each of the four ages, we first compared twin intraclass correlations obtained within MZ and DZ pairs, as presented in Table 4. At 14 months, the average correlation for MZ pairs was .35, whereas that of DZ pairs was .32. At 20 months, the average MZ twin correlation was .30 and was .33 for DZ pairs. Positive correlations that are similar in size for DZ and MZ twin pairs suggest that twin resemblance at these ages is mainly due to shared environment and not to genetic effects.

A different pattern was found in the later ages. At 24 and 36 months, the average MZ twin intraclass correlations were .35 and .33, respectively. The corresponding correlations for DZ twins were .22 and .19, respectively. This difference in the magnitude of correlations between MZ and DZ twins suggests a genetic influence on empathy that becomes stronger with age.

As a more direct test of genetic and environmental effects, we used the common-factor common-pathways multivariate model (e.g., Rijsdijk & Sham, 2002). The model assumes that there is an underlying common factor accounting for individual differences across the different empathy indices and provides an estimate of the proportion of variance in each measure of empathy associated with the common factor. In addition, the model estimates the remaining residual variance that is unique to each index (e.g., variance in empathic concern toward mothers that is not accounted for by the common factor). The benefit of this model is that it can be used to disentangle genetic and environmental effects unique to individual measures (e.g., empathic concern toward the mother) from those applying across empathy indices. One factor affecting all four empathy indices (empathic concern and hypothesis testing toward the mother and the examiner) is estimated. The magnitude of genetic influences, shared environmental influences, and nonshared environmental influences is estimated for this common empathy factor. In addition, the magnitude of variable-specific genetic and environmental influences is estimated. A schematic representation of this model is depicted in Figure 2. The results of this path analysis are presented in terms of components of variance. We performed all genetic analyses using the Mx structural equation modeling software (Neale, Boker, Xie, & Maes, 1999).

In fitting the models to the data, we proceeded by dropping nonsignificant ($p > .05$) path coefficients from the model. At all ages, dropping these paths (estimated at .00 in Table 5) resulted in a more parsimonious model, without worsening model fit, as indicated by the difference in model fit between the full and the modified models at 14 months, $\Delta\chi^2(7) = 1.17$, *ns*; 20 months, $\Delta\chi^2(7) = 1.52$, *ns*; 24 months, $\Delta\chi^2(6) = 3.05$, *ns*; and 36 months, $\Delta\chi^2(6) = 5.98$, *ns*. At 24 months, both the genetic and the shared environment effects on the common empathy factor were not significant, and dropping them separately did not significantly worsen model fit with the present sample size. However, dropping both of them simultaneously did result in a substantially worse fit, $\Delta\chi^2(8) = 69.80$, $p < .01$. Therefore, they were both retained in the model. The models fit the data marginally well, with Akaike's

Table 3
Longitudinal Correlations in Children's Empathy

Examiner/mother and child's age (in months)	Empathic concern			Hypothesis testing		
	14 months	20 months	24 months	14 months	20 months	24 months
Examiner						
20	.20**			.44**		
24	.10	.19**		.46**	.50**	
36	.05	.15**	.16**	.31**	.21**	.41**
Mother						
20	.16**			.38**		
24	.14**	.22**		.21**	.24**	
36	.07	.12*	.15**	.17**	.18**	.11*

Note. The *n*s for these analyses ranged from 309 to 343 children.
* $p < .05$. ** $p < .01$.

Table 4
Twin Intraclass Correlations in Empathy

Age and aspect of empathy toward examiner/mother	Twin zygosity	
	MZ twins	DZ twins
14 months		
Empathic concern		
Examiner	.25**	.12
Mother	.18**	.10
Hypothesis testing		
Examiner	.56**	.65**
Mother	.40**	.39**
20 months		
Empathic concern		
Examiner	.26**	.24**
Mother	.12*	.17*
Hypothesis testing		
Examiner	.57**	.43**
Mother	.23**	.48**
24 months		
Empathic concern		
Examiner	.22**	.02
Mother	.23**	.18*
Hypothesis testing		
Examiner	.53**	.40**
Mother	.41**	.30**
36 months		
Empathic concern		
Examiner	.19**	.04
Mother	.18**	.13
Hypothesis testing		
Examiner	.50**	.30**
Mother	.33**	.28**

Note. MZ = monozygotic; DZ = dizygotic.
* $p < .05$. ** $p < .01$.

information criterion ranging from 24.04 to 95.43 and the RMSEA between .09 and .11.

The underlying common empathy factor. The results of analyses performed separately at each age appear in Table 5. The four empathy indices loaded positively on the underlying common empathy factor, with standardized loadings ranging from .36 to .76 at 14 months, .46 to .78 at 20 months, .41 to .77 at 24 months, and .29 to .63 at 36 months. Table 5 presents the proportion of the variance in each empathy measure accounted for by the latent common factor, which is equivalent to the squared standardized loadings. All indices of empathy also had unique variability not accounted for by the common factor.

Genetic and environmental influences on the common empathy factor. The first column of Table 5 presents the estimates and 95% confidence intervals of the variance components accounting for individual differences in the common empathy factor. Consistent with the MZ and DZ correlations, no genetic influences were found on the common factor at 14 and 20 months. Instead, strong shared environmental influences were observed, accounting for most of the variance. At 24 and 36 months, genetics accounted for 34–47% of the variance in the common empathy factor. Shared environment effects decreased from .69 at 14 months to .00 at 36 months. Finally, the nonshared environment (and any measurement error that is common to the four empathy measures) accounted for 31–53% of the variance across ages.

Genetic and environmental influences on the unique empathy components. Table 5 also presents, for each of the four empathy indices separately, the genetic and environmental contributions to the variance not accounted for by the common factor. For example, in hypothesis testing with regard to the examiner at 14 months, the common factor accounts for 40% of the variability, with the remaining 60% accounted for by an additional, unique shared environment effect (29%) and by a unique nonshared environment effect and measurement error (31%). Additional moderate (.16–.38) unique shared environment effects were found for empathic concern toward the examiner at 20 months and for hypothesis testing toward the examiner at 36 months. Genetic influences on the unique components were found mainly for responses toward the examiner, beyond the genetic effects on the common empathy factor. Almost no genetic influences were found with regard to responses toward the mother (beyond those accounted for by the common factor). Finally, nonshared environment effects were found for all unique components, in addition to the nonshared environment effects on the common factor. These effects include the measurement error unique to each of the four indices of empathy.

Change and Continuity in Genetic and Environmental Effects on Empathy Over Time

We also were interested in the contributions of genetics and the environment to change and continuity in empathy over time. We analyzed the overall empathy of twins ($N = 292$ pairs for which full data was available for all ages), which was computed as the averaged standardized scores on empathic concern and hypothesis testing toward the mother and examiner at each age, by using the Cholesky decomposition method, using within-twin and between-twin multivariate variance–covariance matrices to decompose the variance within and between ages into a set of genetic, shared environmental and nonshared environmental factors. Applied to longitudinal data, the variance is decomposed so that at each age, genetic, shared environmental, and nonshared environmental components are estimated, on which the measures obtained at later ages can load. To the extent that scores at later and younger ages load on the same factors, this indicates continuity. For example, if the genetic effects at 24 months and those at 36 months have substantial loadings on the same genetic factor, this suggests the contribution of genetics to continuity. To the extent that scores at later ages do not load on the same factors as those at younger ages, this indicates change.

Figure 3 presents the results from the Cholesky decomposition. To increase model parsimony, paths for which coefficients were nonsignificant were dropped from the model. All of these paths accounted for less than 5% of the variance, and dropping them from the model did not significantly affect fit, $\chi^2(18) = 21.07$, *ns*. Allowing for rounding error, the squared standardized paths shown leading to the score on empathy at each age, summed across the A, C, and E components, accounted for 100% of the variance. Estimates are not identical to those in Table 5, because the longitudinal analysis focused on the overall empathy score (aggregating across examiner/mother and empathic concern/

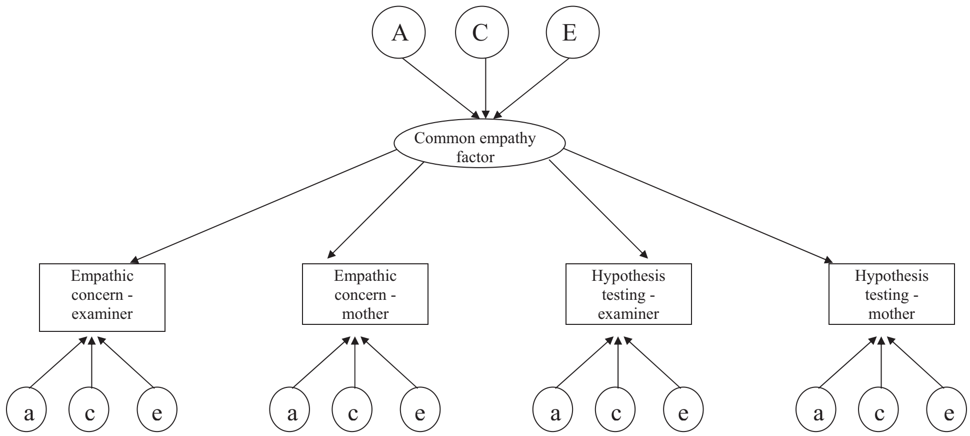

Figure 2. Common-factor common-pathways multivariate model of genetic and environmental effects on empathy. Rectangles indicate observed scores on empathy. Circles indicate the common empathy factor and the variance components estimates. A = heritability; C = shared environment; E = nonshared environment (and error) contributions to the common factor. For each observed score, unique variance components are also estimated for which a = heritability, c = shared environment and e = nonshared environment (and error) contributions to the unique variance of each observed score.

hypothesis testing), whereas the cross-sectional analysis in Table 5 described results for both a common factor and for factors specific to the combinations of examiner/mother and empathic concern/hypothesis testing.

Genetic effects. As seen in the upper panel of Figure 3, the first genetic effects on empathy appeared at 20 months, accounting for 9% of the variance at that age. These genetic effects were carried on, accounting for 16% of the variance at age 24 months. At that age, a "new" genetic effect unique from the earlier genetic effect emerged. This effect accounted for an additional 8% of the variance in empathy at 24 months (totaling a heritability of .24 at this age). The genetic effect derived at 24 months accounted fully for the 25% heritability estimated at 36 months. In summary, genetics accounted for both change and continuity in empathy, but their role changed as children grew up.

Environmental effects. The analysis revealed that the shared environmental effect at 14 months was carried over but waned in importance at later ages (see also Table 5) and that no new significant effects were found. Thus, the shared environment accounted for continuity, but its effects became steadily weaker

Table 5
Estimates of Variance Components (and 95% Confidence Intervals) Accounting for Individual Differences in a Common Empathy Factor and in Specific Factors

Age and variance component	Common empathy factor	Empathic concern		Hypothesis testing	
		Examiner	Mother	Examiner	Mother
14 months					
Variance accounted for by common factor		.13 (.08–.19)	.26 (.19–.34)	.40 (.30–.49)	.58 (.49–.66)
Heritability	.00 (.00–.00)	.18 (.07–.28)	.00 (.00–.00)	.00 (.00–.00)	.00 (.00–.00)
Shared environment	.69 (.58–.78)	.00 (.00–.00)	.00 (.00–.00)	.29 (.21–.37)	.00 (.00–.00)
Nonshared environment	.31 (.22–.42)	.69 (.58–.81)	.74 (.66–.81)	.31 (.25–.39)	.42 (.34–.51)
20 months					
Variance accounted for by common factor		.21 (.14–.29)	.32 (.25–.40)	.42 (.33–.51)	.62 (.52–.70)
Heritability	.00 (.00–.00)	.00 (.00–.00)	.00 (.00–.00)	.26 (.17–.35)	.00 (.00–.00)
Shared environment	.56 (.44–.66)	.16 (.07–.24)	.00 (.00–.00)	.00 (.00–.00)	.00 (.00–.00)
Nonshared environment	.44 (.34–.56)	.63 (.53–.74)	.68 (.60–.75)	.32 (.25–.41)	.38 (.30–.48)
24 months					
Variance accounted for by common factor		.17 (.10–.24)	.43 (.35–.51)	.25 (.17–.33)	.60 (.51–.69)
Heritability	.34 (.00–.74)	.13 (.01–.23)	.00 (.00–.00)	.37 (.27–.46)	.00 (.00–.00)
Shared environment	.30 (.00–.63)	.00 (.00–.00)	.00 (.00–.00)	.00 (.00–.00)	.00 (.00–.00)
Nonshared environment	.36 (.24–.51)	.71 (.59–.83)	.57 (.49–.65)	.39 (.31–.48)	.40 (.31–.49)
36 months					
Variance accounted for by common factor		.13 (.07–.21)	.40 (.26–.59)	.08 (.02–.16)	.31 (.20–.46)
Heritability	.47 (.26–.66)	.12 (.00–.24)	.00 (.00–.00)	.00 (.00–.00)	.24 (.12–.35)
Shared environment	.00 (.00–.00)	.00 (.00–.00)	.00 (.00–.00)	.38 (.28–.46)	.00 (.00–.00)
Nonshared environment	.53 (.34–.74)	.75 (.62–.88)	.60 (.41–.74)	.54 (.46–.64)	.45 (.33–.57)

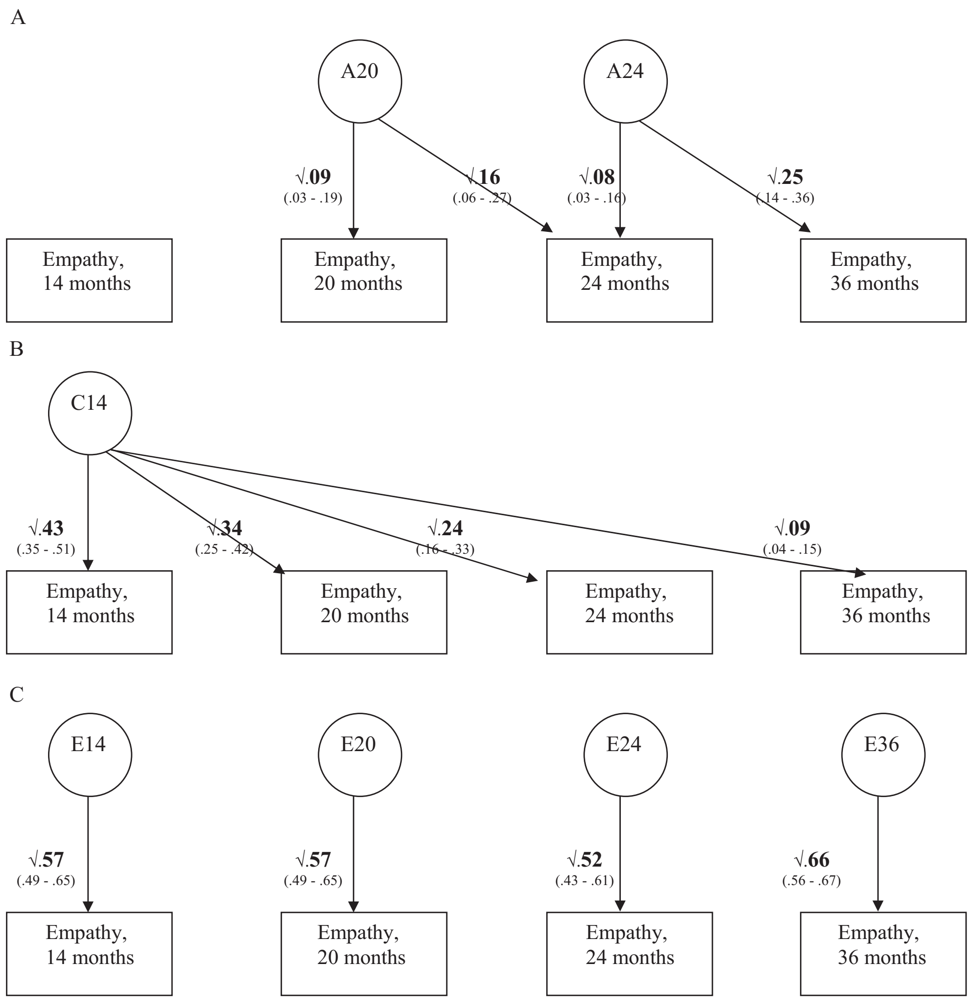

Figure 3. Longitudinal Cholesky decomposition of variance components of empathy. (A) Genetic components. (B) Shared environment components. (C) Nonshared environment components. The three panels represent a single analysis and appear separately to simplify presentation. Circles indicate variance components estimates, and rectangles indicate observed scores on empathic behavior. A = heritability; C = shared environment; E = nonshared environment (and error). The number in each circle represents the age to which the variance component is attributed. Numbers in parentheses are 95% confidence intervals.

as children grew older. In contrast, the large nonshared environmental effects (which include measurement error) loaded on a single factor at each age, indicating that there was no continuity in these effects.

Prevalence of Prosocial Acts

Preliminary analyses showed no differences in the prevalence of prosocial acts by the child's gender or the twin's zygosity. Figure 4 presents the proportion of children who performed prosocial acts toward their mother or the examiner in at least one of the distress simulations (home and lab), at each age. The most consistent finding is that many more children performed prosocial acts toward their mother than toward the examiner. This difference was significant as indicated by the McNemar test: At 14 months, $\chi^2(1) = 11.46$; at 20 months, $\chi^2(1) = 102.15$; at 24 months, $\chi^2(1) = 95.14$; at 36 months, $\chi^2(1) = 89.47$; $p < .005$ at all ages.

Prosocial behavior toward both the mother and the examiner increased with age. The proportion of children behaving prosocially toward their mother in at least one situation increased from 19% at 14 months to 53% at 36 months. The main increase in prosociality toward mothers occurred from 14 to 20 months, $\chi^2(1) = 24.97$, $p < .001$. The increase from 20 to 24 months was smaller but statistically significant, $\chi^2(1) = 3.98$, $p < .05$; and there was further increase from 24 to 36 months, $\chi^2(1) = 3.98$, $p < .05$.

Although prosocial behavior toward the examiner also increased from 14 months (10%) to 36 months (18%), $\chi^2(1) = 6.54$, $p < .01$, a different pattern of results was found. A small decrease in prosociality was noted from 14 to 20 months, $\chi^2(1) = 7.04$, $p <$

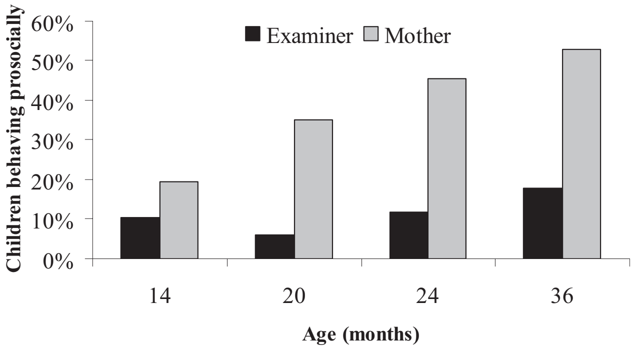

Figure 4. Proportions of children who performed prosocial acts toward their mother or the examiner in at least one distress simulation.

.01; followed by an increase from 20 to 24 months, $\chi^2(1) = 12.07$, $p < .001$; and another slight increase from 24 to 36 months, $\chi^2(1) = 3.85$, $p < .01$. These small differences were not fully replicated with the cotwin subsample and should be treated with caution.

The Relationship Between Empathy and Prosocial Behavior

We hypothesized that empathy toward the person in distress would be associated with prosocial behavior toward that person. Table 6 presents the means and standard deviations of empathic concern and hypothesis testing, comparing children who behaved prosocially toward the mother or the examiner with those who did not. We tested our hypothesis separately at each age and for the mother and examiner (again, one twin was randomly chosen from each pair for these analyses). We used a discriminant analysis (e.g., Betz, 1987), a method of examining the extent to which multiple predictor variables (hypothesis testing and empathic concern) are related to a categorical criterion (performance of prosocial behavior). This analysis, like multiple regression, provides a linear equation that maximizes differences between children who do and children who do not behave prosocially. At each age, separately for examiner and mother, we fitted a discriminant function for children's hypothesis testing and empathic concern as predictors of prosociality.

The hypothesis that empathy is related to prosociality was partially supported for the examiner (see Table 6). At 14 months, no relationship was found. At 20 and 24 months, the overall discriminant function did not predict prosocial behavior, although a significant contribution of hypothesis testing was found at both ages. Finally, at 36 months, both hypothesis testing and empathic concern predicted prosocial behavior significantly but weakly. Support for the hypothesis that empathy is positively associated with prosocial behavior toward the mother was found at all ages. Both hypothesis testing and empathic concern predicted children's prosocial behavior. Canonical correlations between discriminant scores and children's prosociality toward the mother ranged from .25 to .36.

Table 6
Results of Discriminant Analysis of Children's Empathy as Predictor of Prosocial Behavior Toward the Mother or the Examiner

Examiner/mother and child's age (in months)	Empathic concern: *M* (*SD*) Absence	Presence	WL	*F*	SDC	Hypothesis testing: *M* (*SD*) Absence	Presence	WL	*F*	SDC	Discriminant function: WL	$\chi^2(2)$	Canonical correlation
Examiner													
14	2.30 (0.53)	2.42 (0.45)	1.00	*F*(1, 388) = 1.94	1.01	2.25 (0.48)	2.21 (0.42)	1.00	*F*(1, 388) = 0.30	−0.65	.99	3.07	.09
20	2.50 (0.56)	2.76 (0.56)	.99	*F*(1, 347) = 3.83	0.60	2.32 (0.51)	2.55 (0.50)	.99	*F*(1, 347) = 3.90*	0.61	.98	5.57	.13
24	2.54 (0.51)	2.60 (0.51)	1.00	*F*(1, 352) = 0.61	0.07	2.53 (0.55)	2.73 (0.54)	.99	*F*(1, 352) = 5.19*	0.98	.99	5.16	.12
36	2.55 (0.52)	2.78 (0.46)	.97	*F*(1, 338) = 9.40**	0.62	2.59 (0.63)	2.88 (0.64)	.97	*F*(1, 338) = 9.87**	0.65	.96	15.05**	.21
Mother													
14	2.07 (0.61)	2.47 (0.48)	.93	*F*(1, 385) = 27.27**	0.93	2.15 (0.47)	2.34 (0.50)	.98	*F*(1, 385) = 8.98**	0.13	.93	26.61**	.26
20	2.44 (0.61)	2.75 (0.66)	.85	*F*(1, 346) = 20.52**	0.73	2.34 (0.55)	2.58 (0.63)	.92	*F*(1, 346) = 13.75**	0.42	.94	23.05**	.25
24	2.27 (0.57)	2.66 (0.51)	.89	*F*(1, 347) = 43.35**	0.75	2.62 (0.68)	2.98 (0.59)	.96	*F*(1, 347) = 27.55**	0.39	.88	45.76**	.35
36	2.29 (0.57)	2.72 (0.57)	.85	*F*(1, 335) = 48.31**	0.95	2.81 (0.76)	3.07 (0.70)	.97	*F*(1, 335) = 10.87**	0.13	.87	45.58**	.36

Note. Absence = children who did not behave prosocially toward the mother or examiner; Presence = children who behaved prosocially at least in one distress simulation toward the mother or examiner; SDC = standardized discriminant coefficient; WL = Wilks's lambda.
* $p < .05$. ** $p < .001$.

Genetic and Environmental Effects on Prosocial Behavior and Its Relationship With Empathy

Next, we investigated the genetic and environmental contributions to prosocial behavior and to its relationship with empathy at each age. To reduce the number of analyses, we conducted this analysis on overall empathy (averaged empathic concern and hypothesis testing) and prosocial behavior, each standardized and averaged across mother and examiner scores at each age. We used the correlated factors model (Rijsdijk & Sham, 1999), which specifies correlated additive genetic, shared environmental, and nonshared environmental effects that influence prosocial behavior and empathy. The extent to which the MZ cross-trait (e.g., prosocial behavior and empathy) twin correlation exceeds the DZ cross-trait twin correlation indicates the degree of genetic overlap between the two traits weighted by the square roots of heritabilities of the two traits. The model estimates the proportion of the covariance between two variables attributed to genetic covariance between them, or *bivariate heritability* (Plomin & DeFries, 1979). Bivariate shared and nonshared environmental contributions to variance and covariance between the two variables are estimated in a similar way. Together, bivariate heritability and the shared and nonshared environmental effects account for the phenotypic correlation between empathy and prosocial behavior.

The between-twin MZ correlation for prosocial behavior (see Table 7) was higher than that for DZ twins at all ages, except for 20 months, indicating modest heritabilities (.09 to .24) for prosocial behavior at most ages. The shared environment effect was estimated at .00 to .16, and most of the variance was due to the nonshared environment and error (see Table 7). The genetic and environmental contributions to the phenotypic correlations between empathy and prosocial behavior were next estimated in model-fitting analyses. At 24 months, when both prosocial behavior and empathy showed some heritability, bivariate heritability accounted for 46% or the phenotypic correlation. In addition, at 20 months, when the shared environment had substantial effects on both variables, a part (25%) of the phenotypic correlation was estimated as due to bivariate shared environment effects. However, the most consistent finding was that the empathy–prosocial behavior relationship was largely due to bivariate nonshared environment effects at all ages.

Discussion

We examined the building blocks of compassion: the affective and cognitive aspects of empathy and prosocial behavior. This study is the largest to date of children's empathic development in late infancy and early childhood. We found substantial developmental changes in the prevalence of empathy, accompanied by consistency and stability across ages, distress victims, and the affective and cognitive modalities of empathy. Viewed as a relatively stable individual differences variable, empathy has been accounted for by variable genetic and environmental components, with the former increasing with age and the latter decreasing with age and with the environment accounting for the relationship between empathy and prosocial behavior at this young age.

Prevalence of Empathy and Prosocial Behavior

Both empathy and prosocial behavior increased during the first years of life. This pattern is mainly consistent with results from previous research with other longitudinal samples (Volbrecht et al., 2007; Zahn-Waxler & Radke-Yarrow, 1982, 1990; Zahn-Waxler, Radke-Yarrow, et al., 1992). The overall increase in the affective, cognitive, and behavioral aspects of compassion may reflect the development of emotion regulation, self–other differentiation, and the perspective-taking abilities needed for empathy, as well as language and interpersonal skills needed to approach distressed others, inquire about their feelings, and provide support (Hoffman, 2000; Underwood & Moore, 1982; Zahn-Waxler, Radke-Yarrow, et al., 1992). Although the increase in empathic concern took place mainly from 14 to 20 months, complex modes of hypothesis testing further increase in the later ages, possibly reflecting children's increased ability for complex, verbal forms of inquiry.

Both hypothesis testing and prosocial behavior were higher toward the mother than toward the examiner. This is in line with the deeper involvement children have with their mothers (Robinson, Zahn-Waxler, & Emde, 2001). Meaningful (e.g., mother–child) relationships, framed in terms of reciprocated positive behaviors, are likely to result in an overall positive attitude toward the other individual and even increased self-relevance of the other's suffering. The difference favoring mothers increased with

Table 7
Twin Correlations and Variance Component Estimates for Prosocial Behavior, Phenotypic Correlations Between Prosocial Behavior and Empathy, and Proportions of Correlations Mediated by Bivariate Genetic and Environmental Factors

	Prosocial behavior					Prosocial behavior and empathy			
	Twin correlations		Variance component estimates (and 95% confidence intervals)						
Age (in months)	MZ	DZ	Heritability	Shared environment	Nonshared environment and error	Correlation	% Bivariate heritability	% Bivariate shared environment	% Bivariate nonshared environment
14	.20*	−.01	.17 (.05–.29)	.00 (.00–.00)	.83 (.71–.95)	.12*	0	0	100
20	.09	.22*	.00 (.00–.00)	.15 (.05–.25)	.85 (.75–.95)	.27*	0	25	75
24	.25**	.18*	.09 (.004–.37)	.16 (.00–.28)	.76 (.63–.87)	.28*	46	0	54
36	.33**	.27**	.24 (.00–.44)	.09 (.00–.35)	.66 (.55–.79)	.29*	0	0	100

Note. MZ = monozygotic; DZ = dizygotic.
* $p < .05$. ** $p < .01$.

age, possibly reflecting the increasing mother–child closeness and emotional investment in the relationship. Moreno et al. (in press) found that aspects of the mother's emotional availability toward her child early in the second year of life were internalized by the child and reflected in the child's social engagement toward mother by the end of the second year. These internalized relationship skills accounted for substantial variance in observed empathy at age 2 toward mothers and, to a somewhat lesser extent, toward examiners. The difference favoring the mothers was not found for empathic concern. This contrasts with Young et al.'s (1999) finding of higher empathic concern toward mothers at 24 months. These mixed results call for further study.

Consistency, Continuity, and Change in Empathy

As expected, we found support for the role of an overall empathic tendency, generalizing across distress victims, affect and cognition, and age. At each age, the common empathy factor accounted for 42–55% of the variance across the single empathy measures. Across ages, using the overall empathy scores, we found that empathy at earlier ages accounted for 32–58% of the variance in later empathy. Combined with the substantial relationship between empathy and prosocial behavior, these findings support the existence of an altruistic, empathic, or prosocial personality (e.g., Eisenberg et al., 1999).

Although moderate support for an overall empathy disposition was found, there was also evidence for the moderating role of social context (mother vs. examiner) and aspect of empathy (hypothesis testing vs. empathic concern). Similarly, the longitudinal continuity was significant, but substantial changes were simultaneously observed. Longitudinal correlations were stronger for overall empathy than for any single index of empathy. The emergent picture is that of empathy as a multifaceted construct (Singer, 2006). The different aspects of empathy are connected through their common underlying empathy disposition but are also unique to some extent because they are affected by the factors of social context, modality of response (cognitive vs. affective), and developmental stage.

Meaningful cross-situational variability concomitant with a stable disposition has been observed with regard to children's behavior and conceptualized as part of personality by Mischel and Shoda (1995). Similarly, sadness, anxiety/fear, and anger have been shown to have both unique components and a shared pattern of overall negative affect (Watson & Clark, 1992). The differences in response to the mother and examiner reflect a variation of response to situational constraints discussed later.

There were meaningful differences between empathic concern and hypothesis testing, which show that although the two share an underlying common tendency, there are also unique features. The correlations of .27 to .52 between empathic concern and hypothesis testing indicate moderate consistency accompanied by variability and suggest that the two constructs are partially separable. In addition, hypothesis testing rates increased slowly but steadily with age, whereas empathic concern rates increased mainly from 14 to 20 months, suggesting partially different developmental trajectories.

The differential rates of development of empathic concern and hypothesis testing are compatible with neuroscientific evidence. The limbic and paralimbic systems, relevant to the more affective aspects of empathy, develop earlier than the prefrontal and temporal cortices, which are more relevant to the cognitive aspect of empathy indexed by hypothesis testing (Singer, 2006). This differential developmental pattern has been suggested as the basis for expecting that the cognitive aspects of empathy develop later than the affective aspects of empathy (Singer, 2006). Genetic influences on these maturational processes may also account for the differential rates of development. This can be learned from the genetic contributions to the variance in the empathy indices not accounted for by the common empathy factor (see Table 5). Thus, from 20 months on, the genetic contributions to the unique variance in hypothesis testing were larger than those of empathic concern, indicating that some of the later genetic processes taking place were relevant to hypothesis testing but not to empathic concern.

The lowest stability was found in the latest measurement age, suggesting that the dynamics of development continue to exert substantial influences that reduce the generality observed in the earlier ages. The ways in which children experience and express empathy change markedly in the life period studied in the present investigation. In this period, children move from a basic self-differentiation, which enables them to project their own concern on others, to a more sophisticated stage in which they care about what others feel as well as about the way their reaction would be seen by others (Hoffman, 2000; Rochat, 2002). These changes may result not only in the increase in overall empathy levels we observed but also in the psychological antecedents of empathy at different ages (Lewis, 2000). In other words, the changing nature of empathy may mean that the relevance of different genetic, environmental, and psychological factors changes with age.

Genetic and Environmental Influences

The dynamic changes in empathy are accompanied by meaningful shifts in the genetic and environmental contributions to individual differences in empathy. As for other traits (e.g., Knafo & Plomin, 2006b; Plomin et al., 2001), the heritability of empathy tended to increase with age. In addition, the environmental influences on the common empathy factor became increasingly of the nonshared sort.

Because our design followed children in four consecutive time points, we were able to identify the second half of the second year of life as the period in which the main changes in genetic effects on the common empathy factor occur. At 14 months, no overall genetic effect was found. By 24 months, a genetic effect accounting for about a quarter of the variance emerged and remained stable toward 36 months as no further new genetic effects emerged, and heritability at 36 months loaded fully on the genetic components emerging in earlier ages (see Figure 3). This means that a substantial change occurs in this period that is mainly due to genetic factors. This developmental period includes major transitions in self–other differentiation, children's affective regulation, and cooperative play (e.g., Brownell & Carriger, 1990; Eckerman, Davis, & Didow, 1989; Hay, 1979; Nielsen & Dissanayake, 2004; Zahn-Waxler et al., 2001). For example, Moreno et al. (in press) demonstrated that children's cognitive and language gains in the first 2 years, as well as their social engagement skills, contributed significantly to their observed empathy at age 2.

In addition to providing evidence for the importance of both heritability and the environment to individual differences in children's overall empathy, we estimated genetic and environment contributions to specific empathy indices. The most unique genetic effects occurred with regard to the examiner. Robinson, Zahn-Waxler, and Emde (2001) suggested that children's natural inclination toward high or low empathy may be more apparent with strangers (e.g., our examiners) for which no relationship-specific rules have been established with time. This pattern demonstrates the importance of context to development and further stresses the need to consider heritability as the proportion of individual variance affected by genetic factors in a specific context (e.g., age and relationship; Plomin et al., 2001).

Research is still far from elucidating the processes through which genetic variations affect brain processes relevant to empathy. One way for future research to proceed is to identify the temperamental constellations predictive of empathy and look for genetic influences common to temperament and empathy (Zahn-Waxler, Robinson, & Emde, 1992). For example, children's behavioral inhibition was negatively associated with empathy toward an experimenter (Young et al., 1999). To the extent that behavioral inhibition is heritable (e.g., DiLalla, Kagan, & Reznick, 1994), it could mediate the effects of genetics on empathy. As another example, a temperament characterized by low affect was associated with lower empathy toward an examiner (Young et al., 1999). Possibly, genetics indirectly influence empathy through their effects on an overall capacity to experience emotions. An extensive literature documents a relationship between low arousal and antisocial behavior, which is characterized by little or no empathy (Lahey, Hart, Pliszka, Applegate, & McBurnett, 1993). Sociability is yet another trait that shows heritability and is associated with empathy (Volbrecht et al., 2007).

Genetic influences on variability in the functioning of brain regions relevant to empathy and mirror neuron functioning such as the ventromedial prefrontal cortex (Amodio & Frith, 2006) and the anterior insula (Singer et al., 2004) are likely candidates. Evidence from populations with extremely low (Viding, Blair, Moffitt, & Plomin, 2005) or abnormally high (Meyer-Lindenberg et al., 2005; Zahn-Waxler, Shirtcliff, & Marceau, 2008) levels of empathy could also be relevant.

Genetic influences on most psychological traits take the form of many genes affecting behavior, cognition, and affect in an additive or interactive manner, and it would be unlikely for a single gene to have strong influences on the normal variation in a trait (see Plomin et al., 2001). Nevertheless, a careful look for specific genetic influences on empathy may prove fruitful. Hastings et al. (2006) proposed examining the genes associated with the serotonergic systems, as they are relevant to various affective processes (Hariri & Weinberger, 2003). Recent evidence calls for investigating the arginine vasopressin 1a (*AVPR1a*) receptor gene, which is relevant to human altruism and autism—two extreme sides of an empathy–prosociality dimension (Israel et al., 2008; Knafo et al., 2008; Yirmiya et al., 2006). As genetic variability in this gene has been related to behavioral and social differences within and between other mammalian species (Hammock & Young, 2005), it may be one link in which the cross-species empathy patterns described by de Waal (2008) may operate.

Empathy and Prosocial Behavior

Relying on the premise that empathy provides a motivational impetus for prosocial behavior (Batson, in press), we hypothesized that empathy would relate to prosocial behavior. The hypothesis was largely confirmed, with prosocial behavior at each age being positively predicted by empathic responding. The results were more consistent for the mothers, again demonstrating the role of the context in which children operate. Moreover, children may have an established script for helping their mother, based to a great extent on her own behavior toward them (Robinson, Zahn-Waxler, & Emde, 2001), whereas generalizing behaviors modeled by the mother to the examiner's distress is likely to need more effort and more advanced sociocognitive abilities.

Because children's behavioral repertoire becomes more flexible as they grow older and encounter increasingly varied situations, their ability to come up with a prosocial act intended to alleviate the victim's distress increases with age. The relationships between empathy and prosocial behavior were stronger, for both the mother and the examiner, at 24 and 36 months than in the younger ages. The increase in the prosocial behavior–empathy relationships is also compatible with Hoffman's (2000) notion that development in the second year of life enables empathy to become less self-oriented and more other-oriented. The increased self-regulation abilities achieved toward age 2 enable children to not only feel for the victim but also act upon these feelings.

Although there was evidence of genetic influences on empathy, and to a somewhat lesser degree on prosocial behavior in a distress situation, the prosocial behavior–empathy relationship was accounted for mainly by environmental factors. The environmental factors likely to be relevant to both prosocial behavior and empathy and that account for the relationship between prosocial behavior and empathy include parental warmth, inductive discipline, and responsiveness (Hastings et al., 2006). These may be experienced similarly (shared environment) or differentially (nonshared environment) within twin pairs, both of which could influence overall levels of prosociality. Nevertheless, the inconsistent findings in the literature regarding the strength of heritability of prosocial behavior in distress situations suggest the need for further research with a wide range of observationally measured prosocial behaviors, including children's responses to other children.

Strengths and Limitations

This is the largest genetically informative study of young children's empathy. The assessment of the same children at four different ages, across early childhood, is a methodological strength of this study. This period of nearly 2 years between the first and fourth measurement allowed us to examine the development of empathy in an important developmental period accompanied by many social and cognitive changes. It also enabled investigating change and stability as well as their genetic and environmental origins.

We obtained repeated assessments of the same children (four times, twice at the lab and twice at home at each of the four time points) with high retention rates. This well exceeds the number of assessments from any other studies of early empathic and prosocial development and should have contributed to increased reliability and validity. However, even here, genetic and environmental estimates will lack some precision. Although a sample size of about 800 children would be considered a large one for most research purposes, it is a modest sample for a twin study. This is evident in the wide confidence intervals obtained for the genetic estimates, particularly for the heritability of the common empathy factor at 24 months. Generalizations therefore must be treated with some degree of caution. Finally, in future research, it will be important to begin to measure some of the specific biological, dispositional, and environmental (particularly parental socialization) processes implicated in the early development of empathy and prosociality (see, e.g., Knafo & Plomin, 2006a).

Conclusions

This study addressed the origins and development of empathy. Empathic concern and hypothesis testing increased with age, as did prosocial behavior. The relationships between these three variables, as well as the differences between them, emphasize the importance of viewing compassion as a complex constellation of affective, cognitive, and behavioral components. The positive concurrent and longitudinal correlations indicated that early in development, empathy is already a relatively stable disposition, generalizing across its affective and cognitive components, across mother and examiner, and over time. However, the increase in empathy and in its associated genetic influences, and the change in the relevance of shared environmental factors, suggest that the second and third years of life should be considered a period of dynamic changes and developments in children's empathy.

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