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ORIGINAL RESEARCH

The Role of Remembered Parenting on Adult Self-Esteem: A Monozygotic Twin Difference Study

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Abstract

Self-esteem is an attitude about the self that predicts psychopathology and general well-being. Parenting practices have been shown to be related to self-esteem, but these estimates are confounded because parents and children share genes. The aim of the present study was to use the monozygotic (MZ) twin difference design to isolate the non-shared environmental impact of remembered parenting on self-esteem. In a sample of 1328 adults (345 MZ twin pairs, 319 DZ twin pairs), retrospective reports of maternal and paternal affection were related to self-esteem, all of which were significantly heritable. Using MZ difference scores, paternal affection differences, but not maternal affection differences, were significantly related to self-esteem differences. These results suggest that parenting provided by the father directly impacts self-esteem through non-shared environmental mechanisms. Maternal affection, on the other hand, impacts self-esteem through shared genes (not shared environment, as shared environment was not a significant aspect of self-esteem). This has implications for parenting intervention programs.

Keywords Self-esteem · Parenting · Monozygotic twin difference design · Maternal affection · Paternal affection · Non-shared environment

Self-esteem can be conceptualized as an attitude about the self. It incorporates cognitive and affective appraisals of all aspects of the self (Rosenberg et al. 1995). Positive self-esteem is related to general well-being (Crocker et al. 1994) and decreased psychopathology (Dumont and Provost 1999). An extensive body of research has shown that positive parenting is predictive of children's higher self-esteem (e.g. Bean et al. 2003). However, these results could be confounded by the genes that parents and children share (Scarr and McCartney 1983). The monozygotic (MZ) twin difference design can isolate the impact of the nonshared environment on the relationships between traits (Pike et al. 1996). Therefore, the present investigation utilized an MZ twin difference design to isolate the nonshared environmental component of the relationship between remembered parenting practices and adult children's self-esteem.

Self-esteem

Self-esteem consists of cognitive and affective components (Rosenberg et al. 1995). The cognitive component consists of thoughts about the self. It includes factual evaluations about one's successes, failures, and other relevant experiences. The affective component, on the other hand, consists of feelings about the self and also incorporates preferences about which aspects of the self are important or valued. Therefore, according to Rosenberg et al. (1995), experiences related to aspects of the self that the individual values will have more of an impact on the individual's self-esteem than will experiences related to aspects of the self that the individual does not value. Self-esteem is of research interest because it appears to vary with age and is related to a

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number of health outcomes. Older adults tend to report higher self-esteem than younger adults (Orth et al. 2010). Additionally, males tend to report higher self-esteem than females (Bleidorn et al. 2016).

Self-esteem is related to a number of aspects of well-being in adulthood. For example, it has been shown to be related to general life satisfaction (Kang et al. 2003). Self-esteem also appears to be negatively related to psychopathology, particularly internalizing disorders such as anxiety (Farmer and Kashdan 2014) and depression (Zeigler-Hill 2011). Thus, self-esteem has been conceptualized as an important resilience factor (Veselska et al. 2009). Taken together, these findings suggest that understanding the etiology of self-esteem may be important for understanding how to promote resilience and other positive qualities.

Heritability of self-esteem

An extensive body of behavioral genetic research has examined the heritability of self-esteem (Neiss et al. 2002) using the twin design in order to understand the genetic and environmental underpinnings. Variability in self-esteem has been shown to be due to additive genetic (29–49%) and nonshared environmental factors (Neiss et al. 2002). Shared environmental factors have not been found to contribute to variability in self-esteem. Additionally, heritability has been shown to decrease throughout the lifespan. As heritability decreases, nonshared environmental influences become increasingly important. For example, Jonaissant (2010) used the Add Health dataset to examine heritability of self-esteem across the lifespan and found that heritability decreased from adolescence (43%) to middle adulthood (13%). Therefore, throughout adulthood, new experiences that twins do not share increasingly influence variability in self-esteem.

Although researchers using classical twin studies report additive genetic and nonshared environmental effects on self-esteem, more recent investigations using nuclear twin family designs have shown that shared environment is also important for self-esteem. In this design, twins are compared to each other and to additional siblings in the family. The addition of a third sibling allows for examination of more specific effects (e.g. twin specific shared environmental effects vs. environmental effects that are shared among all of the children in a family). Specifically, Bleidorn et al. (2016) found that nonadditive genetic effects and twin-specific shared environments (e.g. being the same age) explained significant variability in self-esteem in twins aged 16–25, as well as their parents and siblings. In other words, although classical twin designs have not found shared environmental effects on self-esteem, extensions of the twin design suggest that families that include twins could produce shared environmental experiences that non-twin (or non-multiple) siblings do not, and these experiences are important for shaping self-esteem.

Parenting and self-esteem

A variety of parenting practices have been shown to be related to self-esteem, both in adolescence and adulthood. In general, feelings of closeness between parents and children are related to higher self-esteem (Harris et al. 2015). More specifically, parental relationship quality has been shown to relate to self-esteem in both children and adults, such that those with closer relationships with their parents report higher self-esteem (Bulanda and Majumdar 2009). Total amount of time spent with parents was not related to self-esteem, suggesting that specific types of positive interactions, rather than total number of interactions, are important for the development of adolescents' self-esteem (Bulanda and Majumdar 2009). Additionally, Bean et al. (2003) showed that positive parental involvement (e.g. helping with the child's schoolwork or knowing the child's friends) was related to higher self-esteem in adolescence.

Discipline practices also have been shown to be related to self-esteem. In general, discipline behaviors designed to correct negative behavior and promote positive behavior are positively related to self-esteem (Aquilino and Supple 2001). In contrast, remembered punitive discipline during adolescence is negatively related to self-esteem in young adulthood. Thus, discipline seems to be related to self-esteem, but the specific types of discipline children experience have differential effects (Aquilino and Supple 2001). These results also illustrate the importance of remembered parenting for predicting behavior in adulthood.

Several studies have examined the construct of remembered parenting in relation to self-esteem. For example, Conte et al. (1996) found that remembered maternal autonomy-granting was significantly related to self-esteem in adult males, and remembered paternal rejection was related to self-esteem in adult females. These results show that remembered parenting is important for the development of self-esteem in adulthood, and they also point to differences between males and females. Additionally, Joubert (1991) found that college students who remembered their parents as having shown interest in their activities and engaged in less verbal abuse were more likely to report higher self-esteem.

Genetic influences on parenting

Genetic influences have been demonstrated for several aspects of parenting, including attention and control (e.g. Rende et al. 1992). Shared and nonshared environmental

influences have also been observed for several aspects of parenting, including affection, control, attention, and responsiveness (e.g. Rende et al. 1992). It is possible that positive parents share those positivity genotypes with their children, yielding children with higher self-esteem simply because they are temperamentally more positive rather than that they received positive parenting. Thus, separating the components of self-esteem that are shared between parents and children is important to understanding how the unique parenting that children experience affects self-esteem. Genetic influences have also been found for remembered parenting. For example, Lichtenstein et al. (2003) found genetic influences for remembered parental warmth. The genes that contributed to remembered parental warmth were shared with genetic factors for optimism, aggression, and humor. These results suggest that personality traits such as optimism may be related to the ways that parenting is remembered in adulthood. Remembered authoritarianism and protectiveness each showed only shared and nonshared environmental influences (Lichtenstein et al. 2003). Thus, a variety of genetic, shared environmental, and nonshared environmental factors appear to contribute to remembered parenting in adulthood.

Genetic, shared environmental, and nonshared environmental factors contribute to parenting. Thus, it is important to use genetically informed designs to understand how parenting relates to other constructs, such as self-esteem. The monozygotic twin difference design is a way of isolating the nonshared environment in order to understand how parenting itself, rather than the genes that parents and children share, relates to outcomes, such as self-esteem.

Isolating the nonshared environment: the MZ twin difference design

Because MZ twins share all of their genes, differences between MZ twins can be used to understand the impact of the nonshared environment using a technique called the MZ twin difference design (Asbury et al. 2003). In the MZ twin difference design, one twin's score on a trait is subtracted from the other twin's score on the same trait. These difference scores can then be regressed on an MZ twin difference score for another trait to ascertain whether differences on one trait predict differences on the other. This design relies on the fact that MZ twins share all of their genes. Thus, differences between MZ twins cannot be due to genetic factors. Differences also cannot be due to the shared environment because, by definition, twins share all of their shared environment. Thus, differences between MZ twins must be a result of factors that the twins do not share. The MZ twin difference design can be used to understand the extent to which environmental aspects of traits (e.g. parenting) contribute to variability in outcome measures (e.g. self-esteem) while controlling for shared genes and environments.

In one MZ twin difference study, Dunkel et al. (2018) examined the relationship between MZ twin differences in parental affection and differences in the general factor of personality. They found that both maternal and paternal affection differences were related to differences in a general factor of personality. Specifically, the twin who experienced more affection was generally higher on a general factor of personality. The present study utilized the same data as Dunkel et al. (2018) from the Midlife in the United States (MIDUS; Brim et al. 2007) study to examine the relationships between remembered parenting and adult self-esteem.

The present study

The present study sought to examine the relationship between differences in retrospective reports of parenting received during childhood and differences in adult self-reported self-esteem in MZ twins. Following past research, affection and discipline were examined as possible predictors of self-esteem. Modeling of generosity (i.e. the extent to which parents were kind to other people) was also included for exploratory purposes due to its close relationship with affection.

The first hypothesis was that the parenting variables of affection, discipline, and modeling of generosity would be positively related to adult offspring's' self-esteem at the phenotypic level. Second, based on prior research using the classical twin design (Neiss et al. 2002), it was hypothesized that variability in self-esteem would be explained by additive genetic and nonshared environmental factors. Parenting was hypothesized to be influenced by additive genetic, shared environmental, and nonshared environmental factors. The third hypothesis was that differences in parenting between twins (nonshared environment) would be a significant aspect of the nonshared environment that is related to differences in twins' self-esteem. This was assessed by employing MZ differences analyses.

Method

The present study utilized data from the publicly available Midlife in the United States (MIDUS) study (Brim et al. 2007). The MIDUS is an examination of factors that contribute to health and well-being in midlife. It contains various measures of social, emotional, and physical health, as well as measures of various factors that may contribute to health in midlife. The MIDUS includes an oversample of twins to

Table 1 Confirmatory factor analysis of self-esteem

Variable	Factor loading	Standard Error
I like most parts of my personality	.50*	.04
When I look at the story of my life, I am pleased with how things have turned out so far	.53*	.04
In many ways, I feel disappointed about my achievements in life	.56*	.04
Self-confident	.59*	.04
Overall, how satisfied are you with yourself?	.52*	.04

*$p < .05$

facilitate genetic analyses. The full sample consists of 7108 individuals aged 20–74 years.

Participants

The present study made use of the twin oversample. The usable sample consisted of 664 pairs of same-sex twins (345 MZ pairs, 319 DZ pairs). Although opposite-sex DZ twins were included in the MIDUS sample ($N = 497$ individuals), they were excluded from the present analysis because potential sex differences in self-esteem would artificially inflate estimates of heritability by causing decreases in DZ but not MZ correlations. Twin pairs were defined as participants who were born to the same family and reported the same birth year. Twins were excluded if their twin sibling did not participate in the study ($N = 62$) or if birth years were not reported ($N = 50$). Twins were also excluded if their zygosity could not be determined ($N = 25$) or if zygosity was not coded ($N = 6$). DZ twins were only used in this study for the development of the self-esteem variable and for the behavioral genetic analyses. Only MZ twins were used in the MZ twin differences regression analyses. Twins ranged in age from 20–73 years ($M = 43.99$ years, $SD = 11.88$ years)[1] and the twin sample was 53% female. The twin sample was predominantly white (92%), with the rest of the sample being black (4%), Native American (0.7%), multiracial (0.3%), or another race (1%), or they did not respond (2%). The demographics of the twin sample were similar to the demographics of the larger dataset.

Measures

Remembered parenting

Parenting items were taken from scales of affection (e.g. "How much love and affection did she/he give you?"), discipline ("How consistent was she/he about the rules?"), and modeling of generosity (e.g. "How generous was she/he to people outside the family?") created for the MIDUS dataset (Ryff and Keyes 1995). Items were identical for mothers and fathers, save for the pronoun that was used to refer to each (she/he). Items for each scale were averaged to create six variables that represented maternal and paternal affection, maternal and paternal discipline, and maternal and paternal modeling of generosity. These scale scores showed good to adequate reliability, alphas were 91, 0.93, 0.75, 0.82, 0.81, 0.88, respectively.

Self-esteem

As there was not an available self-esteem scale in the first wave of the MIDUS, it was operationalized using a latent variable that was created for this research. An initial set of 11 items that shared similar content with the construct of self-esteem was reduced using exploratory factor analyses. Items were taken from scales of self-acceptance, life satisfaction, and other constructs that were thought to provide a face valid representation of self-esteem (Ryff and Keyes 1995). Prior to the factor analyses, the twins (both MZ and DZ) were divided into two subsamples (one twin randomly chosen from each pair for each subsample) and factor analyses were conducted separately on each subsample. Iterative principal axis factoring was used on the first subsample to identify the subset of non-redundant items that provided the greatest variance accounted for with a single factor. The factor accounted for 29.59% of the variance. The original 11 items were then reduced to the five items that best explained self-esteem. These five items accounted for 41.83% of the variance. Confirmatory factor analysis with the second subsample was then used to assess the replicability of the factor analytic solution and to estimate additional indicators of model fit (e.g. RMSEA & CFI). CFA was performed using LISREL 10.20 and demonstrated a good fit of these *five items to a single factor using the second subsample of twins*, χ^2 (5) = 10.61, $p = 0.060$, NNFI = 0.98, CFI = 0.99, RMSEA = 0.04. (Details of these analyses can be provided by the third author upon request). The five items that were identified (see Table 1) were standardized and averaged

[1] Twins comprising four twin pairs were interviewed at different ages. In such cases,twins' ages were averaged in order to account for the age of both twins with a single value priorto use as covariates in the MZ twin difference analyses. All twins who provided data at differentages were tested within one year of each other.

Table 2 Summary of MANOVAs comparing monozygotic and dizygotic twins

	Subsample 1			Subsample 2		
	F	*p*	Hedges *g*	*F*	*p*	Hedges *g*
Maternal affection	.14	.71	.03	0.99	.32	.07
Paternal affection	0.01	.91	.00	1.79	.18	.11
Maternal discipline	0.03	.88	.02	0.00	.99	.00
Paternal discipline	0.14	.71	.03	0.00	.97	.01
Maternal modeling of generosity	0.01	.93	.00	5.56	.02	.21
Paternal modeling of generosity	0.20	.66	.04	1.63	.20	.11

to create a self-esteem variable. The resultant self-esteem variable was not normally distributed. Thus, scores were square-root transformed and phenotypic regression analyses were repeated using transformed self-esteem. Use of the transformed variable did not meaningfully alter results; thus, results for the original self-esteem variable are reported for all analyses. Importantly, the Wave 1 self-esteem variable constructed for this research was significantly correlated with an independent self-esteem measure based on the Rosenberg Self-Esteem Inventory (Rosenberg 1965) that was introduced for the second wave of the MIDUS (Ryff and Keyes 1995; $r = 0.53$ in subsample 1 and $r = 0.63$ in subsample 2). As there was 32% attrition from Wave 1 to Wave 2, the self-esteem variable created from Wave 1 data provided the maximum usable sample size for the MZ twin difference analyses.

Procedure

Twins were identified for participation in the MIDUS (Brim et al. 2007) by screening a random sample of 50,000 households for the presence of a twin. These twin pairs were invited to participate in the phone interview and subsequent questionnaire assessments. The data for the present study were collected via the phone interviews. Extensive information was collected regarding physical and mental health, work history, and family structure. Relevant to the current investigation, retrospective measures of parenting and measures of current well-being and other socioemotional factors were collected.

Analysis plan

Phenotypic regression analyses

Multiple regression analyses were used to test the hypothesis that affection, discipline, and modeling of generosity are related to self-esteem. In order to ensure independence of observation, these regression analyses were performed separately for each subsample of twins described above. Age and sex were included as covariates and were entered in step 1. All parenting variables (maternal affection, maternal discipline, maternal modeling of generosity, paternal affection, paternal discipline, and paternal modeling of generosity) were entered in step 2. Only those variables that were found to be significantly related to self-esteem in these phenotypic analyses were used in subsequent analyses.

Genetic analyses

First, MZ and DZ twins were compared to ensure that they had similar means and variances on all variables of interest. Specifically, MZ and DZ twins did not differ with respect to self-esteem, $t(585) = 0.75$, $p = 0.45$, Hedges $g = 0.06$ in Subsample 1; $t(585) = -1.17$, $p = 0.243$, Hedges $g = -0.10$ in subsample 2. Additionally, MANOVAs comparing MZ twins to DZ twins on remembered parenting variables were not significant, Pillai's Trace = 0.00, $p = 1.00$ in Subsample 1; Pillai's Trace = 0.01, $p < 0.35$ in Subsample 2 (see Table 2). As this assumption was not violated, genetic analyses were undertaken. To examine the second hypothesis assessing the degree to which genes and environment contributed to parenting and self-esteem, Cholesky decomposition models were conducted using LISREL 10.20 to examine the genetic and environmental etiology of parenting and self-esteem. The ACE and ADE models, as well as alternative models, were examined for self-esteem and for those parenting variables that were found to be related to self-esteem.

MZ twin difference regression analyses

MZ twin difference regressions were performed by first subtracting twin 2′s score from twin 1′s score on each variable of interest. The self-esteem difference score was then regressed on the parenting differences scores. Age and age squared were considered as covariates. Age-squared was used because MZ twin differences could be either positive or negative, so age was not expected to predict a linear increase or a linear decrease in self-esteem differences.

Table 3 Descriptive statistics for variables of interest

	Minimum	Maximum	*M*	*SD*	Skewness	Kurtosis
Self-esteem	− 3.15	0.95	0.07	0.70	− 1.09	1.51
Transformed self-esteem	− 2.04	− 0.21	− 0.89	0.38	− 0.08	− 0.41
Maternal affection	1.00	4.00	3.19	0.69	− 0.95	0.24
Paternal affection	1.00	4.00	2.76	0.79	− 0.33	− 0.82
Maternal discipline	1.00	4.00	3.01	0.58	− 0.57	0.11
Paternal discipline	1.00	4.00	3.03	0.69	− 0.73	0.06
Maternal modeling of generosity	1.00	4.00	3.35	0.70	− 0.98	0.42
Paternal modeling of generosity	1.00	4.00	3.25	0.79	− 0.86	− 0.03

Table 4 Phenotypic correlations between variables

	1	2	3	4	5	6	7	8
Age	1.0	.09*	.02	.00	.02	− .05	− .01	− .01
Self-esteem	.11**	1.0	.30**	.26**	.15**	.06	.12**	.10*
Maternal affection	.01	.30**	1.0	.49**	.15**	.16**	.54**	.27**
Paternal affection	.03	.28**	.48**	1.0	.23**	.24**	.29**	.53**
Maternal discipline	.02	.09*	.06	.22**	1.0	.44**	.07	.09*
Paternal discipline	− .03	.08	.11*	.20**	.45**	1.0	.12**	.14**
Maternal modeling of generosity	− .02	.18**	.54**	.27**	.16**	.17**	1.0	.29**
Paternal modeling of generosity	.00	.16**	.23**	.53**	.12**	.17**	.28**	1.0

Note. Subsample 1 correlations appear below the diagonal, and subsample 2 correlations appear above the diagonal

*$p < .05$ **$p < .01$

Table 5 Summary of MANOVAs comparing males and females

	Subsample 1			Subsample 2		
	F	*p*	Hedges *g*	*F*	*p*	Hedges *g*
Maternal affection	6.40	.01	.22	14.50	< .001	.30
Paternal affection	2.13	.15	.10	3.71	.05	.11
Maternal discipline	8.70	.003	.21	4.49	.04	.15
Paternal discipline	1.11	.29	.09	1.65	.20	.13
Maternal modeling of generosity	0.97	.33	.11	2.22	.14	.13
Paternal modeling of generosity	0.26	.61	.04	1.73	.19	.10

Results

Descriptive statistics for key variables of interest are presented in Table 3, and intercorrelations among the variables are presented in Table 4. (Cross-trait cross-twin correlations are presented in Supplemental Table 1). All parenting variables were positively related to one another in both groups of twins ($0.55 > rs > 0.05$, with $ps < 0.07$). Affection and modeling of generosity were significantly related to self-esteem in both subsamples. Maternal and paternal discipline were each related to self-esteem in one subsample. Age was positively related to self-esteem but not to reports of parenting.

Sex differences were assessed for all variables. Multivariate analysis of variance (MANOVA) was used to compare males and females with respect to parenting variables (see Table 5). The overall models were significant in both subsamples (Pillai's trace = 0.98, $F = 5386.73$, $p < 0.001$ in subsample 1 and Pillai's trace = 0.98, $F = 5236.20$, $p < 0.001$ in subsample 2). Males reported more maternal affection and females reported more maternal discipline. Additionally, a *t*-test showed that males ($M = 0.08$) reported higher self-esteem than females ($M = -0.06$) in subsample 1, $t(613) = 2.46$, $p = 0.01$. This result was not replicated in the second subsample, $t(621) = 1.12$, $p = 0.13$, and therefore sex was not entered as a covariate in further analyses of self-esteem. MANOVAs comparing MZ and DZ twins with respect to parenting variables were not

Table 6 Phenotypic regressions predicting self-esteem from parenting

	Subsample 1			Subsample 2		
	β	*t*	*p*	*β*	*t*	*p*
Step 1						
Age	.12	2.76	.01	.10	2.31	.02
Step 2						
Age	.11	2.66	.01	.09	2.35	.02
Maternal affection	.19	3.57	< .001	.24	4.50	< .001
Maternal discipline	.02	0.32	.75	.11	2.46	.01
Maternal modeling of generosity	.01	0.10	.92	− .05	− 1.03	.30
Paternal affection	.16	2.96	.003	.17	3.12	.002
Paternal discipline	.02	0.42	.67	− .05	− 1.15	.25
Paternal modeling of generosity	.03	0.56	.58	− .04	− 0.82	.41

Note. ΔR^2 for step 1 = .01 in subsample 1 and .01 in subsample 2. ΔR^2 for step 2 = .10 in subsample 1 and .11 for subsample 2

$F = 10.59$, $p < .001$ in subsample 1; $F = 11.41$, $p < .001$ in subsample 2

Table 7 Model fit statistics and estimates for best-fitting models for maternal affection, paternal affection, and self-esteem

	Cross-twin correlations		Standardized squared estimates				Model fit indices		
	MZ	DZ	A	C	E	Age	− 2ln(L) (df)	RMSEA [90% CI]	AIC
Maternal affection									
Males	.65***	.40***	.64		.36		− 89.86 (4)	.00 [.00; .11]	− 85.86
Females	.71***	.53***	.41	.31	.28		94.64 (3)	.00 [.00; .09]	100.64
Paternal affection									
Males	.65***	.38***	.64		.36		93.58 (4)	.00 [.00; .11]	97.58
Females	.79***	.61***	.32	.46	.21		166.51 (3)	.00 [.00; .10]	172.51
Self-esteem									
Sexes equal	.55**	.22**	.50		.49	.01	331.66 (8)	.09 [.02; .16]	339.66

significant, Pillai's trace = 0.003, $F(6, 570) = 0.25$, $p = 0.96$ in subsample 1; Pillai's trace = 0.01, $F(6, 580) = 1.10$, $p = 0.36$ in subsample 2. A *t*-test showed that MZ and DZ twins did not differ with respect to self-esteem, $t(613) = 1.06$, $p = 0.29$ in subsample 1 and $t(621) = -0.76$, $p = 0.450$ and 0.24 in subsample 2.

Phenotypic regressions

Multiple regression analyses were used to examine the hypothesis that parenting was related to self-esteem. These analyses were conducted in each twin subsample separately (see Table 6) because siblings cannot be included in a single analysis as this would violate assumptions of sample independence. The use of two separate samples of twins also allowed the same analysis to effectively be conducted twice, using data collected at the same time but including different participants (siblings) in the different analyses, to examine the replicability of the results. Age was entered in step 1 ($R^2_{\text{adjusted}} = 0.02$ in subsample 1, $R^2_{\text{adjusted}} = 0.01$ in subsample 2), followed by maternal variables in step 2 ($\Delta R^2 = 0.08$ in subsample 1, $\Delta R^2 = 0.09$ in subsample 2) and paternal variables in step 3 ($\Delta R^2 = 0.02$ in subsample 1, $\Delta R^2 = 0.02$ in subsample 2). Age was significantly related to self-esteem, $\beta = 0.11$, $p = 0.01$ in subsample 1 and $\beta = 0.08$ $p = 0.03$ in subsample 2. Maternal affection ($\beta = 0.27$, $p < 0.001$ in subsample 1 and $\beta = 0.30$, $p < 0.001$ in subsample 2) and paternal affection ($\beta = 0.16$, $p < 0.01$ in subsample 1 and $\beta = 0.17$, $p < 0.01$) were also positively related to self-esteem, suggesting that more affectionate parenting is related to higher self-esteem in adulthood. Maternal discipline was positively related to self-esteem only in subsample 2 ($\beta = 0.12$, $p = 0.01$) and therefore neither discipline nor modeling of generosity were included in subsequent analyses.

Table 8 Correlations between MZ difference scores and covariates

	1	2	3	4	5
1. Age	1.0				
2. Age Squared	.99***	1.0			
3. Self-Esteem Difference Score	.08	.08	1.0		
4. Maternal Affection Difference Score	.03	.01	.02	1.0	
5. Paternal Affection Difference Score	.03	.03	.22***	.45***	1.0

***$p < .001$

Heritability

Because age was significantly related to self-esteem in the phenotypic regressions, it was included as a covariate in the self-esteem models. Additionally, because significant sex differences were found for maternal affection in both subsamples, all parental models initially were assessed as 4-group models, first freeing paths across males and females and then constraining those paths to determine whether males and females could be combined in analyses. All final best-fitting models are presented in Table 7. All models are presented in Supplemental Tables S2–S4.

For maternal affection, the model equating males and females yielded a significantly worsened fit, change $\chi^2(3) = 16.88$, $p < 0.001$; thus, remaining models were assessed separately for males and females. Comparison of a series of nested models showed that for women, the ACE model best fit the data. However, for men, the AE model provided a better fit to the data. The same pattern was found for paternal affection. Again, equating males and females yielded a significantly decreased fit, change $\chi^2(3) = 14.07$, $p < 0.001$. The ACE model provided the best fit for females, whereas the AE model provided the best fit for males. Thus, shared environment was significant for adult children's remembered maternal parenting but not for paternal parenting.

For adult self-esteem, there was not a significant decrease in fit when parameters were set equal for males and females, change $\chi^2(5) = 6.91$, $p = 0.23$, so the remaining analyses combined males and females. The age covariate could not be dropped, change $\chi^2(1) = 4.29$, $p = 0.04$, showing that as adults got older, self-esteem increased. The best fitting model for self-esteem was the AE model that included the age covariate, showing that shared environment is not a significant factor for adult self-esteem.

Monozygotic twin difference regressions

MZ twin difference regressions were conducted to test the final hypothesis that MZ twin differences in parenting were related to differences in self-esteem. Difference scores were created by subtracting the score for twin 2 from the score for twin 1 for each variable (i.e. maternal affection, paternal affection, and self-esteem). Correlations between difference scores are provided in Table 8. Maternal and paternal affection difference scores were significantly correlated, suggesting that that the twin who reported more maternal affection generally also reported more paternal affection. Paternal affection differences were related to self-esteem differences, suggesting that the twin who reported more paternal affection also reported higher self-esteem.

Table 9 displays the MZ difference results created by regressing self-esteem differences on maternal affection differences and paternal affection differences while controlling for age and age-squared. Neither age nor age-squared were related to self-esteem differences, suggesting that MZ twins do not become more or less similar to each other with respect to self-esteem as they age. Maternal affection differences were not significantly related to self-esteem differences ($\beta = 0.08$, $p = 0.22$). Consistent with hypotheses, paternal affection differences were related to self-esteem differences, ($\beta = 0.18$ $p = 0.01$), such that the twin who reported experiencing more paternal

Table 9 Monozygotic twin difference regression predicting self-esteem differences from parenting differences

	β	t	p
Step 1			
Age	.09	1.49	.14
Step 2			
Age	.08	1.20	.23
Age^2	.03	0.53	.60
Step 3			
Age	.06	0.96	.34
Age^2	.05	0.76	.44
Maternal Affection Difference Score	.08	1.24	.22
Paternal Affection Difference Score	.18	2.78	.01

ΔR^2 for Step 1 = .00. ΔR^2 for Step 2 = .00. ΔR^2 for Step 3 = .03. $\Delta R^2 = .05$

Overall model $F = 4.49$, $p < .01$

affection also reported higher self-esteem, $R^2_{\text{adjusted}} = 0.05$, $F(4) = 4.49$.

Discussion

The present study examined the relationship between remembered parenting and adult self-esteem. Parenting from mothers and fathers were examined separately in order to investigate the possibility that mothers and fathers impact the self-esteem of their children through different mechanisms. Parenting variables that were examined included affection, discipline, and modeling of generosity. Retrospective reports of maternal and paternal affection were related to adult self-esteem, and discipline and modeling of generosity did not predict self-esteem. Age was also related to self-esteem such that older participants had higher self-esteem. In addition, maternal and paternal affection, as well as self-esteem, had heritable components, further substantiating use of the MZ twin difference design in order to control for genetic factors that could contribute to the relationship between affection and self-esteem. MZ twin difference analyses revealed that differences in perceived paternal affection were related to differences in self-esteem. Thus, nonshared environmental factors contribute to the relationship between paternal affection and self-esteem. In contrast, differences in perceived maternal affection were not related to differences in self-esteem.

Parental affection and self-esteem

Although maternal and paternal affection were both related to self-esteem at the phenotypic level, the MZ twin difference analyses suggests that they may operate through different mechanisms. Environmental differences in how fathers treat children seem to be impactful for their self-esteem. Analyses showed that the twin in any given pair who reported greater paternal affection also was more likely to report higher self-esteem. This was not true for maternal affection. Although mothers may provide different levels of affection to their MZ twins, these differences in affection do not meaningfully impact differences in their children's self-esteem in adulthood. Genetic mechanisms may explain how self-esteem is influenced by the degree of maternal affection children experience. These results point to important differences in the mechanisms through which mothers and fathers shape their children's self-esteem.

Mothers tend to have a caregiving role in the lives of their children (Collins and Russell 1991). As this caregiving role may be evolutionarily programmed, mothers may be more likely to perform appropriate amounts of caregiving for all children. Thus, even if children experienced, or remember experiencing, different levels of maternal affection, they still may feel that they were cared for appropriately, and therefore differences in it may not be expected to lead to differences in MZ twins' self-esteem. Fathers, by contrast, perform different functions, such as play (Grossmann et al. 2002). Thus, affection and caregiving may not be an evolutionary imperative for fathers the way that it is for mothers. Although interventions specifically targeting the affection of fathers are not common, these findings suggest that interventions targeting paternal affection may be particularly impactful for promoting self-esteem and other related outcomes. Specifically, it is likely that interventions that increase fathers' affection would lead to increases in children's self-esteem that would persist into adulthood. Interventions designed to increase mothers' affection would not be likely to have the same effect, as their impact on their children's self-esteem appears to be a function of either shared genes or idiosyncratic environmental effects (Plomin 2018).

By contrast, although mothers may provide different levels of affection to their children, it is still important that they provide the amount of affection that each child needs. Thus, MZ twins in the same family may receive different levels of affection, but as long as they receive an amount that will allow them to maximize their potential for self-esteem then it is sufficient (Plomin 2018). An adequate parenting environment (i.e. good-enough parenting; Scarr 1992) provided by mothers may be sufficient for children to develop their genetic potential with regard to self-esteem.

Thus, maternal affection influences self-esteem, but the mechanism through which maternal affection relates to self-esteem is different from the mechanism through which paternal affection relates to self-esteem. It is likely that genetic factors are responsible for the association between maternal affection and self-esteem, as shared environmental factors have not been shown to contribute to self-esteem (Neiss et al. 2002), and the results reported herein corroborate this. These genetic influences may be direct (e.g., the same genes that contribute to maternal affection also contribute to self-esteem). They also may be due to gene-environment interplay, such as gene-environment correlation (rGE; Scarr and McCartney 1983) or gene-environment interaction (GxE; Pluess and Belsky 2010). In other words, it is quite likely that children's levels of self-esteem, which have a genetic component, have an effect on parental affection toward them (reactive rGE). It also is likely that children's self-esteem develops partly from their genetic make-up (which they receive from their parents) as well as their parenting environment (passive rGE). Finally, GxE may also occur, such that children with certain genetic make-up respond differently to different degrees of parental affection, affecting the development of their self-esteem. The current data set

does not allow for the exploration of these complicated gene-environment interplay options, but future research should attempt to address these.

Strengths, limitations, and future directions

The present study adds to the literature in the area of self-esteem development by using an MZ twin difference design to isolate the nonshared environment as it relates to parenting and self-esteem. The MZ twin difference design is a more direct test of the nonshared environment than is traditional twin modeling (Pike et al. 1996). Therefore, the present study provides a robust test of the impact of the nonshared environment on the association between parenting and adult self-esteem that could not be gleaned with a traditional twin-design approach.

A second strength is the examination of a host of parenting variables and their relationships with self-esteem. The use of three distinct parenting dimensions (i.e. affection, discipline, and modeling of generosity) allowed for a more complete picture of the aspects of parenting that are particularly meaningful for promoting later self-esteem. Relatedly, the use of retrospective reports of mother and father parenting allowed for direct examination of the different roles mothers and fathers play in the development of self-esteem. Although retrospective reports of parenting have been used previously to examine the relationship between parenting and self-esteem (e.g. Bulanda and Majumdar 2009), it is less common than other methods of measuring parenting (e.g. observational and questionnaire methods in childhood). Self-reports of parenting assessed in adulthood might be expected to be more strongly related to self-esteem in adulthood than childhood measures of parenting, given that memories of parenting might be more influential than the parenting that actually occurred.

However, the important limitation of retrospective reports of parenting must be acknowledged. As participants were between 20 and 75 years of age, reports of parenting may not have been accurate. Reports given by older participants in the sample may have been particularly biased by a host of adulthood experiences (e.g. their own parenting experiences) as well as recall bias. Reports given by younger participants may have also been biased by these factors, although to a lesser degree. Future research should examine age as a moderator of the relationship between remembered parenting and self-esteem. Given the limitations of retrospective reports of parenting, future MZ twin difference research should examine child reports and observational measures of parenting and their relationships with self-esteem.

Additionally, reports of parenting and self-esteem were collected at the same time point. Due to the cross-sectional nature of the data, it is impossible to definitively determine that parenting practices experienced in childhood influence self-esteem in adulthood. It is possible that self-esteem influences how people remember their parents. Future research should employ longitudinal designs to better understand the relationship between parenting and self-esteem.

Another possible limitation is the discipline measure used. Previous research has shown that overly punitive discipline is negatively related to self-esteem, whereas discipline practices that are designed to gently correct inappropriate and to encourage appropriate behavior are positively related to self-esteem. The discipline measure in the present study combined both punitive (e.g. "How harsh was she when she punished you?") and corrective measures of discipline (e.g. "How consistent was she about the rules?"). Thus, it is possible that a more nuanced measure of parental discipline would have been associated with self-esteem.

Additionally, the validity of the measures used for parenting constructs was not assessed. Although reliabilities for these constructs were satisfactory in the current study and prior work with the MIDUS (e.g., Rossi, 2001), more research will be needed to ascertain their validity as measures of parenting. It is possible that more traditional measures of parenting, especially those designed for assessment of parenting during childhood (e.g. the Child Rearing Practices Report; Deković et al. 1991) would yield different results. Future research should continue to examine specific parenting practices that relate to self-esteem with a variety of psychometrically established measures of parenting and self-esteem.

Another interesting future direction involves investigating reasons that remembered parenting may differ among adult twins. One possibility is that they received different parenting. Thus, nonshared confounders, which are factors that differ among siblings, (e.g. Frisell et al. 2012), may lead to differences in parenting among genetically identical individuals. Also, twins who received similar parenting may nonetheless remember their parenting differently. One potential factor that may lead to these differences is becoming parents themselves and developing personal opinions about effective parenting. Reasons for differences in remembered parenting will be important to investigate in future twin research related to remembered parenting. Relatedly, it would be interesting to investigate these relationships among young children to see if current parenting is related to young children's self-esteem in a manner similar to what was found here with adults.

Finally, the sample used in this study was underpowered for bivariate genetic analyses. Thus, it was not possible to investigate the possible contribution of genes and shared environments to the relationship between parenting and self-esteem. It would be particularly beneficial to investigate the relationship between maternal affection and self-esteem using a multivariate twin model, as the MZ twin difference analyses revealed that nonshared environment

was not important for the relationship. An important goal of future research will be to utilize multivariate twin models to investigate genetic and shared environmental effects on relationships between parenting and self-esteem in adulthood.

Conclusions

It is clear that remembered parenting is related to adult self-esteem. The current study suggests that parental affection may be particularly important. In addition, the present results suggest that parenting is related to self-esteem through a variety of genetic and environmental mechanisms. Specifically, an MZ twin difference design was used to isolate the impact of the nonshared environment on the relationship between parenting and self-esteem. Findings suggest that nonshared environmental mechanisms contribute to the association between paternal affection and self-esteem. In contrast, maternal affection appears to be related to self-esteem primarily through genetic mechanisms. Given these findings, interventions designed to increase paternal affection may be more effective at increasing self-esteem than those designed to increase maternal affection. Although further research is needed in order to understand the mechanisms that underlie the association, it is clear that complex interplay between genetic and environmental factors is responsible for the relationship between parenting and self-esteem.

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Compliance with ethical standards

Conflict of interest Riley L. Marshall, Colin R. Harbke, and Lisabeth Fisher DiLalla declare no conflicts of interest.

Human and Animal Rights and Informed Consent The MIDUS Study complied with the standards of the University of Wisconsin and the Harvard Medical School, and participants provided informed consent.

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