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Roots and Benefits of Costly Giving: Children Who Are More Altruistic Have Greater Autonomic Flexibility and Less Family Wealth

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Abstract

Altruism, although costly, may promote well-being for people who give. Costly giving by adults has received considerable attention, but less is known about the possible benefits, as well as biological and environmental correlates, of altruism in early childhood. In the current study, we present evidence that children who forgo self-gain to help other people show greater vagal flexibility and higher subsequent vagal tone than children who do not, and children from less wealthy families behave more altruistically than those from wealthier families. These results suggest that (a) altruism should be viewed through a biopsychosocial lens, (b) the influence of privileged contexts on children's willingness to make personal sacrifices for others emerges early, and (c) altruism and healthy vagal functioning may share reciprocal relations in childhood. When children help others at a cost to themselves, they could be playing an active role in promoting their own well-being as well as the well-being of others.

Keywords
altruism, socioeconomic status, childhood, vagal tone, autonomic flexibility

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Although altruism is personally costly in terms of material resources, a growing body of research suggests that it may also confer emotional and physiological benefits for people who give. Helping other people can help ameliorate stress (Taylor, 2006; von Dawans, Fischbacher, Kirschbaum, Fehr, & Heinrichs, 2012), is emotionally rewarding (Dunn, Aknin, & Norton, 2014), and is linked to improved physical health and longevity (Brown, Nesse, Vinokur, & Smith, 2003; Schreier, Schonert-Reichl, & Chen, 2013). These findings suggest that when adults provide assistance to other people, they may get something back—improved well-being. If behaving generously is intrinsically beneficial, we might also expect to see this association in young children. One aim of the present study was to examine whether young children who engage in altruistic giving also show healthier physiological functioning.

Although prosociality emerges early in life and can be rewarding, helping other people at a cost to oneself can often be difficult. For young children, altruism, defined as costly helping, is indeed harder than other kinds of prosocial behaviors (Svetlova, Nichols, & Brownell, 2010); in addition, there are considerable individual differences across children (House et al., 2013). A second aim of the present study was to investigate biological and environmental factors related to social engagement as predictors of children's altruism.

Polyvagal theory posits that prosociality is supported by physiological states that foster calm social engagement and inhibit defensive responding (i.e., fight-or-flight behaviors; Porges, 2011). In the autonomic nervous system, increased parasympathetic influence on the heart via the myelinated vagus nerve (i.e., vagal tone) is believed to facilitate perception of the environment as safe, and vagal withdrawal or suppression (i.e., decreased parasympathetic influence) in response to salient tasks supports adaptive orienting and coping with challenge (Porges, 2011; Thayer, Ahs, Fredrikson, Sollers, & Wager,

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2012). In threatening situations, increased sympathetic-nervous-system (SNS) activation mobilizes energy for fight-or-flight responding (Cannon, 1932). Thus, some have proposed that prosociality is supported by activation of the parasympathetic nervous system (PNS) and inhibition of the SNS (Fabes, Eisenberg, & Eisenbud, 1993; Goetz, Keltner, & Simon-Thomas, 2010), but evidence for this is mixed (Hastings, Miller, Kahle, & Zahn-Waxler, 2014).

Furthermore, previous research on the autonomic correlates of children's prosociality has focused on empathy, sympathy, and noncostly prosocial behaviors (Hastings, Miller, Kahle, & Zahn-Waxler, 2014). Researchers have studied neither the autonomic underpinnings nor the potential benefits or consequences of children's helping in contexts that require giving up resources for the good of other people. Higher PNS activity and lower SNS activity at rest reflect effective conservation of bodily energy and are related to better mental and physical health (Thayer & Sternberg, 2006). Thus, we tested whether PNS and SNS activity predicted children's altruistic giving and whether these behaviors, in turn, reciprocally predicted subsequent levels of PNS and SNS activity.

Children's altruism is a function not only of their biology but also of their environmental contexts. Recent research points to socioeconomic status (SES) as an important environmental factor that shapes social engagement (Kraus, Piff, & Keltner, 2011). Higher SES has been linked to lower prosociality in adults (Piff, Kraus, Cote, Cheng, & Keltner, 2010; Stellar, Manzo, Kraus, & Keltner, 2012). One explanation for this finding is that greater access to material resources decreases reliance on others (Kraus et al., 2011). As a result, high SES may increase self-focus and decrease interpersonal sensitivity. It is unclear whether the link between high SES and increased self-focus extends to young children's altruism. Examinations of the relation between family SES and children's altruistic giving using the dictator game, which asks children to allocate resources between themselves and other people, have produced inconsistent findings (Benenson, Pascoe, & Radmore, 2007; Chen, Zhu, & Chen, 2013). These studies, like many that use the dictator game, are missing two important motivational elements for altruism. First, information about the emotional state or need of the potential recipient is not available (de Waal, 2008). Second, the resources that are available for giving are not accumulated through work or effort (Warneken, Lohse, Melis, & Tomasello, 2010). Current evolutionary models posit that altruism evolved out of a system for providing caregiving to dependent, vulnerable offspring but can be directed toward nonkin when the situation shares similar features, such as vulnerability (Preston, 2013). Furthermore, many real-world opportunities for altruism, such as charitable donation, involve distributing one's own earned resources to vulnerable or less fortunate individuals. Thus, we should study children's altruism in contexts that are both evolutionarily meaningful and ecologically valid.

To the extent that maintaining a state of calm social engagement is important for providing costly helping, we expected that greater PNS activity and lower SNS activity in response to perceiving others' needs would predict more altruistic giving. We also hypothesized that more altruistic giving would confer the physiological benefits of subsequent higher PNS activity and lower SNS activity. Finally, we predicted that children from wealthier families would be less altruistic than children from less affluent families.

Method

Participants

This analysis included 74 preschool-age children (mean age = 4.09 years, *SD* = 0.12; 40 girls, 34 boys). These data were collected in the context of an ongoing longitudinal study; every family that participated when the donation procedure was being administered provided data. Families were predominantly White (74%) and were middle to upper-middle SES (mean income range = \$75,000–\$90,000; overall income range = \$15,000–\$30,000 to > \$120,000). Families were recruited via direct mailings, local advertisements, and letters distributed to day-care centers. Children with serious cognitive or physical impairments that might interfere with their ability to complete procedures were excluded from the study.

Procedure

Families visited the laboratory for testing. After arriving, children played with an examiner for approximately 10 min while another examiner obtained mothers' informed consent. During this time, the examiner explained to children that they would be earning tokens over the course of the visit that could be traded in for a prize at the end. Approximately 15 min into the laboratory visit, electrodes were attached to the child's torso to obtain electrocardiographic (ECG) and impedance cardiographic signals (for details, see ECG and Impedance Cardiographic Data). By completing a variety of activities over the course of almost 2 hr, each child gradually earned 20 prize tokens, which were kept for the child in a token box. Just before the end of the visit, the children participated in a donation task with their prize tokens.

Measures

Altruism. Altruistic behavior was assessed using a donation task (Grusec & Redler, 1980), administered near the end of the lab visit and before children received their prizes. The children were given an opportunity to donate their prize tokens to anonymous sick children (fictitious), so that the sick children could also get prizes even though they were unable to come to the lab. The task was divided into three phases.

Instruction phase. The examiner sat with the children at a table and explained the donation task. The children were told that they had earned 20 prize tokens, enough to get a really great prize. The examiner then said she had another job working at a hospital with sick children who could not come to the lab to earn prizes. The examiner explained that if the children wanted to, they could donate some of their own prize tokens by moving tokens from their own boxes to a separate box reserved for the children in the hospital. Both boxes were placed on the table in front of the seated children. The children were told, "You can give them all of your tokens, some of your tokens, or none of your tokens. It's up to you." To ensure that the children understood the task, the examiner asked them to identify which box was for their tokens and which box was for the children in the hospital. The children were given a bell to ring when they were finished deciding, and the examiner then left the room.

Decision phase. The children were left alone in the room to decide whether and how much to share by taking tokens out of their token boxes and placing them into the box for the sick children. The children rang the bell to signal that they were done and ready for the examiner to come back into the room.

Conclusion phase. The examiner returned to the room, closed the token boxes without looking inside them, and put away the materials. The children were not offered feedback on their behavior during this time.

ECG and impedance cardiographic data. Three disposable, pregelled electrodes were attached to each child's chest to obtain an ECG signal. An additional 4 electrodes were placed on each child's chest and back to obtain an impedance cardiographic signal. ECG and impedance cardiographic data were collected, edited, and processed using ambulatory monitors and software from MindWare Technologies (Gahanna, OH).

Respiratory sinus arrhythmia (RSA) refers to heart-rate variability that corresponds with breathing and is a measure of PNS activity (i.e., vagal tone; Berntson et al., 1997). Spectral analysis of the ECG data was used to compute RSA (Berntson et al., 1997). The specific frequency band used to quantify RSA was 0.24 to 1.04 Hz (Huffman et al., 1998), and the sampling rate was set at 500 ms. We used the first derivative of change in the impedance signal (*dz/dt*) as an estimate of respiration (Ernst, Litvack, Lozano, Cacioppo, & Berntson, 1999), and we controlled for it in the computation of RSA. RSA values were computed in 15-s epochs over the course of the altruism task. This is a common epoch length for computing RSA in developmental studies using shorter tasks (Huffman et al., 1998; Miller et al., 2013).

Preejection period (PEP) refers to the time in milliseconds between ventricular depolarization and the opening of the aortic valve and is a measure of SNS activity. PEP was defined as the average time interval between the onset of the R spike (as marked by the Q point in the ECG signal; Berntson, Lozano, Chen, & Cacioppo, 2004) and the B point in the *dz/dt* signal (Lozano et al., 2007). Shorter PEP indicates greater SNS activity. PEP values were computed in 15-s epochs over the course of the altruism task.

Epochs were averaged to form three mean RSA and PEP scores that corresponded with the three different phases of the altruism task (i.e., instruction, decision, and conclusion). The duration of the phases of the altruism task varied across children—instruction phase: $M = 89.69$ s, $SD = 16.45$, range = 47–138 s; decision phase: $M = 49.49$, $SD = 43.15$, range = 9–275 s. The conclusion phase was 30 s for all children. RSA and PEP in the decision phase were not computed for 3 children who took less than 15 s to ring the bell. We had incomplete physiological data for 20 children because either they refused to wear the cardiac monitor or we were unable to obtain useable cardiac data for one or more phases of the task. Thus, in the three phases of the task, the number of children for whom useable data for at least one of these measures (i.e., RSA or PEP) was available ranged from 51 to 62.

Family income. Mothers reported their annual family income before taxes using a 9-point scale with $15,000 increments (1 = 0–$15,000, 9 = > $120,000).

Analyses

We used structural equation modeling to examine hypothesized relations between the children's physiology, altruistic giving, and family income. We tested separate models using RSA or PEP as the physiological variable of interest. In both models, we included an autoregressive component to control for rank-order stability in physiology over the course of the donation task. Model fit was assessed using χ^2 tests, the comparative fit index (CFI), and the Tucker-Lewis index (TLI). Good fit is indicated by nonsignificant χ^2 values and by CFI and TLI values higher than .95 (Hu & Bentler, 1999). χ^2 difference tests were used to compare fit between different models. Full-information maximum-likelihood estimation was used to produce model estimates and account for missing data.

Results

Descriptive statistics and correlations between the main variables are presented in Table 1. There was high

Table 1. Descriptive Statistics and Correlations

Measure	*M*	*SD*	*n*	Correlations 1	2	3	4	5	6	7
1. Tokens donated (0–20)	5.09	6.34	74							
2. RSA in instruction phase	5.45	1.15	62	.17						
3. RSA in decision phase	5.37	1.16	58	−.08	.66***					
4. RSA in conclusion phase	5.89	1.08	60	.09	.73***	.78***				
5. PEP in instruction phase (ms)	94.34	9.94	56	.03	.14	.04	.16			
6. PEP in decision phase (ms)	95.24	9.76	51	.04	.00	−.01	.07	.92***		
7. PEP in conclusion phase (ms)	94.35	9.43	52	.00	.04	.05	.14	.94***	.93***	
8. Family income (1–9)	6.69	2.30	74	−.28*	−.05	.09	.09	.01	.07	.08

Note: RSA = respiratory sinus arrhythmia, $\ln(\text{ms})^2$; PEP = preejection period.
*$p < .05$. ***$p < .001$.

rank-order stability in RSA and PEP over the course of the donation task, and there was a negative association between family income and number of tokens donated. Forty children (54%) chose to donate at least one token to the sick children, and 34 children chose not to donate. The number of tokens donated ranged from 0 to 20 (*Mdn* = 3). An analysis of variance showed that there were significant differences in RSA, $F(2, 53) = 13.83$, $p < .001$, and borderline significant differences in PEP, $F(2, 46) = 2.92$, $p = .06$, over the course of the altruism task. Follow-up analyses showed that RSA was significantly higher during the conclusion phase than during the instruction and decision phases of the altruism task. PEP was significantly longer (i.e., there was less SNS activation) during the decision phase than during the instruction and conclusion phases of the altruism task.

The structural equation model including RSA as the physiological variable of interest is presented in Figure 1. The paths from sex predicting the children's RSA during the decision and conclusion phases of the task were not significant and removing them from the model did not significantly diminish overall model fit, $\chi^2(2, N = 74) = 0.29$, $p = .86$. We excluded these paths to increase the parsimony of the model. In contrast, girls tended to donate more tokens than boys, $\beta = 0.19$, $p = .08$, and removing this path from the model decreased model fit at the trend level as shown by a χ^2 difference test, $\chi^2(1, N = 74) = 3.15$, $p = .08$. Although this variable and path are not shown in Figure 1, they were retained in the final model. We controlled for covariation between RSA during the instruction phase of the altruism task and family income and sex, but these associations were not significant, both $|r|$s < .04, both *p*s > .78.

Our final model showed good fit with the data, $\chi^2(6, N = 74) = 7.35$, $p = .29$, CFI = .99, TLI = .95. The model accounted for 23% of the variance in the children's altruism and 68% of the variance in the children's RSA during the conclusion phase of the task. The children with higher RSA during the instruction period and lower RSA during the decision period donated more tokens, $\beta = 0.43$ and $\beta = -0.41$, respectively, both *p*s < .01. Altruistic giving, in turn, predicted higher RSA levels after the task, $\beta = 0.23$, $p < .01$, over and above the direct and indirect contributions of the children's RSA during the decision and instruction periods. Family income negatively predicted the number of tokens donated, $\beta = -0.28$, $p < .01$, but positively predicted RSA during the conclusion phase, $\beta = 0.15$, $p = .05$. (See the Supplemental Material available online for additional analyses using RSA change scores rather than RSA values.)

We fit a second identical model in which PEP instead of RSA was the physiological variable of interest. This model showed poor fit to the data, $\chi^2(6, N = 74) = 23.20$, $p = .001$, CFI = .92, TLI = .71. PEP showed high rank-order stability over the course of the altruism task, both βs = 0.92, *p*s < .001, but was not significantly associated with the children's donation behaviors or family income, all $|\beta|$s < 0.13, all *p*s > .71.

Discussion

Previous research has shown that altruism, although costly in material resources, can promote well-being among adults who give (Dunn et al., 2014) and that adults' prosociality is closely tied with their neurobiological functioning and socioeconomic resources (Keltner, Kogan, Piff, & Saturn, 2014). Children's prosociality, broadly defined, has also been the subject of considerable neurobiological research (Hastings, Miller, Kahle, & Zahn-Waxler, 2014) and socialization research (Hastings, Miller, & Troxel, 2014). However, the potential benefits, as well as the biological and environmental correlates, of children's altruism are not as well documented. The current study provides evidence that (a) children who sacrifice resources to help other people demonstrate healthier parasympathetic functioning, as demonstrated by both

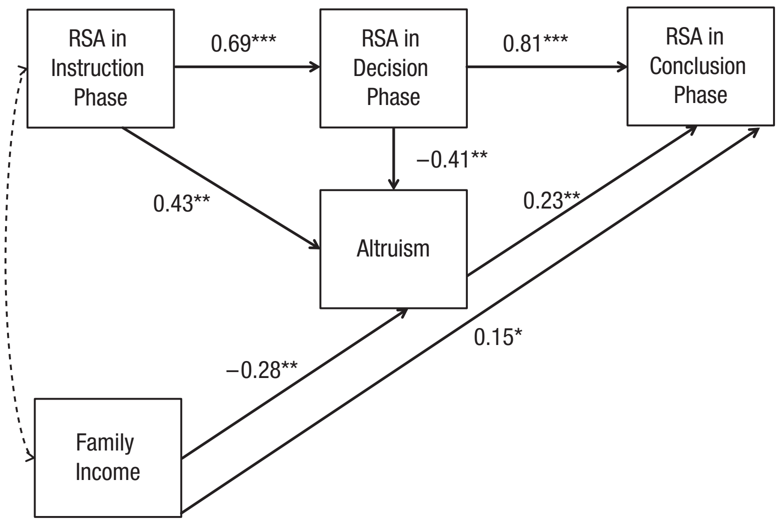

Fig. 1. Structural equation model of the relations among altruism (tokens donated), respiratory sinus arrhythmia (RSA), and family income. Asterisks represent the significance of the standardized regression coefficients (*p < .05, **p < .01, ***p < .001).

greater vagal flexibility during an altruism task and higher vagal tone immediately afterward; (b) children from less wealthy families behave more altruistically than children from wealthier families; and (c) altruism augments vagal tone for children from both lower and higher income families, perhaps offsetting the physiological disadvantage linked to coming from a less economically prosperous background.

To our knowledge, this is the first study of autonomic regulation underlying children's costly giving. The observed changes in the associations between RSA and altruism over the course of the donation task reflected the principles of polyvagal theory (Porges, 2011), in that varying contextual factors influenced whether decreased or increased vagal engagement was appropriate (Hastings, Kahle, & Han, 2014). Our findings help to resolve prior evidence that decreasing and increasing vagal tone are associated with children's prosocial tendencies (Hastings & Miller, 2014) by suggesting that these associations emerge over the changing demands of an altruistic event.

Initially, the children listened to the examiner present an opportunity to help others in need, and greater vagal tone would have reflected the children's calm engagement with that experience. Thus, the children with higher RSA were in a physiological state that facilitates a perception of safety that may have allowed them to experience other-oriented emotions such as compassion. To have acted on that emotion in the decision phase would have required a mobilization of resources for behavior. Thus, vagal suppression in the decision phase would have supported the children's ability to engage in altruistic action. The children showed less change in SNS activity than in PNS activity over the course of the task, but SNS levels were lowest (i.e., the PEP was longest) during the decision phase. Therefore, the physical act of sharing more tokens, which would require increased energy, was supported by releasing the "vagal brake" without engaging in threat-related SNS arousal. Taken together, altruistic engagement with other people appeared to be intrinsically linked to vagal flexibility—the ability to increase and decrease PNS activity as conditions change (Miller et al., 2013). It should be noted that vagal flexibility might support active engagement in tasks in general, rather than altruism in particular. Future research with comparison conditions will be needed to address this possibility.

Findings from recent studies with adults suggest that the cultural milieu of higher SES is characterized by increased self-focus and decreased interpersonal sensitivity (Kraus et al., 2011). Our finding that family income negatively predicted altruism implies that this culture of self-focus could potentially be present in children as young as 4 years old who are from higher SES backgrounds. The implication that their parents socialize greater self-interest in these children is consistent with findings that parents of higher SES value autonomy and individualism as socialization goals, whereas parents of lower SES are concerned with fostering respectfulness and obedience (Hoff, Laursen, & Tardif, 2002). High-SES parents may also model less prosociality in their daily lives, because these communities tend to be less altruistic (Kraus et al., 2011). However, further research is necessary to replicate our findings and clearly identify potential mechanisms by which higher family income might lead to less altruism in children. In addition, we cannot specify the extent to which our findings may be unique to the strongly individualistic cultural milieu of the United States;

cross-cultural comparisons of these biopsychosocial processes would be very informative.

We found that the children had higher vagal tone after the donation task if they donated resources or came from an economically advantaged family. The first path suggests that children's altruism may confer physiological benefits by increasing subsequent vagal tone. This is consistent with a previous finding that toddlers show decreased autonomic arousal after helping or seeing someone help an experimenter in need (Hepach, Vaish, & Tomasello, 2012). Increased parasympathetic influence may underlie perceptions of safety (conscious or unconscious), thus helping to promote health by decreasing stress and related wear and tear on the body (Porges, 2011; Thayer et al., 2012). Furthermore, RSA has been linked to reported positive emotions and well-being (Kreibig, 2010; Oveis et al., 2009). Forgoing self-gain to help others may in turn help children to feel safe and calm at a physiological level. Thus, our findings suggest that children may derive an intrinsic sense of security from the act of helping other people.

The path from higher family income to higher vagal tone after the task is consistent with the well-established link between higher childhood SES and better health (Bradley & Corwyn, 2002; Schreier & Chen, 2013). In the context of the full model, the children from less wealthy families were more altruistic, and this countered the risk for lower vagal tone associated with their lower family income. Exposure to family stress related to economic strain could negatively affect the children's vagal functioning, but our findings suggest that altruism can serve as a compensatory pathway to physiological resilience for children who may otherwise be at risk. Conversely, although the children from wealthier families donated less than the children from less wealthy families, the ones who did donate may have gained a boost in vagal functioning over and above what they gained from their advantaged family circumstances. Thus, altruism may represent a path to enhancing healthy physiological functioning regardless of wealth.

An important consideration is that families in our sample ranged from lower-middle to upper-middle SES in terms of family income. It is noteworthy that we observed this effect in a sample with restricted variance in income, but the extent to which our findings apply to children in true poverty, or extreme wealth, is unclear. Previous research examining SES and children's prosociality, although limited, has generally found a negative association between family economic strain and prosocial development (Hastings, Miller, & Troxel, 2014). This is at odds with our finding, but it should be noted that most of this research involved questionnaire measures of children's empathy and prosocial behavior rather than behavioral measures of altruism. Nevertheless, the possibility of a nonlinear association between SES and children's altruism remains: Children from middle-class families may tend to be more altruistic than children from impoverished or privileged families.

This study speaks to the importance of viewing children's altruism through a biopsychosocial lens. The children from less affluent families, as well as those who showed more vagal flexibility, were more likely to sacrifice their earned resources to promote the well-being of other, less fortunate children. Furthermore, economic advantage and altruism in turn predicted higher vagal tone after the task. To the extent that vagal activation supports detection of safety in the environment, our findings suggest that children derive security (at the physiological level) from providing costly help to others. Altruism appears to be intrinsically beneficial for physiological functioning, and encouraging children's altruism may help protect against adverse health outcomes.

Author Contributions

All authors contributed to the design of the study. J. G. Miller and S. Kahle collected the data. J. G. Miller processed the physiological data, conducted the analyses, and drafted the manuscript. P. D. Hastings and S. Kahle provided critical revisions.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Supplemental Material

Additional supporting information can be found at http://pss.sagepub.com/content/by/supplemental-data

References

Benenson, J. F., Pascoe, J., & Radmore, N. (2007). Children's altruistic behavior in the dictator game. *Evolution and Human Behavior*, *28*, 168–175. doi:10.1016/j.evolhumbehav.2006.10.003

Berntson, G. G., Bigger, J. T., Eckberg, D. L., Grossman, P., Kaufmann, P. G., Malik, M., . . . van der Molen, M. W. (1997). Heart rate variability: Origins, methods, and interpretive caveats. *Psychophysiology*, *34*, 623–648. doi:10.1111/j.1469-8986.1997.tb02140.x

Berntson, G. G., Lozano, D. L., Chen, Y.-J., & Cacioppo, J. T. (2004). Where to Q in PEP. *Psychophysiology*, *41*, 333–337. doi:10.1111/j.1469-8986.2004.00156.x

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology*, *53*, 371–399. doi:10.1146/annurev.psych.53.100901.135233

Brown, S. L., Nesse, R. M., Vinokur, A. D., & Smith, D. M. (2003). Providing social support may be more beneficial than receiving it: Results from a prospective study of mortality. *Psychological Science*, *14*, 320–327. doi:10.1111/1467-9280.14461

Cannon, W. B. (1932). *The wisdom of the body*. New York, NY: W. W. Norton.

Chen, Y., Zhu, L., & Chen, Z. (2013). Family income affects children's altruistic behavior in the dictator game. *PLoS ONE*, *8*(11), Article e80419. Retrieved from http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0080419

de Waal, F. B. M. (2008). Putting the altruism back into altruism: The evolution of empathy. *Annual Review of Psychology*, *59*, 279–300. doi:10.1146/annurev.psych.59.103006.093625

Dunn, E. W., Aknin, L. B., & Norton, M. I. (2014). Prosocial spending and happiness: Using money to benefit others pays off. *Current Directions in Psychological Science*, *23*, 41–47. doi:10.1177/0963721413512503

Ernst, J. M., Litvack, D. A., Lozano, D. L., Cacioppo, J. T., & Berntson, G. G. (1999). Impedance pneumography: Noise as signal in impedance cardiography. *Psychophysiology*, *36*, 333–338. doi:10.1017/S0048577299981003

Fabes, R. A., Eisenberg, N., & Eisenbud, L. (1993). Behavioral and physiological correlates of children's reactions to others in distress. *Developmental Psychology*, *29*, 655–663. doi:10.1037/0012-1649.29.4.655

Goetz, J. L., Keltner, D., & Simon-Thomas, E. (2010). Compassion: An evolutionary analysis and empirical review. *Psychological Bulletin*, *136*, 351–374. doi:10.1037/a0018807

Grusec, J., & Redler, E. (1980). Attribution, reinforcement, and altruism: A developmental analysis. *Developmental Psychology*, *16*, 525–534. doi:10.1037/0012-1649.16.5.525

Hastings, P. D., Kahle, S., & Han, G. H.-P. (2014). Developmental affective psychophysiology: Using physiology to inform our understanding of emotional development. In K. H. Lagattuta (Ed.), *Children and emotion: New insights into developmental affective science* (pp. 13–28). Basel, Switzerland: Karger.

Hastings, P. D., & Miller, J. G. (2014). Autonomic regulation, polyvagal theory, and children's prosocial development. In L. Padilla-Walker & G. Carlo (Eds.), *Prosocial development: A multidimensional approach* (pp. 112–127). New York, NY: Oxford University Press.

Hastings, P. D., Miller, J. G., Kahle, S., & Zahn-Waxler, C. (2014). The neurobiological bases of empathic concern for others. In M. Killen & J. Smetana (Eds.), *Handbook of moral development* (2nd ed., pp. 411–434). Mahwah, NJ: Erlbaum.

Hastings, P. D., Miller, J. G., & Troxel, N. (2014). Making good: The socialization of children's prosocial development. In P. D. Hastings & J. E. Grusec (Eds.), *Handbook of socialization* (2nd ed., pp. 637–660). New York, NY: Guilford.

Hepach, R., Vaish, A., & Tomasello, M. (2012). Young children are intrinsically motivated to see others helped. *Psychological Science*, *23*, 967–972. doi:10.1177/0956797612440571

Hoff, E., Laursen, B., & Tardif, T. (2002). Socioeconomic status and parenting. In M. H. Bornstein (Ed.), *Handbook of parenting: Vol. 2. Biology and ecology of parenting* (2nd ed., pp. 231–252). Mahwah, NJ: Erlbaum.

House, B. R., Silk, J. B., Henrich, J., Barrett, H. C., Scelza, B. A., Boyette, A. H., . . . Laurence, S. (2013). Ontogeny of prosocial behavior across diverse societies. *Proceedings of the National Academy of Sciences, USA*, *110*, 14586–14591. doi:10.1073/pnas.1221217110

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*, 1–55. doi:10.1080/10705519909540118

Huffman, L. C., Bryan, Y. E., del Carmen, R., Pedersen, F. A., Doussard-Roosevelt, J. A., & Porges, S. W. (1998). Infant temperament and cardiac vagal tone: Assessments at twelve weeks of age. *Child Development*, *69*, 624–635. doi:10.1111/j.1467-8624.1998.tb06233.x

Keltner, D., Kogan, A., Piff, P. K., & Saturn, S. R. (2014). The sociocultural appraisals, values, and emotions (SAVE) framework of prosociality: Core processes from gene to meme. *Annual Review of Psychology*, *65*, 425–460. doi:10.1146/annurev-psych-010213-115054

Kraus, M. W., Piff, P. K., & Keltner, D. (2011). Social class as culture: The convergence of resources and rank in the social realm. *Current Directions in Psychological Science*, *20*, 246–250. doi:10.1177/0963721411414654

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology*, *84*, 394–421. doi:10.1016/j.biopsycho.2010.03.010

Lozano, D. L., Norman, G., Knox, D., Wood, B. L., Miller, B. D., Emery, C. F., & Berntson, G. G. (2007). Where to B in dZ/dt. *Psychophysiology*, *44*, 113–119. doi:10.1111/j.1469-8986.2006.00468.x

Miller, J. G., Chocol, C., Nuselovici, J. N., Utendale, W. T., Simard, M., & Hastings, P. D. (2013). Children's dynamic RSA change during anger and its relations with parenting, temperament, and control of aggression. *Biological Psychology*, *92*, 417–425. doi:10.1016/j.biopsycho.2012.12.005

Oveis, C., Cohen, A. B., Gruber, J., Shiota, M. N., Haidt, J., & Keltner, D. (2009). Resting respiratory sinus arrhythmia is associated with tonic positive emotionality. *Emotion*, *9*, 265–270. doi:10.1037/a0015383

Piff, P. K., Kraus, M. W., Cote, S., Cheng, B. H., & Keltner, D. (2010). Having less, giving more: The influence of social class on prosocial behavior. *Journal of Personality and Social Psychology*, *99*, 771–784. doi:10.1037/a0020092

Porges, S. W. (2011). *The polyvagal theory: Neurophysiological foundations of emotions, attachment, communication, and self-regulation*. New York, NY: W. W. Norton.

Preston, S. D. (2013). The origins of altruism in offspring care. *Psychological Bulletin*, *139*, 1305–1341. doi:10.1037/a0031755

Schreier, H. M. C., & Chen, E. (2013). Socioeconomic status and health of youth: A multi-level multi-domain approach to conceptualizing pathways. *Psychological Bulletin*, *139*, 606–654. doi:10.1037/a0029416

Schreier, H. M. C., Schonert-Reichl, K. A., & Chen, E. (2013). Effect of volunteering on risk factors for cardiovascular disease in adolescence: A randomized controlled trial. *JAMA Pediatrics*, *167*, 327–332. doi:10.1001/jamapediatrics.2013.1100

Stellar, J. E., Manzo, V. M., Kraus, M. W., & Keltner, D. (2012). Class and compassion: Socioeconomic factors predict responses to suffering. *Emotion*, *12*, 449–459. doi:10.1037/a0026508

Svetlova, M., Nichols, S. R., & Brownell, C. A. (2010). Toddlers' prosocial behavior: From instrumental to empathic to altruistic helping. *Child Development*, *81*, 1814–1827. doi:10.1111/j.1467-8624.2010.01512.x

Taylor, S. E. (2006). Tend and befriend: Biobehavioral bases of affiliation under stress. *Current Directions in Psychological Science*, *15*, 273–277. doi:10.1111/j.1467-8721.2006.00451.x

Thayer, J. F., Ahs, F., Fredrikson, M., Sollers, J. J., III, & Wager, T. D. (2012). A meta-analysis of heart rate variability and neuroimaging studies: Implications for heart rate variability as a marker of stress and health. *Neuroscience and Biobehavioral Reviews*, *36*, 747–756. doi:10.1016/j.neubiorev.2011.11.009

Thayer, J. F., & Sternberg, E. (2006). Beyond heart rate variability: Vagal regulation of allostatic systems. *Annals of the New York Academy of Sciences*, *1088*, 361–372. doi:10.1196/annals.1366.014

von Dawans, B., Fischbacher, U., Kirschbaum, C., Fehr, E., & Heinrichs, M. (2012). The social dimension of stress reactivity: Acute stress increases prosocial behavior in humans. *Psychological Science*, *23*, 651–660. doi:10.1177/0956797611431576

Warneken, F., Lohse, K., Melis, A. P., & Tomasello, M. (2010). Young children share the spoils after collaboration. *Psychological Science*, *22*, 267–273. doi:10.1177/0956797610395392