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Age Differences in the Heritability of Mean and Intraindividual Variation of Psychological Distress

Michelle Neiss[a] David M. Almeida[b]

[a]University of Southampton, Southampton, UK, and [b]Human Development and Family Studies, Pennsylvania State University, State College, Pa., USA

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Negative affect · Behavioral genetics · Intraindividual variation · Emotion regulation

Abstract
Background: An important question in the study of intraindividual variability is whether the same explanatory mechanisms govern between person variation and within person variation. ***Objective:*** This paper investigates genetic and environmental influences on affect across varying time frames and genetic and environmental influences on within person variation in affect. ***Methods:*** Twin participants aged 25–74 years provided information on their affective experiences over monthly, weekly, and daily recall periods. Questionnaires and daily telephone interviews were used to assess frequency of negative emotions. ***Results:*** Monthly, weekly, and daily reports of negative affect all showed modest genetic influence. Monthly and daily measures also demonstrated modest shared environmental influence. Sibling resemblance in within-person variation in affect was accounted for entirely by shared environment. Tests for age differences in magnitude of genetic and environmental effects revealed that genetic influences on monthly reports of affect were greater among older adults, but genetic influences on daily affective experiences were lower among older adults. ***Conclusions:*** Lowered heritability in daily affect among older adults contradicts standard behavior genetic expectations, and is consistent with the proposition that older adults gain skills in emotion regulation.

An important question in the study of intraindividual variability is whether the same explanatory mechanisms govern between person variation and within person variation. When this is the case the phenomenon is considered to have a property of ergodicity. For certain phenomena this property is unlikely [1]. For example, between-person differences reflected by mean levels of emotions may represent emotional set points and are likely to be influenced by genetically based dispositions whereas fluctuations around such set points (i.e. intraindividual variations) are more influenced by environmental conditions [2].

This paper uses a behavior genetic design to inform us about dispositional and environmental influences on negative affect within a life span framework. While substantial evidence suggests that negative mood is influenced by genetic factors [3, 4], few studies have investigated age differences in heritability. We investigate environmental and genetic influences on monthly, weekly, and daily

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Prof. Dave Almeida
Pennsylvania State University, Gerontology Center
135 E. Nittany Avenue, Suite 405
State College, PA 16801-5363 (USA)
Tel. +1 814 865 3252, Fax +1 814 863 9423, E-Mail almeida@psu.edu

reports of negative affect. A focus on differing time frames allows us to compare more molar time referents (i.e. monthly) that may reflect personality factors with more micro time referents (i.e., daily and weekly) that may reflect more situational and contextual influences on affect. The study also looks at intraindividual variability of daily affect. Using daily reports of negative mood, our diary design allows us to examine environmental and genetic sources of fluctuation in mood.

Our study was sparked by interest in the idea that people gain skills in emotional regulation as they age. Research suggests that older people report lower levels of negative affect [5]; a finding that is sometimes interpreted as indirect evidence of developmental gains in the ability to regulate emotions [5, 6]. An alternative explanation, however, is that affect primarily reflects innate disposition and what is often interpreted as emotional regulation is in fact a genotype → environment effect [7]. Scarr's [7] work on intelligence, for example, shows increasing heritability for intelligence over time, which she interprets as evidence that people are selecting opportunities or contexts based on their interests and talents.

Gene → environment effects highlight potential correlations between persons and their environments, such that people with more negative emotional dispositions experience more negative environments. This may reflect active gene-environment correlation, whereby people with greater temperamental positive affectivity are more likely to choose social partners or contexts that maintain relatively positive emotions. Gene–environment correlation can also reflect more evocative effects. Some temperamental styles may facilitate the development of positive relationships, whereas other styles may inhibit the development of relationships. For example, some people with depressive symptoms engage in excessive reassurance seeking, which leads to greater interpersonal rejection, which in turn can lead to greater depression [8]. Over time, therefore, we might see that environments covary with and amplify the effect of initial genetic differences between people. If so, the cumulative effect of genetic differences on emotional experiences may lead to higher heritability estimates among older adults.

In contrast to the dispositional viewpoint, theories concerning age and emotional regulation suggest that older adults are better able generally to control their emotions. This explanation relies less on individual differences, which are potentially under genetic influence, than on general developmental gains. Labouvie-Vief and her colleagues have suggested that in adulthood, people reintegrate affective awareness into their cognitive understanding [9]. In support of her theory, adults were found to have significantly higher levels of emotional understanding and control when compared to adolescents. Other researchers have also found evidence of increased emotional regulation among older adults [5, 10]. Gross et al. [10] found that older adults across diverse cultural and social groups reported greater emotional control than younger adults, suggesting that this gain is a general developmental change. If people acquire generally the ability to control more effectively their emotions, this developmental gain is independent of personality. To the extent that personality is heritable, we would thus expect genetic effects to decrease over time. The purpose of this study is to examine age differences in heritability estimates as a way of investigating whether affect among older adults seems to be more reflective of innate temperament or whether there is evidence of developmental changes in the source of between-person and within-person variation.

Method

Sample and Procedure

Data for the analyses are from the National Study of Daily Experiences (NSDE), one of the in-depth studies that are part of the National Survey of Midlife in the United States Survey (MIDUS) carried out under the auspices of the John D. and Catherine T. MacArthur Foundation Research Network on Successful Midlife. The total NSDE sample of 1,483 is comprised of 1,031 randomly selected respondents from the MIDUS random digit dialed (RDD) subsample and 452 MIDUS twins. We selected twins if twin pairs had high self-reported certainty of zygosity. For the present analysis we used 210 same-sex twin pairs: 111 identical or monozygotic (MZ) pairs, 99 fraternal or dizygotic (DZ) pairs.

Twins ranged in age from 25 to 74 years. Forty-seven percent of the respondents were male, 53% were female. The majority (76%) of respondents were married, 9% were divorced, 2% were separated, 2% were widowed, and 11% were never-married. Respondents were primarily white (92%). Six percent of the respondents were African American. Seventy-seven percent of the respondents were currently working, while 6% were retired.

Over the course of eight consecutive evenings, respondents completed short telephone interviews about their daily experiences. On the final evening of interviewing, respondents also answered several questions about their previous week. To aid independence of reporting, co-twins were interviewed at least two weeks apart. The initiation of interviews was staggered across the day of the week to control for the possible confounding between day of study and day of week.

Negative Affect

Our analyses make use of four measures of negative affect that differ in interval of recall and in level of aggregation. Each affect measure used an inventory of emotions from the Non-Specific Psychological Distress Scale [11]. The scale includes emotions such as sadness, hopelessness, anxiety, and restlessness. Respondents indicated how much of the time they experienced each emotion on a

Table 1. Age differences and sibling resemblance for negative affect variables

Negative affect variable	Younger		Older		t	MZ pairs, r	DZ pairs, r
	mean	SD	mean	SD			
Monthly recall	0.16	0.15	0.14	0.13	−1.99*	0.18	0.14
Weekly recall	0.10	0.10	0.07	0.09	−3.20**	0.22*	0.04
Daily recall	0.06	0.07	0.04	0.05	−4.00***	0.29**	0.13
Intraindividual variation	0.07	0.06	0.05	0.05	−3.90***	0.21*	0.27**

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

5-point scale from *none of the time* to *all of the time*. For each of the following measures of negative affect, mean scores across these items were calculated.

Monthly negative affect: during the initial baseline MIDUS data collection, respondents indicated how often they felt each of 6 emotions 'during the past thirty days' (Cronbach's alpha = 0.87). *Weekly negative affect* was assessed at the conclusion of the final day of interviewing, when respondents were asked how often they felt each of 10 emotions 'during the past week' (Cronbach's alpha = 0.85). *Daily negative affect:* during the daily telephone interviews, respondents indicated how often they felt each of 10 emotions 'during the past 24 hours'. A daily aggregate measure was created by computing the mean of the daily reports across the eight diary days (Cronbach's alpha = 0.90). *Intraindividual variation in negative affect* was measured by calculating the within person standard deviation of the daily negative affect scores across the 8 diary days. This score represents an individual's fluctuation of daily negative affect.

Results

Preliminary Analyses

Inspection of our variables revealed the presence of extreme values (z-scores >4). We used a log transformation to reduce the influence of outliers for all four variables. The daily affect scores for two individuals remained quite extreme (z-scores >5) after these transformations. We recoded these extreme values to missing.

Age and gender effects can serve to increase twin resemblance, which may be problematic when estimating genetic and environmental influences. Age was related significantly to all affect variables ($r_{monthly} = -0.17$, $p < 0.001$; $r_{weekly} = -0.14$, $p < 0.01$; $r_{daily} = -0.14$, $p < 0.01$), such that older adults tended to have lower levels of negative affect regardless of time frame. Older adults also reported less variability in daily affective ratings as compared to younger adults ($r = -0.15$, $p < 0.01$). Table 1 displays the age differences by providing the means and standard deviations for each of the affect variables for younger and older participants. The younger group (101 pairs) consisted of people whose ages ranged from 25 to 40. The older group (109 pairs) contained people age 41 and over. Respondents, on average, reported greater levels of negative affect when asked to recall over the entire week as compared to the aggregate of daily reports of negative affect across that same week. The discrepancy between the daily measure and the weekly measure suggested that respondents tended to overestimate the frequency of negative affect when they recalled their emotions over longer time intervals.

Significant gender effects were also present. Women reported higher levels of negative affect at the weekly ($t = -2.11$, $p < 0.05$) and daily ($t = -2.39$, $p < 0.05$) levels. Women also reported greater variability in daily affective ratings ($t = -3.98$, $p < 0.001$). Given these main effects, we controlled all four affect variables for both age and gender at the individual level. We then standardized each variable.

Sibling Correlations

In the first step of the behavior genetic analysis we computed the within-sibling correlations for each of the four variables (table 1). For the first three measures, the correlations for the identical twins were slightly to moderately higher than the correlations for the fraternal twins, indicating some genetic influence for the mean level of negative affect. For intraindividual variability in affect, however, the correlation among fraternal twins was actually higher than that among identical twins. This pattern suggests twin resemblance for variability in affect can be attributed to shared environment and that genetic factors do not explain individual differences in intraindividual variability.

Structural Equation Modeling

To obtain estimates of genetic and environmental influences on negative affect, we conducted a series of

Table 2. Model fitting results

Negative affect variable	χ^2	p	d.f.	RMSEA	AIC	Proportion of variance		
						a^2	c^2	e^2
Monthly	0.68	0.88	3	0.000	−5.32	0.09	0.10	0.82
Weekly	1.11	0.77	3	0.000	−4.89	0.20	0.00	0.80
Daily	2.60	0.46	3	0.018	−3.40	0.14	0.15	0.71
Intraindividual variation	4.52	0.21	3	0.053	−1.48	0.00	0.24	0.76

Table 3. Model fitting results for age-difference model in daily negative affect

Negative affect	χ^2	d.f.	p	RMSEA	AIC	a^2	c^2	e^2
Monthly	7.84	6	0.25	0.085	−4.16			
Younger people						0.00	0.24	0.76
Older people						0.13	0.00	0.87
Daily	6.68	6	0.35	0.037	−5.32			
Younger people						0.20	0.23	0.57
Older people						0.00	0.09	0.91

Structural Equations Models via the Mx program [12]. This procedure allowed us to decompose the observed variance in each of the variables into three factors: Additive genetic influences (a), shared environmental influences (c), and non-shared environmental influences (e). Genetic influences accounted for between 9 and 20% of the variance in mean levels of negative affect. Shared environmental influences accounted for minimal variance in the mean levels weekly negative affect, but had a modest effect on both monthly and daily affect. The largest share of variance in all models was attributable to unique (non-shared) environmental influences. The last row in table 2 shows the results for intraindividual variation. Shared environmental influences accounted for 24% of the variance in daily mood, whereas genetic influences were minimal. Again, non-shared environment accounted for a substantial portion of the variance (74%).

Age Differences

The final set of analyses assessed age differences in the magnitudes of genetic and environmental influences in the previous models. We compared models that constrained parameters to be equal across the age groups with models that allowed parameters for younger twin pairs to differ from older pairs. This allowed us to see whether observed phenotypic variance within each group can be differentially apportioned.

A model in which parameters differed across the two age groups fit better than one in which genetic and environmental estimates were constrained to be equal for both monthly and daily levels of negative affect. Model fitting results and parameter estimates for the age difference models are provided in table 3. For monthly levels of negative affect, the pattern follows the standard behavioral genetic prediction: genetic influences are larger among older adults as compared to younger adults. In addition, shared environmental influences are stronger among younger adults. A different pattern emerges for daily levels of negative affect; however, heritability is larger among younger adults than among older adults, as is shared environment.

Discussion

The results of these analyses suggest three findings. First, regardless of time frame, mean level of negative affect is partially heritable. This finding is consistent with prior studies noting significant heritability for depression [13] and negative affect [3]. Our results provide evidence that genetic influences can account for individual differences in general affective tendencies and in day-to-day negative mood. Second, evidence for shared environment was found for monthly and daily levels of negative mood,

as well as variation in daily mood. Shared environment among these adult twins may be reflective of daily events or stressors that revolve around the family. In addition, the role of shared environment in negative affect may reflect parental socialization concerning emotion. Eisenberg, Cumberland, and Spinrad [14] note that emotional socialization may focus particularly on negative emotions. Third, for both age groups, there was no evidence for genetic influences on intraindividual variation. Shared environmental influences, however, were sizeable. This finding supports the set point theory [2]: baseline or average mood is heritable, while fluctuations around that set point are primarily due to environmental events.

Age differences in genetic and environmental effects were present for monthly and daily affect. Genetic influences explained more of the variance in older adults' monthly affect, and shared environmental influences explained less, as compared to younger adults. This pattern followed the dispositional viewpoint, with genetic effects amplified over time. Daily affect, however, revealed a different pattern of results. Shared environmental estimates were again higher among younger adults. This finding is not surprising, reflecting greater temporal proximity to the shared rearing environment. The absence of genetic influence on affect among older adults, however, fails to confirm the dispositional viewpoint. Overall, the pattern supports the idea that temperament is no longer as strong a predictor of differences in day-to-day negative affect among older adults. While the cross-sectional nature of the study does not allow us to interpret this as an age change, the finding is consistent with the concept of developmental gains in emotional regulation.

How can we reconcile the disparate patterns for daily and monthly affect? We suggest that this difference arises, in part, because monthly and daily measures of affect assess different aspects of affective experience. Prior research has shown that people tend to overestimate the intensity of emotions over longer time frames [15, 16] and tend to rely on most recent (end) and peak affective experiences when recalling retrospectively [17, 18]. Our respondents demonstrated a similar pattern, recalling greater frequency of negative affect over the past week than indicated by their actual daily experiences. Perhaps some of the genetic effect on affect is unique to the experience of particularly intense or frequent negative emotions, which serve to bias people's recall.

It should be noted that while we can test whether sources of variance differ between age groups, we cannot explain mean-level differences between groups using our basic behavior genetic model. Nevertheless, significant age differences in the proportion of variance attributed to genetic and environmental influences provide a unique perspective on developmental changes. Our findings highlight two divergent patterns, with differing implications. In the case of monthly affect, heritability was greater among older adults. The next step is to understand how this difference develops. Is it an age-related change? What environments or experiences can account for an amplification of genetic effects over time? In the case of daily affect, heritability was lower among older adults. Decreased heritability over time calls for its own unique developmental explanation. We suggest that this pattern is consistent with the idea that people gain emotional regulation skills over time, but this connection should be explored explicitly in future research. Younger adults had higher levels of daily affect, and a greater portion of the differences among younger adults in daily affect was attributable to genetic effects. Overall, our findings suggest that temperament plays less of a role in explaining between-person differences in day-to-day affect as we age. A decline in the role of temperament can be explained by a general developmental gain in emotional regulation that is independent of personality or innate factors.

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References

1 Molenaar PCM, Huizenga HM, Nesselroade JR: The relationship between the structure of inter-individual and intra-individual variability: A theoretical and empirical vindication of developmental system theory; in Staudinger UM, Lindenberger U (eds): Understanding Human Development: Dialogues with Lifespan Psychology. Dordrecht, Kluwer, 2003, pp 339–360.

2 Lykken D, Tellegen A: Happiness is a stochastic phenomenon. Psychol Sci 1996;7:186–189.

3 Baker LA, Cesa IL, Gatz, M, Mellins C: Genetic and environmental influences on positive and negative affect: Support for a two-factor theory. Psych Aging 1992;7:158–163.

4 Gatz M, Pedersen NL, Plomin R, Nesselroade JR, McClearn GE: Importance of shared genes and shared environments for symptoms of depression in older adults. J Abnormal Psych 1992;101:701–708.

5 Lawton MP, Kleban MH, Rajagopal D, Dean J: Dimensions of affective experience in three age groups. Psych Aging 1992;7:171–184.

6 Carstensen LL, Isaacowitz DM, Charles ST: Taking time seriously: A theory of socioemotional selectivity. Am Psychol 1999;54:165–181.

7 Scarr S: Biological and cultural diversity: The legacy of Darwin for development. Child Dev 1993;64:1333–1353.

8 Joiner TE, Metalsky GI, Katz J, Beach SRH: Depression and excessive reassurance-seeking. Psychol Inquiry 1999;10:269–278.

9 Labouvie-Vief G, Hakim-Larson J, DeVoe M, Schoeberlein S: Emotions and self-regulation: A life span view. Human Dev 1989;32:279–299.

10 Gross JJ, Carstensen LL, Pasupathi M, Tsai J, Gotestam Skorpen C, Hsu AYC: Emotion and aging: Experience, expression, and control. Psych Aging 1997;12:590–599.

11 Mroczek DK, Kolarz CM: The effect of age on positive and negative affect: A developmental perspective on happiness. J Pers Social Psych 1998;75:1333–1349.

12 Neale MC: Mx: Statistical Modeling, ed 4. Richmond, Department of Psychiatry, 1997.

13 McGue M, Christensen K: Genetic and environmental contributions to depression symptomatology: Evidence from Danish twins 75 years of age and older. J Abnormal Psych 1997; 106:439–448.

14 Eisenberg N, Cumberland A, Spinrad TL: Parental socialization of emotion. Psychol Inquiry 1998;9:241–273.

15 Parkinson B, Briner RB, Reynolds S, Totterdell P: Time frames for mood: Relations between momentary and generalized ratings of affect. Pers Social Psych Bull 1995;21:331–339.

16 Thomas DL, Diener E: Memory accuracy in the recall of emotions. J Pers Social Psych 1990;59:291–297.

17 Kahneman D: Objective happiness; in Kahneman D, Diener E, Schwartz N (eds): Well-Being: The Foundations of Hedonic Psychology. New York, Russell Sage Foundation, 1999, pp 1–25.

18 Redelmeier D, Kahneman D: Patients' memories of painful medical treatments: Real-time and retrospective evaluations of two minimally invasive procedures. Pain 1996;116:3–8.