

Emotion

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Jiah Yoo, Yuri Miyamoto, and Carol D. Ryff

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Positive Affect, Social Connectedness, and Healthy Biomarkers in Japan and the U.S.

Jiah Yoo, Yuri Miyamoto, and Carol D. Ryff
University of Wisconsin, Madison

Previous studies have shown that positive affect (PA) and social connectedness predict better health in the United States (U.S.). However, the relevance of such findings for other cultural contexts has been largely ignored. The present study investigated the interplay of PA, social connectedness, and health using large probability samples of Japanese and U.S. adults. Health was measured objectively with biomarkers that represent well-functioning physiological systems: HDL (high-density lipoprotein) and DHEA-S (dehydroepiandrosterone-sulfate). Lower levels of both biomarkers (i.e., less healthy biomarker profile) were found among those in Japan who reported high PA in combination with low social connectedness. In the U.S., the general pattern was that those with greater PA showed healthier HDL levels regardless of social connectedness. The findings highlight cultural variations in the health implications of how PA and social connectedness come together.

Keywords: positive affect, culture, social connectedness, HDL, DHEA-S

Previous studies have shown that PA has numerous health benefits in Western cultures (Boehm & Kubzansky, 2012; Boehm, Peterson, Kivimaki, & Kubzansky, 2011; Ong, Mroczek, & Riffin, 2011; Pressman & Cohen, 2005; Steptoe, Dockray, & Wardle, 2009; Steptoe, Wardle, & Marmot, 2005). However, cross-cultural studies offer a more nuanced perspective following from the idea that PA varies with cultural scripts and norms (Kitayama, Markus, & Kurokawa, 2000; Kitayama, Mesquita, & Karasawa, 2006; Tsai, 2007; Tsai, Knutson, & Fung, 2006). As such, it is unclear whether the PA is equally beneficial for health across different cultural contexts. Particularly, in East Asian cultures, PA may complicate relational concerns (e.g., creating jealousy, overshadowing others; Kitayama et al., 2000; Miyamoto, Uchida, & Ellsworth, 2010; Uchida & Kitayama, 2009). Such relational concerns may, in turn, undermine the health benefits of PA. Alternatively, in the U.S., both PA and social connectedness have been suggested to improve health (Cohen, 2004; Pressman & Cohen, 2005). The present study investigated the interplay between PA, social connectedness, and health in different cultural contexts, specifically Japan and the U.S. The overarching question was whether PA would be beneficial for health, measured objectively with healthy biomarkers, but in ways that possibly vary by cultural context and its relationship with social connectedness.

PA, Health, and Culture

Building from research on the health concomitants of negative affect (NA), the effects of PA on health have increasingly been studied (Pressman & Cohen, 2005). Higher PA is associated with fewer chronic symptoms, higher self-rated health, and better health-related behaviors. Objective health outcomes, such as morbidity and longevity, are also predicted from PA (Koivumaa-Honkanen et al., 2000; Maier & Smith, 1999). Other studies have focused on biological pathways, finding that PA is associated with better immune system and cardiovascular functioning (Cohen, 1988; Marsland, Pressman, & Cohen, 2007; Steptoe et al., 2005). The inverse relationships between stress hormones and PA have been supported by both correlational and experimental studies (Berk et al., 1989; Codispoti et al., 2003).

Most prior research has been conducted with Western samples. Thus, little is known as to whether cultural context plays a role in the PA-health link. Emotional experiences are embedded within culture-specific definitions of “resources,” drawing on lay theories, schemas, behavioral routines, and so forth (Kitayama & Markus, 2000). For example, in East Asian cultures, the middle way between PA and NA is valued, whereas the maximization of PA and the minimization of NA is an ideal in North America (Bagozzi, Wong, & Yi, 1999; Schimmack, Oishi, & Diener, 2002; Sims et al., 2015; Spencer-Rodgers, Williams, & Peng, 2010). Since cultural norms shape views of adaptive coping strategies, the health correlates of emotion must incorporate information about which emotional styles are culturally dominant (Miyamoto & Ryff, 2011). Following this reasoning, consideration of cultural scripts about NA led to differential predictions on how NA is associated with health. As predicted, in the U.S., high levels of NA were positively linked with an inflammatory marker (interleukin-6, IL-6) involved etiologically in pathways to multiple disease outcomes, while in Japan, NA showed a weaker, nonsignificant association with IL-6 (Miyamoto et al., 2013; see also Curhan et al.,

Jiah Yoo and Yuri Miyamoto, Department of Psychology, University of Wisconsin, Madison; Carol D. Ryff, Department of Psychology and Institute on Aging, University of Wisconsin, Madison.

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Correspondence concerning this article should be addressed to Jiah Yoo, Department of Psychology, University of Wisconsin, 702 West Johnson Street, Suite 1101, Madison, WI 53706. E-mail: jyoo32@wisc.edu

2014). To date, no study has examined whether the cultural differences in PA might be reflected in objective health outcomes.

Cultural Differences in PA: The Key Role of Social Connectedness

Although PA is generally considered good and valued, perhaps due to its rewarding nature (Sommers, 1984), cultural scripts related to PA are not universal (Kitayama & Markus, 2000; Kitayama et al., 2000). In a country like the U.S., which is dominantly individualistic, PA is pursued not only as an individual prerogative, but also as an encouraged social norm that elevates positives linked to individuals' goals. However, in East Asian cultures, social norms regarding PA are more complicated. Individuals with high PA risk undermining social relationships (Kitayama et al., 2006; Mesquita & Karasawa, 2002; Miyamoto et al., 2010; Uchida & Kitayama, 2009) given that in collectivistic societies like East Asia the primary rule of social scripts is to act in ways that do not hurt relationships with close others or harmony of the group to which one belongs.¹ Maximizing personal happiness may thus go against this rule in that it may create jealousy among other people, or make one insensitive to the feelings of others who are less fortunate. In fact, such concern for troubling others, in extreme cases, can manifest as a culturally specific form of social anxiety called "Taijin Kyofusho," fear of embarrassing others rather than the self (Kleinknecht, Dinnel, Kleinknecht, Hiruma, & Harada, 1997). Thus, individuals in these cultures tend to be cautious about being happy, given overarching relationship concerns (Diener, Oishi, & Lucas, 2003; Kitayama et al., 2006; Mesquita & Karasawa, 2002; Miyamoto et al., 2010; Oishi & Diener, 2001; Uchida & Kitayama, 2009).

That East Asian cultures put less emphasis on maximizing personal goods and more emphasis on being attuned to social norms, compared to North Americans, is also evident in the literature on psychological well-being (Diener et al., 2003; Oishi & Diener, 2001). For example, life satisfaction—an index of subjective well-being—was predicted mainly by the valence of individuals' emotions in individualistic cultures: the higher the frequency of PA, the higher life satisfaction people reported. However, life satisfaction in collectivistic cultures was less strongly predicted by individuals' emotions and more strongly predicted by normative value of life satisfaction (Suh, Diener, Oishi, & Triandis, 1998). Therefore, the meanings of PA that are assigned differently across culture may also lead to differences in the effect of PA on physical well-being. Particularly, high PA combined with social uneasiness could prevent East Asians from enjoying full benefits of PA on health.

Social Connectedness and PA in Each Cultural Context

East Asian Context

Since PA in East Asian cultures has complex layers of meanings, it is necessary to formulate links between PA and health with consideration of cultural influences. In East Asian contexts, individuals' social connectedness may be a key moderator of the link between PA and health. This idea emerges from observations that PA may conflict with social relations (Kitayama et al., 2006;

Mesquita & Karasawa, 2002; Miyamoto et al., 2010). However, individuals in East Asia who are high on social connectedness, that is those who have good social relationships or have personal traits that promote social connection, may be licensed to experience high level PA without creating social unease. On the contrary, for those with weak social ties or lacking psychological characteristics that facilitate social relationships, having high PA may cause social unease, which can undermine health benefits of PA.

The primary sources of PA may also vary depending on one's level of social connectedness. People with both high social connectedness and high PA may derive more of their PA from social relationships, whereas people with low social connectedness and high PA may draw their PA more from individual achievement (Kitayama et al., 2000, 2006). Such a focus on personal happiness over social connectedness among people with low social connectedness and high PA may contribute to social disruption, which could account for why East Asian cultures are cautious about maximizing PA. It is not adaptive to prioritize PA at a cost of relational concerns in such cultures; thus, health benefits of PA may not result for those with low social connectedness. For these reasons, the relationship between PA and health may be importantly contingent on social relationships in East Asian countries.

Western Context

In the U.S., both PA and social relationships have been studied as influences on health. Studies with North American and Western European samples have shown that PA robustly predicts better health outcomes (e.g., better cardiovascular function and immune system, decreased pain and disease; Pressman, Gallagher, & Lopez, 2013). Measures of social relationships vary across studies (e.g., strength of social ties, involvement in social activities, perceived social support), but findings generally converge to show that good social relationships play a protective role in physical health (Berkman, Glass, Brissette, & Seeman, 2000; Uchino, 2006). Relatedly, there is a reliable negative association of social belongingness and morbidity (Cohen, 1988; Cohen, Gottlieb, & Underwood, 2000; House, Landis, & Umberson, 1988). Positive social relationships have also been linked with enhanced immune function and suppressed neuroendocrine responses (Cohen, 1988; Uchino, 2006). Following prior research, both PA and social connectedness are likely associated with better health when studied as independent predictors.

In addition, there has been recently a growing interest in how PA and social connectedness come together in predicting health. Studies focused on the reciprocal link between PA and positive social relationships have been documented with Western samples (e.g., Ramsey & Gentzler, 2015). Based on these findings, researchers who are examining PA as a focal predictor of health have proposed social connectedness as a potential pathway by which PA promotes health (Pressman & Cohen, 2005; Steptoe et al., 2009). Given that people who feel PA frequently were more likely to have better quality of social ties and engage in social activities (Diener & Seligman, 2002; Lyubomirsky, King, & Diener, 2005), and that

¹ It should be noted that the relations between social concerns and PA may be specific to East Asian collectivistic cultures, and may not be generalized to other collectivist contexts (e.g., Mexico; Ruby, Falk, Heine, Villa, & Silberstein, 2012).

the health outcomes associated with PA, such as longevity and stress hormones, are also predicted by social ties, social connectedness may mediate (at least partially) the link between PA and health. Kok et al. (2013) provided empirical evidence that increase in PA via loving-kindness meditation led to better health indicated by increase in vagal tone, and the effect was mediated by people's perceptions of their positive social relationships. Thus, the present study examined PA and social connectedness as separate predictors of health in the United States, along with considering whether social connectedness mediates the link between PA and health.

Objectives of the Present Study

The present study brought a cultural perspective to the growing research on links between PA and health. Although previous studies examined the relationships among PA, social connectedness, and health in Western cultures, the relationships have not been examined in other cultural contexts. In East Asian cultures, given the potential social unease PA may instill, social relationships are formulated as critical to the association between PA and health. In western cultures, based on the previous findings, both social relationship and PA are expected to be positively linked to health, with social relationship mediating the link between PA and health. Therefore, the current study tested how PA and social connectedness came together in predicting health within each cultural context.

Health was measured by two objective indicators that represent well-functioning physiological systems: HDL and DHEA-S (Kubzansky, Boehm, & Segerstrom, 2015). Each biomarker reflects a healthy regulation of the circulatory system and the neuroendocrine system, respectively. First, HDL plays a key role in cholesterol metabolism and the circulatory system by removing excess cholesterol from the arterial wall and delivering it back to the liver. High HDL levels in blood prevent cholesterol from depositing on artery walls—caused by high levels of low-density lipoprotein (LDL) in blood, and thus have a protective effect against coronary heart diseases (Gordon & Rifkind, 1989; Krieger, 1999; Toth, 2005; Wilson, Abbott, & Castelli, 1988). Second, DHEA-S indicates a healthy response of the hypothalamic-pituitary-adrenocortical axis. It is known as one of anabolic hormones because it can counteract catabolic hormones (i.e., cortisol) that have deleterious effects on physical and mental health (Epel, Burke, & Wolkowitz, 2007). Furthermore, low levels of DHEA-S have been linked to aging-related pathologies, such as abdominal obesity, diabetes, cardiovascular disease, rheumatoid arthritis, periodontal disease, cognitive decline, and dementia (Barrett-Connor, Khaw, & Yen, 1986; Barrett-Connor, von Mühlen, Laughlin, & Kripke, 1999; Carlson & Sherwin, 1999; Feldman, Johannes, McKinlay, & Longcope, 1998; Hartaigh et al., 2012; Kalmijn et al., 1998; Mazat et al., 2001; Moriyama et al., 2000; Nawata, Yanase, Goto, Okabe, & Ashida, 2002; Savineau, Marthan, & Dumas de la Roque, 2013). Therefore, HDL and DHEA-S are indices of biomarkers of which high levels indicate positive functioning across two distinct body systems.

Because of the role social connectedness plays in determining normativeness of PA in Japan (Mesquita & Karasawa, 2002; Uchida & Kitayama, 2009), a moderating approach was hypothesized, in which social connectedness was expected to work interactively with PA in predicting health outcomes. That is, in Japan,

for people with high social connectedness, higher PA was expected to contribute to higher levels of HDL and DHEA-S, whereas these associations were predicted to be weaker or absent for people with low social connectedness. On the contrary, based on the prior findings on the links among PA, social connectedness, and health among Western samples (e.g., Cohen, 1988; Pressman & Cohen, 2005; Steptoe et al., 2005), both high PA and high social connectedness were expected to independently predict higher levels of HDL and DHEA-S in the U.S. In addition, social connectedness was examined as a possible mediator of the association of PA with HDL, and DHEA-S.

Method

Participants

American participants were a subset from the second wave of the Midlife in United States (MIDUS) survey. The first wave of MIDUS (1995–1996) was based on a national probability sample recruited through random digit dialing. The survey included a telephone interview and a self-administered questionnaire. A follow-up study was conducted in 2004, with a retention rate of 75%, adjusted for mortality. Biological data were collected from a subset of MIDUS II respondents, who traveled to a General Clinical Research Centers (GCRC) for an overnight visit. Research sites for biological data collection were at the University of Wisconsin-Madison, the University of California-Los Angeles, and Georgetown University. The present analyses include 1,043 participants for whom physical health data were available (472 males, 571 females; $M = 55.24$ years). The parallel survey, the Midlife in Japan (MIDJA), was conducted in 2008 with participants randomly selected from the Tokyo metropolitan area. They completed a self-administered questionnaire. A subset of the sample was recruited to participate in biological data collection ($N = 382$; 168 males, 214 females; $M = 54.24$ years). The data were collected at a clinic near the University of Tokyo (for details about the protocol of biomarker collection, see Coe et al., 2011).

Measures

The following self-rated measures were collected as a part of self-assessment questionnaires both in MIDUS II and MIDJA prior to physical examination.

PA. Participants were asked to rate how frequently they felt each emotion during the past 30 days (Mroczek & Almeida, 2004) using a 5-point rating scale: *none of the time* (1), *a little of the time* (2), *some of the time* (3), *most of the time* (4), and *all the time* (5). The measure included 10 items: cheerful, in good spirits, extremely happy, calm and peaceful, satisfied, full of life, enthusiastic, attentive, active, and proud. PA scores represent each respondent's average rating of these items. Cronbach's alphas of the scale were .92 for both Japanese and Americans.

Social connectedness. To measure the extent to which participants have good social relationships or have personal traits that promote social connection, we included three psychological variables, each measuring different aspects of social relationships. First, we included support received from friends; social support is one of the most widely used indicators of social connectedness that have been linked to health (Cohen, 2004). At the same time,

previous studies have suggested that Easterners use social support less than Westerners do (Kim, Sherman, & Taylor, 2008). We thus supplemented social support by two additional measures, namely, agreeableness and interdependence, to capture the nature of social connectedness appropriate to East Asians as well. Agreeableness is a personality trait related to how individuals present themselves to others and how they are perceived by others in return (Graziano & Tobin, 2009); it indicates whether an individual is likable, kind, and warm to others. Interdependence assesses the extent to which individuals defines themselves within social relationships. The measure is particularly relevant to social connectedness in East Asia where it is normative to value social relationships as a part of self.

Social support from friends was measured with four items modified from Schuster, Kessler, and Aseltine (1990), (e.g., “How much do your friends really care about you?”, “How much do they understand the way you feel about things?”). The scores were rated on a 4-point scale, ranging from *not at all* to *a lot* and averaged to compute as a single measure ($\alpha = .879$ for Americans and $\alpha = .805$ for Japanese).

Agreeableness was assessed with the following five items: helpful, warm, caring, softhearted, and sympathetic. The adjectives were selected from existing trait lists and inventories (Goldberg, 1992; Trapnell & Wiggins, 1990). Participants were asked to rate how much each item describes them using a 4-point rating scale: *not at all* (1), *a little* (2), *some* (3), and *a lot* (4). The ratings of the four items were averaged to compute agreeableness scores ($\alpha = .817$ for Americans and $\alpha = .877$ for Japanese).

Interdependence was measured by 10-item version of the Singelis Scale (Singelis, 1994). The examples of items are “It is important for me to maintain harmony or smooth relationships within my group,” “It is important to listen to others’ opinions.” Participants rated how much they agree with each statement using a 7-point rating scale, ranging from *strongly disagree* (1) to *strongly agree* (7). Responses were averaged to compute an interdependent self-construal score ($\alpha = .973$ for Americans and $\alpha = .710$ for Japanese).

Biomarkers. For assessing biomarkers, frozen blood samples were collected at the clinic visit and shipped on dry ice from the three GCRC sites in the U.S. and from Tokyo in Japan to a single laboratory, MIDUS Biocore Lab in Madison, WI. To ensure consistency, all samples were collected and processed using standardized procedures.

HDL was assessed at Meriter Labs (Madison, WI) by using a Cobas Integra analyzer (Roche Diagnostics, Indianapolis, IN). Because the distribution of HDL in our samples was positively skewed, values were log transformed for statistical analysis.

DHEA-S assay was performed at the Associated Regional and University Pathologists laboratory (Salt Lake City, UT) with a Roche Modular Analytics E170 analyzer, using an Elecsys kit (Roche Diagnostics, Indianapolis, IN). To reduce the effects of extreme outliers and also correct for positively skewed distribution, DHEA-S was winsorized at three standard deviations from the mean in each culture and log transformed for statistical analysis.

Control variables. Analyses controlled for several confounding variables that have been linked to HDL and DHEA-S (Boehm, Williams, Rimm, Ryff, & Kubzansky, 2013; Hartaigh et al., 2012). Demographic variables including age, gender, and years of edu-

cation were controlled for. We included negative affect (NA) to sharpen the focus on the independent effect of PA and social connectedness, net of psychological ill-being. NA had the following 11 items: so sad nothing could cheer you up, nervous, restless or fidgety, hopeless, that everything was an effort, and worthless, afraid, jittery, irritable, ashamed, and upset. Participants’ ratings of 11 items were averaged into a single score for the analyses ($\alpha = .907$ for Americans and $\alpha = .900$ for Japanese).

Health behavior and health status were also controlled for. Health behavior was assessed with smoking and alcohol consumption. Smoking was categorized into three groups—never, former, current—while alcohol consumption was assessed in terms of the number of drinks consumed per week and log transformed to adjust the skewed distribution. Health status variables included chronic conditions and waist/hip ratio (WHR). The number of chronic conditions that have been linked to lipid and hormone levels (heart disease, hypertension, stroke, blood clots, diabetes, cancer, depression, and arthritis; maximum = 8 conditions) was assessed by the item “Have you ever had any of the following conditions or illnesses diagnosed by a physician?” The presence of any emotional disorders, including depression and anxiety, was controlled for as well (Yes/No). Waist and hip circumference were measured when participants visited clinic for physical examination. Waist/hip ratio (WHR) was calculated and log transformed to adjust the skewed distribution.

Results

Descriptive statistics of the key variables and control variables are presented in Table 1. Because different models were hypothesized for each culture, analyses were conducted separately for the Japanese and U.S. data. Separate multiple regression models were run for each health outcome variable as well as each social connectedness predictor variable. In each model, PA, social connectedness, and the interaction term were entered while controlling for basic demographic variables, NA, health behaviors (smoking and alcohol consumption) and health status (the number of chronic conditions, depression/anxiety, and WHR). The results are summarized in Tables 2 and 3.

Analyses in Japan

HDL. As predicted, there was a significant interaction between PA and support from friends on HDL, $b = .035$, $t(329) = 2.449$, $p = .015$, $\eta_p^2 = .018$. The simple effects tests are shown in Figure 1a; the increase in PA was negatively associated with HDL levels among people low on support from friends (-1 SD from the mean level), $b = -.034$, $t(329) = -2.507$, $p = .013$, but not among people with high support from friends ($+1$ SD from the mean level), $b = .009$, $t(329) = .609$, $p = .546$. We further probed the interaction using the Johnson-Neyman technique (Preacher, Curran, & Bauer, 2006) to demonstrate the region of significance on a moderator where the association between PA and HDL is significant. The negative association between PA and HDL in Japan was significant for people whose support from friends was lower than 2.291 (39.4% of the sample). There was no association between PA and HDL for Japanese whose support from friends rating was higher than 2.291.

DHEA-S. PA showed interaction effects with two social connectedness measures, interdependence and agreeableness [agree-

Table 1
Descriptive Statistics for Japanese and American Participants

Variable	Japanese			Americans		
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>
PA	381	3.21	0.67	1,049	3.51	0.67
Social connectedness						
Agreeableness	381	2.69	0.63	1,050	3.44	0.50
Support from friends	381	2.56	0.60	1,048	3.33	0.64
Interdependence	381	4.80	0.64	1,052	5.22	0.60
Biomarkers						
HDL (mg/dL)	382	71.24	21.28	1,043	54.63	17.61
DHEA-S (ug/dL)	382	154.90	98.83	1,040	105.43	76.21
Covariates						
Age	382	54.24	14.11	1,054	55.26	11.78
Gender	382	1.56	0.50	1,054	1.55	0.50
Education	378	13.62	2.40	1,051	14.58	2.42
NA	381	1.79	0.61	1,046	1.50	0.51
Smoking Status	356			1,054		
Never smoker		48.4%			56.9%	
Former smoker		23.3%			32.4%	
Current smoker		21.5%			10.6%	
Missing		6.8%			0.5%	
Alcohol (drinks/week)	379	7.24	11.75	1,051	3.15	5.53
Depression/anxiety (% of Yes)	377	10.3%		1,054	19.6%	
Chronic conditions	382	0.39	0.70	1,054	0.89	0.10
WHR	382	0.83	0.08	1,053	1.46	0.09

Note. Gender (1 = male, 2 = female). NA = negative affect; PA = positive affect; HDL = high-density lipoprotein; DHEA-S = dehydroepiandrosterone-sulfate; WHR = waist/hip ratio.

ableness: $b = .160, t(329) = 2.558, p = .011, \eta_p^2 = .020$; interdependence: $b = .171, t(329) = 2.691, p = .007, \eta_p^2 = .022$]. The pattern of the interactions on DHEA-S was in line with the interaction on HDL. PA was significantly associated with DHEA-S in a negative direction among people with low agreeableness, $b = -.174, t(329) = -2.581, p = .010$ (see Figure 1b). For people with agreeableness lower than 2.523 (39.7% of the

sample), PA was negatively associated with DHEA-S. However, there were no significant relationships of PA and DHEA-S for people whose agreeableness was above 2.523. Likewise, the negative association between PA and DHEA-S was found among people with low interdependence, $b = -.147, t(329) = -2.298, p = .022$ (see Figure 1c). This negative association was significant for people whose interdependence was lower than 4.410 (28.5% of

Table 2
Unstandardized Regression Coefficients in Predicting HDL and DHEA-S as a Function of Positive Affect, Social Connectedness, and the Interaction Between Positive Affect and Social Connectedness in Japan

Predictors	HDL		DHEA-S	
	<i>b</i>	<i>p</i>	<i>b</i>	<i>p</i>
PA	-.011	.318	-.069	.123
Agreeableness	-.007	.474	.061	.223
PA × Agreeableness	.015	.239	.160	.011
PA	-.013	.236	-.042	.419
Support from friends	.001	.853	-.017	.742
PA × Support from friends	.035	.015	-.010	.152
PA	-.014	.195	-.041	.428
Interdependence	.001	.911	.018	.707
PA × Interdependence	-.001	.923	.171	.007

Note. HDL = high-density lipoprotein; DHEA-S = dehydroepiandrosterone-sulfate; PA = positive affect. Results control for all the covariates (age, gender, education, negative affect, smoking, alcohol consumption, waist/hip ratio, chronic conditions, depression/anxiety). Bolded coefficients are significant at the .05 level.

Table 3
Unstandardized Regression Coefficients in Predicting HDL and DHEA-S as a Function of Positive Affect, Social Connectedness, and the Interaction Between Positive Affect and Social Connectedness in the U.S.

Predictors	HDL		DHEA-S	
	<i>b</i>	<i>p</i>	<i>b</i>	<i>p</i>
PA	.015	.047	.001	.981
Agreeableness	.003	.705	-.014	.764
PA × Agreeableness	.017	.078	-.001	.990
PA	.014	.059	.001	.971
Support from friends	.008	.220	-.024	.513
PA × Support from friends	.010	.189	.011	.803
PA	.014	.053	-.008	.856
Interdependence	.005	.441	.080	.026
PA × Interdependence	-.003	.710	-.008	.865

Note. HDL = high-density lipoprotein; DHEA-S = dehydroepiandrosterone-sulfate; PA = positive affect. Results are control for all the covariates (age, gender, education, negative affect, smoking, alcohol consumption, waist/hip ratio, chronic conditions, depression/anxiety). Bolded coefficients are significant at the .05 level.

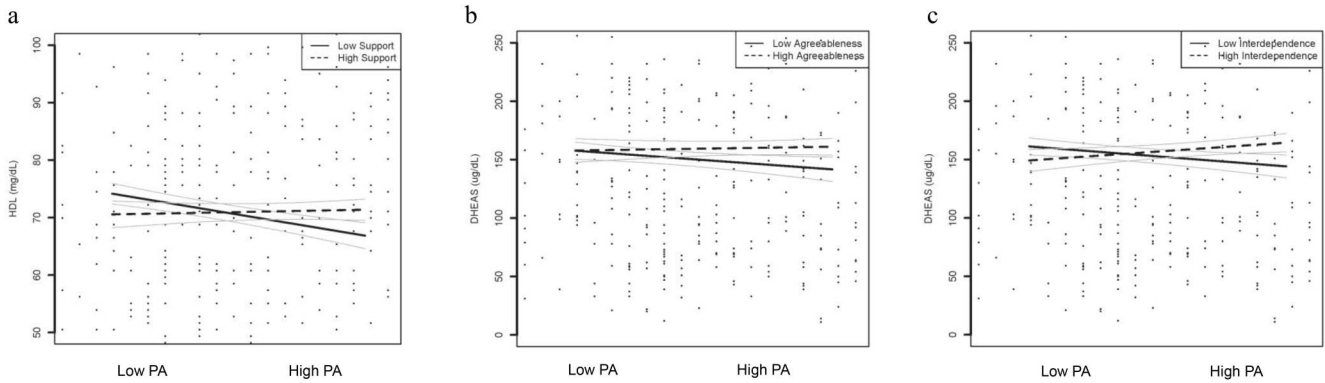


Figure 1. HDL and DHEA-S as a function of social connectedness and PA in Japan controlling for all the covariates. “Low” is one standard deviation below the mean and “high” is standard deviation above the mean. (a) PA was negatively associated with HDL for Japanese with low support from friends, $b = -.034$, $SE = .013$, $t(329) = -2.507$, $p = .013$, but not for Japanese with high support from friends, $b = .009$, $SE = .014$, $t(329) = .609$, $p = .546$; (b) PA was negatively associated with DHEA-S for Japanese with low agreeableness, $b = -.174$, $SE = .067$, $t(329) = -2.581$, $p = .010$, but not for Japanese with high agreeableness, $b = .027$, $SE = .065$, $t(329) = .412$, $p = .681$; and (c) PA was negatively associated with DHEA-S for Japanese with low interdependence, $b = -.147$, $SE = .064$, $t(329) = -2.298$, $p = .022$, but not for Japanese with high interdependence, $b = .073$, $SE = .067$, $t(329) = 1.083$, $p = .280$. HDL = high-density lipoprotein; DHEA-S = dehydroepiandrosterone-sulfate; PA = positive affect.

the sample). There were no significant relationships of PA and DHEA-S for people with high levels of interdependence, except for three people whose interdependence was at the .09% highest of the sample. For them, PA was significantly associated with DHEA-S in a positive direction.

Analyses in the U.S.

HDL. Supporting our hypothesis, PA significantly predicted HDL when agreeableness was included as a social connectedness variable [$b = .015$, $t(1,010) = 1.986$, $p = .047$, $\eta_p^2 = .004$] and marginally predicted HDL when support from friends [$b = .014$, $t(1,008) = 1.890$, $p = .059$, $\eta_p^2 = .004$] or interdependence [$b = .014$, $t(1,013) = 1.963$, $p = .053$, $\eta_p^2 = .004$] was included as a social connectedness variable. None of the social connectedness measures predicted HDL (see Table 3).

DHEA-S. Contrary to our prediction, PA did not predict DHEA-S in any models (see Table 3). Among the social connectedness measures, only interdependence predicted DHEA-S, $b = .080$, $t(1,010) = 2.226$, $p = .026$, $\eta_p^2 = .005$, whereas the others did not (see Table 3). The independent effects of PA and social connectedness on DHEA-S were largely unsupported.

Further, no evidence was obtained that social connectedness mediates the link between PA and HDL in the U.S., or that any interactions were evident in the prediction of HDL or DHEA-S.

Discussion

The present study investigated whether the roles of PA and social connectedness on two indicators of objective health (HDL, DHEA-S) differ by cultural context. In Japanese culture where PA might conflict with maintaining relational harmony, social connectedness was predicted to moderate the association between PA and health. In the U.S., both PA and social connectedness were

expected to be associated with better objective health, and possibly that social connectedness might mediate the link between PA and health.

In Japan, supporting our hypothesis, the interaction effects between PA and social connectedness were found for HDL and DHEA-S health outcomes. Social support from friends moderated the association between PA and HDL, whereas interdependence and agreeableness moderated the association between PA and DHEA-S. The simple effect results underscored possible health costs associated with having high PA in combination with *low* social connectedness in Japan. Such findings suggest that in Japan having PA without *fulfilling social expectations*—maintaining harmonious social relationships—is associated with poorer health. Cultural norms about emotions in Japan (Kitayama et al., 2000; Kitayama et al., 2006) may account for these findings. That is, for those with low social connectedness, high levels of PA may constitute a kind of nonnormative (deviant) profile in Japanese culture, and thus may invite social sanctions. That higher PA was associated with lower levels of healthy biomarkers among people with low social connectedness echoes the emphasis from previous studies that being attuned to cultural norms is especially important for health in collectivistic contexts (Kitayama, Karasawa, Curhan, Ryff, & Markus, 2010; Stephens, Townsend, Markus, & Phillips, 2012).

Interestingly, among people with high social connectedness in Japan, PA was mostly unrelated to health benefits or costs. Because those with high social connectedness are fulfilling social expectations to maintain harmony, their experience of high PA may be less likely to invite social sanctions and thus may be less costly. At the same time, the fact that PA was not associated with better health even among people with high social connectedness points to a possibility that health benefits of PA are generally weak in Japan, an interpretation that extends recent evidence showing a

weaker or no association between NA and physical health in Japan (Curhan et al., 2014; Miyamoto et al., 2013). The results are also consistent with prior work showing that a focus on gaining positive features is less predictive of outcomes such as academic success and subjective well-being than a focus on preventing negativity, particularly social disruption, in East Asian cultures (Elliot, Chirkov, Kim, & Sheldon, 2001; Lockwood, Jordan, & Kunda, 2002).

In the U.S., PA was associated with higher HDL levels, which supported our hypothesis and converges with previous literature on the link between PA and health (Pressman & Cohen, 2005). Further, that PA predicted HDL independently of one's level of social connectedness underscores the importance of PA for health in the U.S. DHEA-S was, however, associated with interdependence self-construal, but no support was found for the mediation of PA on health via social connectedness. No other effects were evident for remaining measures of social connectedness. Given that interdependence has been rarely employed as a measure of social connectedness in Western studies, the association between DHEA-S and interdependence is noteworthy. The finding suggests that valuing social groups may have health implications in the U.S. where groups are usually less prioritized than individuals. In addition, none of the prior literature linking social relationships to health has examined HDL and DHEA-S as used in the current study. Thus, these new indicators may account for the obtained U.S. findings, although further research is needed to confirm the replicative consistency of these results.

Previous studies examining psychosocial correlates of biological health have utilized negative biomarkers, which indicate malfunction, such as elevated inflammatory processes and stress hormones (Kubzansky et al., 2015). The present study, in contrast, examined biomarkers (HDL, DHEA-S) that indicate a healthy profile of lipids and hormones, respectively. Using these biomarkers, we found that PA interacts with social connectedness to predict HDL and DHEA-S in Japan, and that PA predicts HDL in the U.S. These results highlight the importance of examining positive biological processes to understand how PA and social connectedness can promote health. Moreover, the use of these biomarkers contributes to new directions to research on culture and health. Although biological risk factors have been examined in testing cultural differences in the associations of negative emotions and health (Kitayama et al., 2015; Miyamoto et al., 2013), no prior cross-cultural studies on *positive emotions* and health have examined biological measures (cf., Pressman et al., 2013; Pressman, Gallagher, Lopez, & Campos, 2014). Our results underscored the role of culture in that PA negatively predicted HDL and DHEA-S in Japan when accompanied by low levels of social connectedness, whereas PA positively predicted HDL in the U.S. Future research may benefit from examining other health indicators involved in cardiovascular and neuroendocrine systems (e.g., LDL, proinflammatory markers, cortisol). Given that different biomarkers work through their specific molecular mechanisms, extending the investigations may help us to sharpen the understanding of how emotion and cultural contexts "get under the skin" as well as how different mechanisms come together for optimal health.

Prior research has shown that the arousal level of PA plays an important role in cultural variation in valuation of PA. Although high-arousal PA (e.g., excitement, fun) is considered less desirable among East Asians compared to European Americans, low-arousal

PA (e.g., calm, relaxed) is valued more by East Asians compared to European Americans (Tsai et al., 2006). Low arousal states help individuals pay attention to surroundings (Schupp, Cuthbert, Bradley, Birbaumer, & Lang, 1997) so it may not conflict with social tasks in East Asia, such as caring about feelings and needs of others. At the same time, it is also possible that even low-arousal PA may cause social unease if experienced by someone with low social connectedness, as low-arousal PA experienced in such contexts may still be nonnormative. Thus, it is important to examine whether the interaction between social connectedness and PA would be mostly attributed to high-arousal PA but not to low-arousal PA. Unfortunately, because the measure of PA used in the present study only had one clear low-arousal PA item, it was difficult to test the effects of low versus high arousal PA separately. Future investigation may benefit from supplementing emotion measures with different arousal levels of PA.

The present findings are limited by cross-sectional data, which makes it impossible to discern causal directionality between psychosocial factors and biomarkers. Longitudinal research will be needed to clarify whether PA and social connectedness, in fact, shape biological health. In addition, it would be worth investigating the cross-time dynamics between PA and social connectedness in Japan. In the U.S., studies have shown that PA can facilitate better social connectedness (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008; Lyubomirsky et al., 2005). In Japan, however, people may create worse impressions on others if they feel more positive emotions despite their low social connectedness, which could further impair their social relations. Employing experimental approaches would also be useful to elucidate characteristics of social interactions among Japanese with low social connectedness and high PA profiles (i.e., whether those people are perceived to be socially deviant by others during the interaction, and whether that perception by others causes negative physiological/psychological responses during social interactions). Also, future research may benefit from exploring whether the characteristics of events that trigger PA vary with the levels of social connectedness. People with high social connectedness and high PA may primarily experience PA from events that promote social relationship. On the contrary, however, people with low social connectedness and high PA may experience PA mainly from personal events, which could contribute to social disruption, particularly in Japan (Kitayama et al., 2000, 2006). Such research could clarify the interaction of PA and social connectedness over time among Japanese.

Although both social connectedness and PA have been shown to be important for health in Western contexts, few studies have examined their interplay and no work has addressed their import for Eastern cultural settings. The present study addressed these omissions in the prior literature by investigating the predictive influence of social connectedness and PA on health, measured with two biomarkers. Findings underscored the interactive influence of both factors in Japan, via a pattern showing worse biological health among those with low social connectedness combined with high PA. Such interplay was not present in the U.S., where PA and social connectedness were shown to predict different measures of biological health. These new results warrant further inquiry to assess their replicative consistency as well as to discern their cross-time dynamics.

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