



Loneliness within a nomological net: An evolutionary perspective [☆]

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Abstract

Loneliness is characterized by feelings of social pain and isolation and has both heritable and unshared environmental underpinnings. An evolutionary theory of loneliness is outlined, and four studies replicate and extend prior research on the characteristics of lonely individuals. Studies 1 and 2 indicate that loneliness and depressed affect are related but separable constructs. Study 3 confirms that lonely, relative to nonlonely, young adults are higher in anxiety, anger, negative mood, and fear of negative evaluation, and lower in optimism, social skills, social support, positive mood, surgency, emotional stability, conscientiousness, agreeableness, shyness, and sociability. The set of six personality factors associated with loneliness (surgency, emotional stability, agreeableness, conscientiousness, shyness, and sociability) do not explain the associations between loneliness and negative mood, anxiety, anger, optimism (pessimism), self-esteem, and social support, as each association remained statistically significant even after statistically controlling for these personality factors. Study 4 used hypnosis to experimentally manipulate loneliness to determine whether there were associated

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changes in the participants' personality and socioemotional characteristics. Results confirmed that loneliness can influence the participants' personality ratings and socioemotional states.

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1. Introduction

...by the 1970's, it was dawning on many evolutionary biologists, especially those interested in behaviour, that evolution by natural selection was not much about competition between species, not even mostly about competition between individuals, but was about competition between genes using individuals and occasionally societies as their temporary vehicles. (Ridley, 2000, p. 127).

Loneliness has been described as a complex set of feelings that occurs when intimate and social needs are not adequately met and that “drives” individuals to seek the fulfillment of these needs (Russell, Peplau, & Cutrona, 1980; Weiss, 1973, p. 15). Estimates by Peplau and Perlman (1982) suggest that at any one time approximately 20% of the population complains of feelings of loneliness. Why are people plagued by this plight? In the present paper, we outline an evolutionary model to address this question in which loneliness reflects the operation of selfish genes using individuals to insure their perpetuation.

Darwin's (1959) insight was that organisms compete for resources, and those that had some advantage in a habitat would be more likely to transmit this advantage to future generations via their offspring. Building on Darwin's seminal insight, Dawkins (1990) describes how genes evolve and function to perpetuate themselves. According to Dawkins (1990), the world of the selfish gene is generally one of savage competition, ruthless exploitation, and deceit. Even apparently collective actions that foster survival, such as fish swimming in schools, can be explained in terms of individual self-interest. When sardines are predated, they form a dynamic fish ball as a last means of defense. The emergence and unfolding of this collective action can be explained by a single, selfish rule: Swim to the middle.

The genetic constitution of species characterized by brief periods of dependency is reducible to the reproductive success of individual members of the species. Simply stated, if an organism survives to reproduce, the genes of the organism are more likely to be included in the gene pool of the species. The genetic constitution of *Homo sapiens*, however, derives not simply from an individual's reproductive success but more critically from the success of one's offspring to reproduce (Cacioppo & Hawkey, 2003). Humans are not particularly strong, fast, or stealthy relative to other species. They lost their canine teeth thousands of years ago and they never had the safety offered by natural armor or flight. It is the ability to think and use tools, to employ and detect deceit, and to communicate, work together, and form alliances that makes *Homo sapiens* such a formidable species.

The importance of these capacities produced a selective pressure for larger brains with greater associative, reasoning, integrative, and communicative power (Calvin, 2004). Larger brains were achieved in part by greater folding of the cortices to squash more brain matter into a limited cranial space. Larger brains were also achieved by modifications of the pelvic skeletal structure in women, which although less optimal for walking, increased the likelihood that the mother and infant would survive childbirth. The cranial skull itself

evolved to be incomplete at birth. Even though the hole at the top of the skull places a newborn at greater risk for injury or death from a blow, it improves the chances of successful transport through the birth canal. And the human infant is born to a prolonged period of abject dependency. It appears part of the solution in the negotiation between a larger brain and successful transport through the birth canal is that much of development and expansion of the human brain occurs after birth.

The fact that humans are born in modal litter sizes of one and to a long period of abject dependency changes the effects of the operation of the “selfish gene.” If infants do not elicit nurturance and protection from caregivers, or if caregivers are not motivated to provide such care over an extended period of time, the infants perish along with the genetic legacy of the parents. The selfish gene therefore had to add to its repertoire the evolution of social connection and care. Ancestors who were inclined to form social connections, communicate and work together, share food and defense, and retaliate in the face of violations of reciprocity norms had a selective advantage to survive. In conditions of hardship, hunter-gatherers who had a genetic disposition to experience social pain from social separation (i.e., loneliness) may have been more likely to return to share their food, shelter, or defense with their family and allies to diminish the pain of loneliness. Individuals with no such feelings of loneliness when separated from others may have roamed the earth better nourished than those who felt distressed by social separation, but the abandoned offspring—and the genetic predisposition of the parents—would have been less likely to survive.

The present model has features in common with Bowlby’s (1969/1982) emphasis on infant attachment but the need to form attachments represents only a part of the story. Social pain in response to disconnections, the reward felt when those connections are reinstated, and individual differences in sensitivity to social pain and reward are also fundamental to the evolutionary model. Physical pain evolved as a reflex to protect the organism from tissue damage. Physical pain is influenced by situational factors but there are also stable individual differences in pain sensitivity. According to our evolutionary model (Cacioppo & Hawkey, 2003) loneliness is thought to operate in part through social pain, which co-opts the physical pain system (Eisenberger, Lieberman, & Williams, 2003), and social reward, which co-opts the appetitive system (Rilling et al., 2002), to protect the gene if not the individual. Specifically, the social pain of loneliness and the social reward of connecting with others motivate the person to repair and maintain social connections even when his or her immediate self-interests are not served by the sharing of resources or defense. In this way, loneliness, like punitive altruism (Boyd, Gintis, Bowles, & Richerson, 2003; Fehr & Gächter, 2002), promotes adaptive collective behavior to preserve the selfish molecules known as genes (Dawkins, 1990). Moreover, loneliness like physical pain and reward is posited to be influenced by situational factors but there are also stable individual differences in sensitivity.

Recent work by Eisenberger et al. (2003) on social pain and by Rilling et al. (2002) on social pain and by Rilling et al. (2002) on social reward is in accord with the notion that loneliness may have evolved to use the physical pain and reward systems to extend its protective function to include others. In a recent functional magnetic resonance imaging (fMRI) study in which participants were excluded from or included in a social situation (i.e., a ball tossing game), for instance, Eisenberger et al. (2003) found neural activation localized in a dorsal portion of the anterior cingulate cortex (ACC) that is implicated in the affective component of the pain response. The authors argue that the similarity in activation of the dorsal ACC to physical pain (e.g., Rainville, Duncan, Price, Carrier, & Bushnell, 1997) and to social pain suggests that the experiences of physical and social pain may share a common

neuroanatomical basis. Furthermore, Eisenberger and her colleagues suggest that “Because of the adaptive value of mammalian social bonds, the social attachment system... may have piggybacked onto the physical pain system to promote survival” (p. 291).

According to our evolutionary model, a person made to feel lonely also feels unsafe and activates an anachronistic survival mechanism that heightens sensitivity to threats from all sides. Lonely individuals are not simply unhappy, they have heightened sensitivity to threats and attacks. Defensive behaviors such as preventative rejection of others may help fend off treachery, rejections or attacks. It is this ingrained, self-protective focus on threats that drives their anxiety and caustic interactions and allows them to minimize the short term damage of negative interactions but at the cost of potentially self-defeating hostility, fault finding, and blaming (Cacioppo & Hawkley, 2005; Rotenberg, 1994). Consistent with this model, prior research has shown loneliness to be related to a constellation of socio-emotional states and traits that include poor mood, anxiety, anger, optimism, low social support, dysphoria, and lower self esteem (e.g., see reviews by Berscheid & Reis, 1998; Duck, Pond, & Leatham, 1994; Ernst & Cacioppo, 1999; Rook, 1984; Shaver & Brennan, 1991).

If the motivation to form and maintain social bonds has evolutionary origins, one might expect significant genetic contributions to loneliness. The first investigation of the heritability of loneliness was published by McGuire and Clifford (2000). In their first study, 69 biologically related sibling pairs and 64 unrelated pairs in adoptive families in the Colorado Adoption Project completed an 8-item loneliness scale when they were 9, 10, 11, and 12 years of age. In a second study, 22 monozygotic (MZ) twins, 40 dizygotic (DZ) twins, and 80 full-siblings 8–14 years of age completed a 16-item scale to assess loneliness in relation to their schoolmates. Results revealed significant genetic ($h^2 = 55$ and 48%, respectively, in Studies 1 and 2) and unshared environmental contributions to individual differences in loneliness.

The adoption studies of McGuire and Clifford (2000), however, can be explained in terms of an alternative model that attributes the resemblance in loneliness between relatives to shared environment. Heritability estimates of complex traits such as loneliness may also change across the lifespan, as the frequency, duration, and range of exposure to environmental influences accrues. We, therefore, extended the work of McGuire and Clifford (2000) using data from the Netherlands Twin Register Study (Boomsma, Willems, Dolan, Hawkley, & Cacioppo, 2005). Data on loneliness from 7665 young adult and adult Dutch twins (average age 24 years) were analyzed with genetic structural equation models, which provide estimates of the shared environmental and unique environmental contributions as well as the genetic contributions. The estimate of genetic contributions to variation in loneliness in adults was 47%, with the remaining variance explained by unique environmental factors. Thus, the heritability estimates in adults were similar to that found previously in children. No evidence was found for sex or age differences in genetic architecture or for nonadditive genetic effects.

In sum, loneliness is posited to be heritable for several reasons. First, the separation from those with whom an individual has formed connections produces social pain (loneliness) that, like physical pain, motivates the person to repair the social disconnections even when his or her immediate self-interests are not served by the sharing of resources or defense. Furthermore, social acceptance and affirmation is posited to be rewarding. That is, social pain leads to negativity, lowered feelings of control, depressed affect, and lower self-esteem, whereas social cooperation and acceptance leads to increased feelings of control,

positive affect, and higher self esteem. Thus, loneliness and depressed affect should be closely related. In addition, though, those who feel socially isolated also feel unsafe, which in turn activates a constellation of socioemotional processes including threat vigilance, stress, mood, anxiety, anger, and low social support. Depressed affect does not trigger the same constellation (e.g., Kremen, 1996). Thus, loneliness and depressed affect are conceived as related but separable constructs. In Studies 1 and 2, we attempted to evaluate whether the two constructs could be statistically disentangled. A common factor analysis of the items in a depressed affect inventory and a loneliness measure was conducted using data collected from two samples—a study of 2525 young adults (Study 1), and a population-based sample of 229 English-speaking Blacks/African Americans (37 males, 44 females), non-black Hispanics (33 males, 33 females), and non-Hispanic Caucasians (39 males, 43 females) between the ages of 50 and 68 years ($M = 57.5$, $SD = 4.5$) from the Chicago Health, Aging, and Social Relations Study (CHASRS).

An assumption built into studies that compare lonely versus nonlonely groups or that limit analyses to linear correlation/regression is that individuals average in loneliness are as similar to individuals low in loneliness as they are to those high in loneliness. However, prior research suggests that loneliness scores are positively skewed with most individuals reporting low loneliness (e.g., Russell et al., 1980; see Shaver & Brennan, 1991). Given this distribution, it is possible that individuals average in loneliness, whose loneliness ratings are more similar to those of others in the high frequency portion of the distribution (i.e., those low in loneliness), may be more similar to individuals low than high in loneliness on related socioemotional scales and interpersonal behaviors, as well. Such a result is entirely consistent with the emphasis in prior research on individuals high in loneliness as a psychological problem. If there is a threshold for feelings of loneliness, then the association between loneliness and states such as anxiety and depressed affect may be characterized by quadratic as well as linear components. Such a step-function might be expected if loneliness reflects an inhibited temperament (Cole, Kemeny, & Taylor, 1997; Kagan, Snidman, Arcus, & Reznick, 1994). Therefore, we tested for quadratic as well as linear effects in Study 3. Another aim of Study 3 was to investigate whether the association between loneliness and the socioemotional states of mood, anxiety, anger, optimism, fear of negative evaluation, social skills, social support, dysphoria, and self esteem was secondary to one or more personality dimensions such as surgency (extraversion), emotional stability (neuroticism), or shyness.

Finally, the evolutionary model casts loneliness as capable of influencing a constellation of socioemotional states. If those who feel socially isolated not only feel unhappy but also unsafe, then changes in loneliness should activate a constellation of socioemotional processes. To investigate this question, we used hypnosis to manipulate feelings of loneliness in a within-participants design, and we measured the effects of this manipulation on states and traits investigated in Study 3. By doing so, we were able to investigate the possible causal role of loneliness in social and emotional processes.

2. Study 1

Loneliness and depressed affect are correlated (Segrin, 1998), and the strength of their association often raises questions about their conceptual or functional separation. Indeed, the conflation of loneliness with depressed affect is such that measures of depressed affect (e.g., the Center for Epidemiologic Studies Depression Scale, Radloff, 1977) include items

about feeling lonely. A formal structural examination of the relationship between loneliness and depressed affect was performed to address this question. If factor analyses of items purported to measure loneliness and depressed affect show these constructs load on two separate factors, this would lend support to their being treated as conceptually related but separable constructs.

2.1. Method

2.1.1. Participants and procedure

Two thousand six hundred and twenty-eight undergraduate students at Ohio State University were recruited broadly from residence halls, fraternities and sororities, and introductory psychology classes to participate in the prescreening for this study. They completed a survey packet of demographic and psychological assessment forms, including the R-UCLA and the MMPI Lie Scale (Hathaway & McKinley, 1983). In the residence halls, Resident Assistants were instructed how to administer the surveys and asked to distribute surveys to their residents. Residents who returned completed surveys were entered into a lottery with prizes of \$200, \$75, and \$25. Resident Assistants who assisted in survey distribution and collection were entered into a lottery with prizes of \$75 and \$25. Fraternity and sorority houses that agreed to participate in the study were paid \$1 for each completed survey returned. Students in introductory psychology courses volunteered to complete the survey forms for credit toward research experience hours as a course requirement. After eliminating individuals for whom part or all of the R-UCLA form had not been completed or who had MMPI Lie Scale scores greater than 8 on a 12-point Lie Scale, 2531 students remained.

Participation consisted of completing between five and nine questionnaires that included demographic and psychological assessment forms. All participants completed the R-UCLA Loneliness Scale and the Beck Depression Inventory. Other questionnaires included a demographic information form and a filler questionnaire inquiring about sleep patterns. Half the survey packets presented the R-UCLA Loneliness Scale first, the other half presented the Beck Depression Inventory first. Packet order was equally represented in the returned completed surveys. Reliable and complete data for both the R-UCLA Loneliness Scale and the Beck Depression Inventory were available from 2525 students (1197 males, 1314 females, and 14 undeclared).

2.1.2. Measures

2.1.2.1. R-UCLA Loneliness Scale. Loneliness was indexed using the Revised UCLA Loneliness Scale (R-UCLA), a 20-item questionnaire measuring general feelings of social isolation, loneliness, and dissatisfaction with one's social interactions (Russell et al., 1980). The questionnaire consists of a list of statements such as "People are around me but not with me," and "There are people I can turn to." Participants were asked to rate how often they felt the way described by the items on a scale ranging from 1 (never) to 4 (often). Once certain items were reverse-scored, all of the items were summed to tabulate loneliness scores for each participant, with higher scores indicating greater loneliness. The R-UCLA Loneliness Scale has been found to have high internal consistency, with a coefficient α of .94 found in two studies and .93 in the current study. The R-UCLA loneliness scale has been shown to possess adequate concurrent and discriminant validity (Russell et al., 1980): people who score high on loneliness also experience emotions theoretically related to

loneliness and do not experience emotions not linked to loneliness; loneliness scores correlate more highly with a self-labeling loneliness index than with measures of mood and personality variables such as social risk-taking and negative affect.

2.1.2.2. Beck Depression Inventory. The 13-item Beck Depression Inventory (Beck & Beck, 1972) has been validated as a measure of depressed affect and dysphoria. Each of the items has four response options that are rated on a scale of 0–3, corresponding to increasing degrees of symptoms and dysphoria “felt over the past week and today.” Participants may choose one or more responses to each item. Cronbach’s α for the 13 items was .86. Using the highest scoring response to each item, responses are summed to produce a total depression score. Possible scores range from 0 to 39, with higher scores indicating greater depressed affect.

2.2. Results

The factor structure of the loneliness and depressed affect items was assessed by conducting exploratory factor analyses using SPSS (version 12.0). Data were subjected to a principal axis factor analysis with oblique rotation (Promax with Kaiser normalization) to allow for the possibility of correlated factors. Five factors had eigenvalues greater than one, but no items loaded on the fifth factor, indicating overfactoring. An exploratory factor analysis that constrained the number of factors to four revealed that these four factors were decidedly distinguishable on the basis of their scale source. The first, third, and fourth factors consisted entirely of items from the R-UCLA Loneliness Scale, and the second factor consisted of the 13 items from the BDI. Factor loadings are displayed in Table 1. Notably, the loadings of loneliness items on the depressed affect factor were very low (i.e., <0.10), as were the loadings of depressed affect items on the loneliness factors (i.e., <0.19).

Moreover, the patterning of factors previously identified in the R-UCLA Loneliness Scale (Hawley, Browne, & Cacioppo, 2005) was not disrupted by including the BDI items in the factor analysis. Namely, the first loneliness factor corresponded to the Isolation factor, the third to the Relational Connectedness factor, and the fourth to the Collective Connectedness factor. In the current analysis, each of these factors exhibited moderately sized correlations with the depressed affect factor, $r_{\text{factor 1-factor 2}} = .58$, $r_{\text{factor 3-factor 2}} = .50$, and $r_{\text{factor 4-factor 2}} = .44$, comparable to the correlation exhibited between total loneliness and depressed affect scores, $r = .56$.

An additional factor analysis in which the number of factors was constrained to two also showed a clear separation of the factors as indicated by scale-specific items on each factor, with only one BDI item (item 8) showing low (i.e., <0.33) but dual loadings on both factors. The two factors were correlated at $r = .59$, highly similar to the correlation between the two scale scores, $r = .56$. These results support the notion that loneliness and depressed affect are separable though correlated constructs.

3. Study 2

The results of Study 1 replicated prior research arguing for the separability of loneliness and depressed affect. The external validity of these results may be limited, however, by the use of college undergraduates as participants. We, therefore, replicated our analyses using

Table 1

Factor loadings in an exploratory factor analysis of the R-UCLA Loneliness Scale and the Beck Depression Inventory^a ($N = 2525$)

	Factor 1	Factor 2	Factor 3	Factor 4
UCLA11. I feel left out	0.79	0.04	-0.14	0.06
UCLA14. I feel isolated from others	0.79	0.00	-0.07	0.13
UCLA18. People are around me but not with me	0.72	-0.06	-0.09	0.20
UCLA2. I lack companionship	0.71	-0.06	0.05	-0.08
UCLA17. I am unhappy being so withdrawn	0.67	0.09	-0.07	-0.03
UCLA4. I feel alone	0.64	0.10	0.00	-0.11
UCLA3. There is no one I can turn to	0.57	0.03	0.38	-0.24
UCLA12. My social relationships are superficial	0.56	-0.03	0.00	0.01
UCLA7. I am no longer close to anyone	0.55	-0.02	0.27	-0.06
UCLA13. No one really knows me well	0.52	-0.06	0.17	0.08
UCLA8. My interests and ideas are not shared by those around me	0.51	-0.06	-0.07	0.24
BDI6. I hate myself	0.06	0.68	0.00	-0.05
BDI9. I can't make any decisions at all anymore	-0.06	0.67	-0.06	0.01
BDI11. I can't do any work at all	-0.02	0.65	-0.07	0.01
BDI3. I feel I am a complete failure as a person	-0.08	0.63	0.12	-0.02
BDI2. I feel that the future is hopeless and that things cannot improve	-0.04	0.63	0.05	0.00
BDI5. I feel guilty all of the time	-0.03	0.57	0.00	-0.01
BDI1. I am so sad or unhappy that I can't stand it	0.19	0.55	0.04	-0.07
BDI12. I am too tired to do anything	-0.05	0.54	-0.07	0.05
BDI10. I feel that I am ugly or repulsive looking	0.08	0.53	-0.03	-0.05
BDI4. I am dissatisfied or bored with everything	0.06	0.49	0.00	0.13
BDI7. I would kill myself if I had the chance. ^b	0.06	0.47	0.07	0.01
BDI13. I have no appetite at all anymore	-0.06	0.42	-0.03	0.04
BDI8. I have lost all of my interest in other people	0.07	0.34	0.04	0.23
UCLA20. There are people I can turn to	-0.04	0.00	0.96	-0.01
UCLA19. There are people I can talk to	-0.04	-0.03	0.87	0.04
UCLA10. There are people I feel close to	0.08	-0.02	0.57	0.17
UCLA16. There are people who really understand me	0.16	0.00	0.49	0.13
UCLA15. I can find companionship when I want it	0.23	0.04	0.36	0.06
UCLA6. I have a lot in common with the people around me	0.07	0.00	0.05	0.69
UCLA1. I feel in tune with the people around me	0.07	0.08	0.06	0.58
UCLA5. I feel part of a group of friends	0.21	-0.05	0.17	0.39
UCLA9. I am an outgoing person	0.15	0.00	0.05	0.37
Factor 1	1.00			
Factor 2	0.58	1.00		
Factor 3	0.72	0.50	1.00	
Factor 4	0.67	0.44	0.60	1.00

^a The most extreme statement for each item is presented here.

^b Participants who endorsed this statement, or the slightly less extreme version ("I would like to kill myself"), were referred for counseling, and their data were not included in these analyses.

data from the CHASRS, a longitudinal population-based study of African American, Hispanic, and Caucasian men and women born between 1935 and 1952 who reside in Cook County. Study 2 also allowed us to examine whether the ability to distinguish between loneliness and depressed affect at the measurement level extended to an alternate measure

of depressed affect, namely the 20-item CES-D (Center for Epidemiologic Studies Depression Scale, Radloff, 1977).

3.1. Methods

3.1.1. Participants and procedures

A population-based sample of 229 English-speaking Blacks/African Americans (37 males, 44 females), non-black Hispanics (33 males, 33 females), and non-Hispanic Caucasians (39 males, 43 females) between the ages of 50 and 68 years ($M = 57.5$, $SD = 4.5$) from Cook County, Illinois, served as participants. Although 229 participants enrolled in the study, these analyses were based on data from a sample of 181 older males and females of Caucasian (37 males, 36 females), African American (31 males, 29 females), and Hispanic (22 males, 26 females) ethnicity ($M_{\text{age}} = 57$) for whom complete data were available.

A multi-stage probability sampling design was used to select the respondents. The first stage involved drawing a sample of households, using a sampling frame owned and maintained by GENESYS Sampling Systems. This frame consists of all households with listed phone numbers, augmented by additional households identified through available sources such as voter registration records, school registration records, and magazine subscription lists. Once this subset of households was identified, a stratified equal probability of selection (EPSEM) sample was drawn from it. The following three strata were used: (1) households from census tracts in which at least 80% of the residents were African American, (2) households for which the associated surname (as listed in GENESYS's records) was among the roughly 13,000 surnames identified by the US Census Department as "Hispanic," and (3) all remaining households. For the full frame, Stratum (1) contains approximately 80% of all African American households in Cook County. Stratum (2) is less effective at targeting Hispanics, as only about 60% of persons with Hispanic surnames identify themselves as Hispanic and a similar fraction (60%) of Hispanics have Hispanic surnames. The sample was drawn in replicates, with the proportion from each stratum varied to achieve an approximately equal distribution among the three racial/ethnic groups in the final sample.

The second stage involved within-household selection. Each sampled household was screened by telephone for the presence of at least one age-eligible individual. This screening was performed by the University of Chicago Survey Lab. If a household contained more than one age-eligible individual, the person with the most recent birthday was selected. The selected individual was then screened further to exclude those who identified themselves as belonging to a racial/ethnic group other than the three identified above and those not sufficiently ambulatory to come to the University and participate in the study. All remaining individuals were asked to participate in the study. Participants were paid \$126 for participating in the first year. To maximize our ability to distinguish between groups and to perform subset analyses, we used a quota sampling strategy at both the household and individual levels to achieve an approximately equal distribution of participants across the six gender by racial/ethnic group combinations. As we expected, eligible Hispanic participants were the most difficult to identify and to recruit (e.g., many age-eligible Hispanics did not speak and read English well enough to participate), and this meant that the final replicates consisted entirely of households from the Hispanic surname stratum. In addition, once the desired number of whites and blacks were recruited (one-third each of the target sample size), newly sampled households without age-eligible Hispanics were discarded, and the within-household selection was made from among eligible Hispanic participants only.

Participants arrived at the laboratory at approximately 8:30 a.m. for approximately 8 h of testing for Year 1 of a 5-year longitudinal study of social isolation and health. This day at the laboratory included informed consent, questionnaires, interviews, lunch, and a cardiovascular protocol, which is not directly related to this study. As part of the testing, participants completed the Revised UCLA Loneliness Scale (R-UCLA) and the Center for Epidemiologic Studies Depression Scale (CES-D).

3.1.2. Measures

3.1.2.1. *R-UCLA Loneliness Scale.* The Revised UCLA Loneliness Scale (Russell et al., 1980) is described above in Study 1. In the present study, the coefficient α was .92.

3.1.2.2. *Center for epidemiologic studies depression scale.* Depressive feelings and behavior were assessed using the Center for Epidemiologic Studies Depression (CES-D) Scale, which is a 20-item measure (Radloff, 1977). This scale, which has been used extensively to gauge depression in epidemiological studies, consists of a list of items such as “I felt depressed,” and “I enjoyed life.” Participants were asked to rate how often they felt the way described by the items during the past week on a scale ranging from 0 (rarely or none of the time) to 3 (most or all of the time). After specific items were reverse scored, all of the items were summed to calculate depressed affect scores for each participant, with higher scores indicating higher levels of depressive symptoms. The CES-D depression scale has demonstrated high internal consistency, with coefficient α s of .85 in a general population sample and .90 in a sample of psychiatric patients. In the present study, the coefficient α was .89. Discriminant validity of the CES-D has been supported by low correlations between CES-D scores and scores on scales designed to measure different phenomena, such as positive affect and aggression, and high correlations between CES-D scores and scores on other scales used to measure symptoms of depressed affect.

3.2. Results

We conducted an exploratory principal axis factor analysis (SPSS, v. 12.0) of the items from the R-UCLA Loneliness and the CES-D, and employed oblique rotation (Promax with Kaiser normalization) to allow for the possibility of correlated factors. Nine factors were extracted, and again, each factor was largely scale-specific. As can be seen in Table 2, five of the factors consisted of loneliness items, and four others consisted of CES-D items. An additional factor analysis in which the number of factors was constrained to two also showed a clear separation of the two factors as indicated by scale-specific items on each factor, with four CES-D items (i.e., items 4, 12, 15, and 16) and one R-UCLA item (i.e., item 15) showing low (i.e., <0.36) but dual loadings on both factors. The two factors were correlated at $r = .54$, a level comparable to the scale score intercorrelation, $r = .59$.

3.3. Discussion

As in prior research, we found loneliness and depressed affect to be correlated in Studies 1 and 2. The results of Studies 1 and 2 further provided evidence that loneliness and depressed affect can be thought of as distinct constructs on theoretical and statistical grounds. For instance, the items from the R-UCLA Loneliness Scale and the Beck Depression Inventory loaded uniquely on separate factors, with three factors representing

Table 2

Factor loadings in an exploratory factor analysis of the R-UCLA Loneliness Scale and the CES-D ($N = 181$)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
CESD5. I had trouble keeping my mind on what I was doing	0.75	0.07	0.07	-0.06	0.04	-0.13	-0.03	0.04	-0.01
CESD3. I felt that I could not shake off the blues even with help from my family or friends	0.72	-0.17	-0.18	-0.06	-0.17	-0.07	0.05	0.05	0.11
CESD2. I did not feel like eating; my appetite was poor	0.68	-0.14	-0.04	-0.01	0.28	0.02	0.21	-0.15	0.08
CESD6. I felt depressed	0.65	-0.04	0.06	0.35	-0.26	-0.15	-0.18	-0.09	-0.02
CESD1. I was bothered by things that usually don't bother me	0.62	-0.02	-0.17	-0.18	-0.05	0.03	-0.05	0.29	-0.17
CESD20. I could not get 'going'	0.61	0.17	0.02	-0.08	-0.14	-0.03	-0.18	-0.02	-0.05
CESD11. My sleep was restless	0.54	0.03	0.13	0.08	0.05	-0.23	0.10	0.07	-0.10
CESD7. I felt that everything I did was an effort	0.54	0.10	0.13	0.06	-0.08	0.16	-0.06	-0.08	0.12
CESD17. I had crying spells	0.52	-0.22	-0.17	0.32	0.11	0.10	-0.05	-0.00	0.13
CESD18. I felt sad	0.42	-0.06	0.03	0.33	-0.13	0.01	-0.01	0.02	-0.03
CESD15. People were unfriendly	0.26	0.17	-0.18	0.05	0.12	0.20	-0.06	-0.06	-0.10
UCLA18. People are around me but not with me	-0.02	0.85	-0.05	-0.04	-0.00	0.14	-0.07	0.06	0.07
UCLA13. No one really knows me well	0.02	0.79	-0.14	-0.10	0.09	-0.03	-0.13	-0.02	-0.11
UCLA11. I feel left out	-0.11	0.52	-0.17	0.24	-0.07	-0.03	0.09	0.11	0.11
UCLA14. I feel isolated from others	-0.11	0.52	-0.21	0.29	-0.12	-0.12	0.01	0.06	-0.12
UCLA12. My social relationships are superficial	-0.02	0.51	-0.07	0.03	0.13	-0.16	0.04	-0.34	0.06
UCLA17. I am unhappy being so withdrawn	-0.01	0.49	-0.09	0.26	0.05	0.20	0.17	0.06	-0.00
UCLA8. My interests and ideas are not shared by those around me	0.01	0.48	0.09	-0.28	-0.10	0.13	0.19	0.04	-0.04
UCLA7. I am no longer close to anyone	0.11	0.37	-0.16	-0.02	-0.02	-0.02	0.23	-0.03	-0.05

Table 2 (continued)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Factor 8	Factor 9
UCLA20. There are people I can turn to	-0.05	-0.15	0.85	0.03	-0.16	-0.04	0.04	-0.04	-0.02
UCLA19. There are people I can talk to	-0.08	-0.12	0.79	0.06	-0.06	-0.11	0.13	0.09	0.02
UCLA10. There are people I feel close to	0.19	-0.16	0.61	0.06	0.05	-0.01	-0.01	0.05	0.05
UCLA16. There are people who really understand me	-0.08	-0.21	0.53	0.12	0.08	-0.04	0.08	0.09	-0.03
CESD10. I felt fearful	0.09	-0.07	0.10	0.80	0.12	0.15	-0.08	-0.09	-0.20
CESD14. I felt lonely	0.11	0.17	0.14	0.53	-0.06	0.07	0.20	0.05	-0.07
UCLA15. I can find companionship when I want it	-0.02	0.25	0.30	-0.32	-0.07	-0.13	-0.18	0.03	0.31
CESD12. I was happy	-0.2	-0.06	-0.01	0.17	0.74	-0.09	0.00	0.06	-0.04
CESD16. I enjoyed life	0.03	-0.01	-0.11	-0.14	0.74	-0.22	0.02	0.12	0.04
CESD8. I felt hopeful about the future	0.08	0.27	0.18	0.20	0.39	-0.24	-0.32	-0.04	0.10
CESD4. I felt that I was just as good as other people	0.19	0.01	0.12	-0.10	0.24	-0.65	-0.03	-0.01	-0.10
CESD9. I thought life had been a failure	0.25	0.03	-0.02	0.33	-0.01	0.44	-0.03	-0.02	0.03
CESD19. I felt that people disliked me	0.32	0.21	0.00	0.09	-0.06	0.43	0.02	-0.01	0.17
UCLA2. I lack companionship	-0.1	0.20	0.14	-0.00	0.01	0.06	0.74	-0.13	0.09
UCLA4. I feel alone	0.06	0.33	-0.02	0.17	0.01	-0.14	0.57	0.06	0.16
UCLA3. There is no one I can turn to	0.19	0.32	-0.08	-0.07	0.01	-0.11	0.37	-0.06	-0.00
UCLA1. I feel in tune with the people around me	0.05	0.06	0.16	-0.09	0.11	-0.06	-0.08	0.65	-0.09
UCLA5. I feel part of a group of friends	-0.09	-0.06	0.20	0.09	0.17	0.09	-0.19	0.42	0.08
UCLA6. I have a lot in common with the people around me	0.12	-0.18	0.24	-0.00	0.09	0.04	-0.03	0.40	0.20
UCLA9. I am an outgoing person	0.05	0.00	0.11	-0.23	0.02	0.16	0.15	-0.03	0.74
CESD13. I talked less than usual	0.23	0.27	0.33	0.12	0.02	0.08	0.14	0.08	-0.35
Factor 1	1.00								
Factor 2	0.38	1.00							
Factor 3	-0.33	-0.51	1.00						
Factor 4	0.45	0.36	-0.34	1.00					
Factor 5	-0.41	-0.45	0.53	-0.48	1.00				
Factor 6	0.39	0.09	-0.18	0.00	-0.11	1.00			
Factor 7	0.39	0.49	-0.54	0.41	-0.48	0.13	1.00		
Factor 8	-0.17	-0.35	0.40	0.03	0.16	-0.29	-0.20	1.00	
Factor 9	-0.32	-0.27	0.31	0.08	0.18	-0.48	-0.39	0.39	1.00

loneliness and one factor representing depressed affect. Notably, no items exhibited substantial loadings on both a loneliness factor and the depressed affect factor. The factor structure further indicated that the experiential overlap between loneliness and depressed affect could not be attributed to measurement overlap. Item loadings showed an exact correspondence with the scale from which each item was derived—that is, the items from the loneliness scale loaded on the loneliness factor, and the items from the depressed affect scale loaded on the separate depressed affect factor.

The results of factor analyses are, of course, dependent on the particular mix of items subjected to the analysis. It is noteworthy, therefore, that: (a) the three factor solution for loneliness is a robust structure found previously in analyses, for instance, of the UCLA Loneliness Scale (e.g., Hawkley et al., 2005; McWhirter, 1990), and (b) the separability of loneliness and depressed affect was replicated when an alternative measure of depressed affect was employed. The CES-D, like the BDI, is a validated measure of dysphoria and depressed affect but is more suitable for a population-based sample of older adults (Radloff, 1977) such as the sample in Study 2. The results confirmed that depressed affect as measured by the CES-D was again distinguishable from loneliness as measured by the R-UCLA Loneliness Scale. An exploratory factor analysis revealed that depressed affect and loneliness items loaded on unique factors, and no factors showed a combination of loneliness and depressed affect items that might indicate overlapping constructs. Moreover, the loneliness and depressed affect factors were correlated at a level comparable to correlations between the scale scores, consistent with the notion that loneliness leads to depressed affect. This causal hypothesis is tested experimentally in Study 4.

The factor analyses of Studies 1 and 2 conform to the prediction that loneliness and depressed affect are stochastically separable. However, participants were asked to rate how often they felt the way described by each of the items in the loneliness scale, whereas they were asked to rate how they felt during the past week in the measures of depressed affect. Could the factor structure found in Studies 1 and 2 have resulted from the UCLA loneliness items reflecting a trait rather than a state variable, in contrast to the items in the measures of depressed affect reflecting a state rather than a trait variable? To examine whether UCLA loneliness scores were associated with state as well as trait loneliness, we correlated responses to the UCLA loneliness scores with responses to the State-Trait Loneliness Measure (Shaver & Brennan, 1991) from a sample of 715 undergraduates at Ohio State University. The UCLA loneliness measure was correlated with both state loneliness ($r(715) = +0.78, p < .05$) and trait loneliness ($r(713) = +0.60, p < .05$), with the correlation between the UCLA score and state loneliness significantly stronger than the correlation between the UCLA score and trait loneliness ($p < .05$).

In a study with a related aim, Kremen (1996) investigated the separability of the constructs of anxiety and depression using factor analysis. Kremen found the two to form separate factors with a strong “interpersonal component” in depression that was less noticeable in anxiety. In light of the results of the factor analyses, we used data from Study 2 to investigate whether the interpersonal component in measures of depressed affect might reflect neuroticism or loneliness. Results suggested the former: emotional stability (neuroticism) was correlated with depressed affect ($r(212) = -0.39, p < .05$) and loneliness ($r(214) = -.25, p < .05$), however, loneliness was not correlated with emotional stability when depressed affect was statistically controlled ($r(208) = -0.04, p > .5$) even though depressed affect remained correlated with emotional stability when loneliness was statistically controlled ($r(208) = -0.31, p < .05$). Note, this finding also suggests that loneliness

and depressed affect are not simply associated manifestations of neuroticism. In Study 3, we examined the extent to which the effects attributed to loneliness were explicable by a broader personality factor such as neuroticism.

Finally, if loneliness and depressed affect were reflecting the same overarching construct, then the peripheral physiological correlates should overlap. [Hawley, Browne, and Cacioppo \(2004\)](#) examined the combined and unique association of loneliness, depressed affect, perceived stress, hostility, and low social support with autonomic and neuroendocrine activity in the CHASRS sample. Extending prior research, loneliness predicted significantly elevated systolic blood pressure (SBP) net of demographic variables, health behavior variables, and the remaining psychosocial factors (including depressed affect); net effect size was 0.85 mm Hg per standard deviation of loneliness for each addition year of age. Loneliness did not have independent effects on overnight urinary cortisol levels but instead perceived stress was directly related to cortisol levels while depressed affect was inversely related to it. These results complement the results of Studies 1 and 2 on the stochastic separability of loneliness and depressed affect and indicate there are separable functional effects of loneliness and depressed affect, as well.

4. Study 3

According to our evolutionary model of loneliness, a person made to feel lonely not only feels unhappy but also feels unsafe, feelings that activate an anachronistic survival mechanism that heightens sensitivity to threats from all sides. This implies that loneliness should influence not only depressed affect but also mood, anxiety, anger, optimism, fear of negative evaluation, social skills, social support, and dysphoria. In addition, Leary's sociometer theory ([Leary & Baumeister, 2000](#); [Leary, Tambor, Terdal, & Downs, 1995](#)) suggests that self-esteem, an internal, psychological system that gauges the degree to which an individual feels included versus excluded by other people, should also be influenced by loneliness. The prior literature is consistent with these predicted associations (e.g., see review by [Berscheid & Reis, 1998](#); [Duck et al., 1994](#); [Ernst & Cacioppo, 1999](#); [Rook, 1984](#); [Shaver & Brennan, 1991](#)), but we sought to examine these associations in Study 3 and to test the hypothesis that experimental manipulations of loneliness influence the levels of these variables in Study 4.

Lonely individuals report higher levels of stress in their everyday life and exhibit poorer control over their attentional focus as indicated by their performance on a dichotic listening task ([Cacioppo et al., 2000](#)). We therefore included measures of intrusive and avoidant thoughts regarding traumatic experiences to examine whether lonely individuals are also characterized by more intrusive thoughts about traumatic events. In a study of bereaved mothers, [Lepore, Silver, Wortman, and Wayment \(1996\)](#) reported that the frequency of intrusive thoughts about the traumatic event was positively correlated with social constraint, a term the authors used to describe mothers' strained social support and inhibited ability to talk about their loss. They further found that intrusive thinking predicted depressive symptoms in high social constraint mothers but not in low constraint mothers. Loneliness was not examined by [Lepore et al. \(1996\)](#), however, and the associations between loneliness and intrusive and avoidant thinking are not known.

Second, given the heritability of loneliness we sought to examine the relationship between loneliness and personality. The Big Five taxonomy—which parses personality into five major factors: surgency, agreeableness, conscientiousness, emotional stability, and

openness—has become an integrative tool in research on personality and on affective and social vulnerabilities (John & Srivastava, 1999). Components of the Big 5 have been associated with loneliness in prior research (e.g., Russell et al., 1980; Stephan, Fath, & Lamm, 1988; cf. Cheek & Busch, 1981), but the extent to which these components can explain the associations between loneliness and mood, anxiety, anger, optimism, fear of negative evaluation, shyness, social skills, social support, dysphoria, sociability, and self esteem has not been investigated. Relatedly, to the extent loneliness is functionally independent of depressed affect, loneliness may exhibit unique patterns of association with personality (e.g., surgency, shyness) and socioemotional variables (e.g., mood, self-esteem), independent of levels of depressed affect.

Finally, an assumption of correlational techniques or analyses of variance contrasting extreme groups (i.e., high versus low loneliness) is that the association between loneliness and related variables is *only* linear—that is, individuals average in loneliness are as similar to individuals low in loneliness as they are to individuals high in loneliness. To test this assumption, we gauged the loneliness of 2531 participants in pretesting. For Study 3, one-third of the participants were recruited from people whose loneliness score on the pretest fell into the bottom quintile, one-third of the participants came from people whose loneliness score on the pretest fell into the middle quintile, and one-third of the participants came from people whose loneliness score on the pretest fell into the top quintile. This insured that the loneliness scores of the people in Study 3 would vary along a wide range of loneliness scores. Loneliness was then treated as a continuous variable in Study 3, and we examined both linear and quadratic associations between loneliness and the study variables.

4.1. Method

4.1.1. Participants

The 2531 participants tested in Study 1 (Time 1) served as potential participants for Study 3. Only a small percentage of the eligible participants were randomly selected for Study 3 (see Hawkey et al., 2004). The primary determinant of eligibility was that scores on the R-UCLA Loneliness Scale at Time 1 were in the upper quintile (high lonely group: total score ≥ 44 ; $M = 51.4$), middle quintile (average lonely group: $33 \leq$ total score ≤ 39 ; $M = 35.3$), or lower quintile (low lonely group: total score < 28 ; $M = 24.5$). The final sample consisted of an equal number of male and female participants in each quintile who met additional inclusionary criteria: (a) a score no higher than 13 on the 13-item version of the Beck Depression Inventory (Beck & Beck, 1972) (included to avoid including participants with a high likelihood of clinical depression); (b) a body mass index no greater than 27 (included to avoid confounding obesity with physiological measures included in the larger study); (c) enrollment in at least 6 credit hours and class standing of neither a first-quarter freshmen nor a last-quarter senior; (d) neither married nor living with a significant other; (e) US citizen (c–e were included to ensure that all participants had similar access to social contacts at the time their loneliness levels were measured); and (f) neither speech nor needle phobic (included to avoid confounds with other aspects of the larger study such as a fear of needles and having their blood drawn). This group of 135 students (44 high lonely, 46 average lonely, and 45 low lonely) completed a second R-UCLA Loneliness Scale 2 weeks to 2 months later (Time 2), upon entry into Study 3. Loneliness scores exhibited considerable stability from Time 1 to Time 2, Spearman's $r = .74$, and significant group differences in loneliness scores were maintained across this time period (see below).

The 135 participants in Study 3 (67 females; mean age = 19.23, $SD = 1.1$, range 18–24) described their ethnic origins as 83% white or European (non-Hispanic), 7% black or African-American, 7% Asian, Asian-American, or Pacific Islander, 1% Hispanic or Latin American and 2% other. Participants were part of a larger study assessing the emotions, social lives, and physiology of individuals differing in loneliness and were paid \$200 for their participation in the study from which these data were drawn.

4.1.2. Measures

4.1.2.1. *Loneliness.* Loneliness was assessed using the Revised-UCLA Loneliness Scale (R-UCLA; Russell et al., 1980) as described in Study 1. Cronbach's α in this subsample of Study 1 was .94.

4.1.2.2. *Beck Depression Inventory.* Depressed affect was assessed using the 13-item Beck Depression Inventory (Beck & Beck, 1972) as described in Study 1. Cronbach's α in this subsample of Study 1 was .84.

4.1.2.3. *Shyness and sociability.* The Shyness and Sociability Scale consists of 14 items that ask participants to rate how each item describes them using a 5-point Likert scale that ranges from 0 (extremely uncharacteristic) to 4 (extremely characteristic). The 14 items were broken down into two separate subscales, shyness and sociability. The shyness subscale consisted of 9 items with a Cronbach's α of .86; summing the responses across the items yielded possible shyness scores ranging from 0 (low shyness) to 36 (high shyness). The sociability subscale consisted of 5 items with a Cronbach's α of .82; summing the responses across the items yielded possible sociability scores ranging from 0 (low sociability) to 20 (high sociability). See Cheek and Buss (1981) for scale design and psychometric properties.

4.1.2.4. *The Big 5 measure of personality.* The "Big 5" (see Goldberg, 1992, for scale construction, validity, and reliability) is a self-report questionnaire in which participants are asked to rate how accurately each of 100 trait words describes themselves at the present time using a 9-point Likert scale that ranges from 1 (extremely inaccurate) to 9 (extremely accurate). The 100 items constitute five personality factors consisting of 10 positive and 10 negative items each. These subscales, and their reliabilities in our sample, are surgency ($\alpha = .92$), agreeableness ($\alpha = .92$), conscientiousness ($\alpha = .90$), emotional stability ($\alpha = .84$), and openness ($\alpha = .89$). Scores for each subscale were computed by reverse scoring the negative items in each factor and then calculating the mean item response for all 20 items. This yielded subscale scores with potential ranges of 1–9; the higher the score, the more the participant considered the personality characteristic of herself/himself.

4.1.2.5. *Positive and negative affect schedule.* The PANAS is a 20-item questionnaire that asks participants to rate the extent to which they have felt the way described by the items during the past week on a 5-point Likert scale that ranges from 1 ("very little or not at all") to 5 ("extremely"). The 20-item PANAS scale is broken down into two 10-item subscales: a positive affect subscale ($\alpha = .89$) and a negative affect subscale ($\alpha = .87$). Subscale scores were computed by summing the responses to all items in the subscale and yielded possible subscale score ranges of 10 (low in given affect) to 50 (high in given affect). See Watson, Clark, and Tellegen (1988) for scale design and validation.

4.1.2.6. Spielberger trait anger and anxiety. The Spielberger Trait Anger and Anxiety Scale is a 20-item instrument that has two 10-item subscales, anger and anxiety. For all 20 items, participants were asked to rate each item with the term that best described how they generally felt on a 4-point Likert scale that ranges from 1 (“almost never”) to 4 (“almost always”). Subscale scores for all participants were computed by summing the responses to all items in the subscale. The subscale scores have a range of 10 (low trait anxiety or anger) to 40 (high trait anxiety or anger). The anxiety and anger subscales had Cronbach’s α s of .89 and .84, respectively. For scale design and psychometric properties, see [Spielberger, Jacobs, Crane, and Russell \(1983\)](#).

4.1.2.7. Revised Life Orientation Test. The Revised Life Orientation Test for optimism is a 10-item questionnaire that asks participants to rate their agreement with the items on a 5-point Likert scale ranging from 0 (“strongly disagree”) to 4 (“strongly agree”). Four items served as filler items, and scale scores were calculated by summing the responses to the remaining six items. Cronbach’s α in our sample was 0.78. The range for the scale scores is 0 (low optimism) to 24 (high optimism). See [Scheier, Carver, and Bridges \(1994\)](#) for scale design and psychometric properties.

4.1.2.8. Social skills. Social skills were assessed using the 9 items from a social competence scale ([Levenson & Gottman, 1978](#)), and four additional items that repeated earlier items but phrased them in terms of someone of the same sex (as opposed to someone of the opposite sex). The 13 items describe specific behaviors asking participants to rate their likelihood of behaving in that way on a 4-point Likert scale ranging from 1 (I never do this) to 4 (I do this almost always). A scale score for each participant was computed by summing the responses to all items and yielded a potential scale score range of 13 (low social skills) to 52 (high social skills). Cronbach’s α for this scale was .82. Example items are “I stand up for my rights” and “Maintain a long conversation with a member of the opposite sex.”

4.1.2.9. Rosenberg Self-Esteem Inventory. Self esteem has been conceptualized as a general gauge of a person’s interpersonal relationships ([Leary et al., 1995](#)). The Rosenberg Self-Esteem Inventory ([Rosenberg, 1965](#)) is a 10-item questionnaire that asks participants to indicate their agreement with each self-descriptor item using a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Scale scores for each participant were computed by summing the responses to all items and yielded a possible scale range of 10 (low self-esteem) to 40 (high self-esteem). Cronbach’s α for this scale in our sample was .90. For further discussion of the psychometric properties of the scale, see [Crandall \(1973\)](#) and [Dobson et al. \(1979\)](#).

4.1.2.10. Brief fear of negative evaluation. The Brief Fear of Negative Evaluation Scale is a 12-item instrument developed by [Leary \(1983\)](#) based on the full version of the Fear of Negative Evaluation scale by [Watson and Friend \(1969\)](#). Participants are asked to rate how characteristic the 12 items are of them on a 5-point Likert scale ranging from 1 (“not at all characteristic of me”) to 5 (“extremely characteristic of me”). A total score was calculated for each participant by summing the responses for each item, yielding a possible scale score range of 12 (low fear of negative evaluation) to 60 (high fear of negative evaluation). Cronbach’s α was .94.

4.1.2.11. Interpersonal Support Evaluation List. We used 6 items assessing appraisal support from the Interpersonal Support Evaluation List (Cohen & Hoberman, 1983). This self-report questionnaire asks participants to rate how truly each item reflects their own feelings on a 4-point Likert scale that ranged from 1 (“definitely true”) to 4 (“definitely false”). Scale scores were computed by summing the responses to all items, and yielded a possible scale score range of 6 (low perceived social support) to 24 (high perceived social support). Cronbach’s α was .84.

4.1.2.12. Impact of Event Scale. The Impact of Event Scale is a 15-item self-report questionnaire that asks the participant to first identify a recent serious life event and to report the approximate date and nature of the event on the form (Horowitz, Wilner, & Alvarez, 1979). All items are then asked in relation to that event. For each item, the participant was asked to rate, on a weighted 4-point Likert scale, how often the comments were true of them over the past 7 days: 0 (not at all), 1 (rarely), 3 (sometimes), and 5 (often). A 7-item intrusion ($\alpha = .88$) and an 8-item avoidance subscale ($\alpha = .82$) were computed by totaling the sum of all items in each subscale. The intrusion subscale measures the extent to which the participant thinks about the event, and total scores can range from 0 to 35. The avoidance subscale measures the extent to which the participant denies, blunts, or ideationally reconstructs the event, and total scores can range from 0 to 40.

4.1.3. Procedure

Students began their participation in this study in the early evening at the General Clinical Research Center (GCRC) of the Ohio State University Hospital. Participants completed questionnaires during three time periods that evening, interspersed with cardiovascular testing and a meal. The final set of questionnaires was completed the following morning after spending the night at the hospital. Physiological measures were also obtained, the results of which are reported elsewhere (Cacioppo, Hawley, Berntson, et al., 2002; Cacioppo, Hawley, Crawford, et al., 2002).

The questionnaires were created using Teleform for Windows (version 5.0, Cardiff Software). Completed forms were scanned and verified for accuracy and the data saved in a desktop PC database. For most scales, if fewer than 10% of items were missing values, the values of the missing items were imputed with the mean of the intact values. For scales between 5 and 10 items in length, scores were not calculated if more than one item was missing. If scales shorter than 5 items long were missing any values, scores were not computed.

4.1.4. Statistical analysis

Data were imported into SPSS (version 12.0, SPSS) for reduction and analysis. The General Linear Model (GLM) multivariate procedure (MANCOVA) was employed to evaluate the effect of loneliness on multiple dependent variables. Separate models were tested to examine loneliness differences among (1) personality and (2) socioemotional variables. In this MANCOVA procedure, which is the multivariate equivalent of a univariate regression approach, loneliness (linear term) and loneliness squared (quadratic term) are treated as continuous covariates in the analysis, and no categorical independent variables are specified. Loneliness and all outcome variables were standardized prior to analysis. Coefficients are therefore interpretable as beta weights (*SD* change in outcome associated with 1 *SD* change in loneliness). The Wilks-lambda criterion was used to evaluate

significance for the MANCOVA omnibus tests. Significant omnibus tests were followed up with GLM univariate analyses of covariance (ANCOVAs). Cell sizes in the analyses were adjusted for incomplete data from participants. Statistical significance was set at $p < .05$ unless otherwise noted.

4.2. Results

Because the loneliness groups were assigned based on prescreening assessments performed 2 weeks to 2 months earlier, we examined current loneliness scores using the R-UCLA scale. A one-way ANOVA (loneliness group: high, average, lonely) with the R-UCLA score as a dependent variable revealed a significant effect for loneliness, $F(2, 132) = 62.90$, $p < .05$, and confirmed that the groups differed as expected: $M_{\text{high loneliness}} = 44.01$, $SD = 9.28$, $M_{\text{average loneliness}} = 35.66$, $SD = 7.20$, $M_{\text{low loneliness}} = 26.76$, $SD = 4.55$. Post hoc analyses using the Tukey-*B* procedure revealed that each group differed significantly from the other groups; effect sizes (d 's) contrasting the high lonely with the average and low lonely groups were 1.01 and 2.36, respectively, and contrasting the average and low lonely groups was 1.48. For the purposes of the following analyses, we employ the continuous loneliness scores from Time 1, obtained at the time of assignment into loneliness groups, because we sought to examine the correlates, and the possible effects, of loneliness.

A multivariate GLM procedure treating all variables as continuous was performed with the socioemotional variables serving as the outcome variables (i.e., negative mood, positive mood, anxiety, anger, optimism, self-esteem, fear of negative evaluation, social skills, social support, intrusive thoughts, and avoidant thoughts). The omnibus effect for loneliness was significant, $F(11, 121) = 11.793$, partial eta-squared = 0.52. Follow-up univariate GLM procedure indicated a significant linear relationship between loneliness and each of the socioemotional variables, with the exception of intrusive thinking, $p > .5$. β weights (SD change in outcome associated with 1 SD change in loneliness) confirmed that higher loneliness scores predicted greater negative mood, $b = 0.42$ ($SE = .08$), anxiety, $b = 0.63$ ($SE = .07$), anger, $b = 0.25$ ($SE = .09$), fear of negative evaluation, $b = 0.24$ ($SE = .09$), and avoidant thinking, $b = 0.17$ ($SE = .09$), and predicted lower positive mood, $b = -0.40$ ($SE = .08$), optimism, $b = -0.40$ ($SE = .08$), self-esteem, $b = -0.47$ ($SE = .08$), social skills, $b = -0.40$ ($SE = .08$), and social support, $b = -0.62$ ($SE = .07$).

We next examined the linear relationship between loneliness and personality variables. The multivariate GLM analysis produced a significant omnibus effect for loneliness, $F(7, 121) = 8.559$, partial eta-squared = 0.33, and was followed by univariate GLM procedure indicating a significant linear relationship between loneliness and each of the personality measures except intellect (openness), $p > .2$. Replicating and extending prior research, β weights indicated that higher levels of loneliness were associated with lower surgency (extraversion), $b = -0.42$ ($SE = .08$), emotional stability (neuroticism), $b = -0.30$ ($SE = .09$), agreeableness, $b = -0.36$ ($SE = .08$), conscientiousness, $b = -0.38$ ($SE = .08$), sociability, $b = -0.29$ ($SE = .09$), and shyness, $b = 0.44$ ($SE = .08$).

A second set of multivariate GLM procedures were conducted to test whether loneliness exhibited a quadratic relationship with personality and socioemotional variables. For these analyses, the raw loneliness score and a squared loneliness score (representing the quadratic term) were entered as simultaneous predictors. The omnibus test of the quadratic term was not significant for the personality variables, $F(7, 120) = 1.343$, $p > .2$, or the

socioemotional variables, $F(11, 120) = 1.400, p > .1$. Only the linear associations were statistically significant.

As indicated by the β weights above, loneliness was significantly associated with the personality factors of surgency, agreeableness, emotional stability, conscientiousness, shyness, and sociability. To examine whether the associations between loneliness and the socioemotional variables we examined were attributable to an overarching personality factor, the linear GLM analyses above were repeated simultaneously holding constant the effects of surgency, agreeableness, emotional stability, conscientiousness, shyness, and sociability. This did not alter the relationships between loneliness and negative mood, anxiety, anger, optimism, self-esteem, and social support. Intrusive thinking remained nonsignificant, and avoidant thinking, positive affect, fear of negative evaluation, and social skills were rendered nonsignificant when the six personality variables that were correlated with loneliness served as covariates.

4.3. Discussion

The first aim of Study 3 was to replicate the finding in prior studies that loneliness was associated with mood, anxiety, anger, optimism, self-esteem, fear of negative evaluation, social skills, and social support. The results of Study 3 not only replicated these associations but demonstrated that loneliness was also related to avoidant (but not intrusive) thinking and determined that the form of these associations was linear. A second aim was to examine the association between loneliness and broader personality constructs, and results confirmed that loneliness covaried in a strictly linear fashion with emotional stability, surgency, agreeableness, conscientiousness, shyness, and sociability.

Importantly, the measurement of these variables in the same study made it possible to determine to what extent the associations between loneliness and socioemotional states could be explained in terms of the influence of one or more broad personality factors. The set of six personality factors associated with loneliness (surgency, emotional stability, agreeableness, conscientiousness, shyness, and sociability) could plausibly explain the associations between loneliness and avoidant thinking, positive affect, fear of negative evaluation, and social skills, but the associations between loneliness and negative mood, anxiety, anger, optimism (pessimism), self-esteem, and social support remained statistically significant. Except perhaps for the finding for fear of negative evaluation, these results are in accord with the notion that feeling lonely does more than make one feel unhappy, it also heightens feelings of insecurity and the sensitivity to threats and rejection.

As an ancillary aim, we sought to examine whether intrusive thinking about traumatic events might be responsible for the finding in the literature that lonely individuals feel less control and more depressed affect, anxiety, anger, and pessimism than nonlonely individuals. The results of Study 3 showed there was no relationship between loneliness and intrusive thinking, ruling out that account. Avoidant thinking was found to covary with loneliness but this association became nonsignificant when personality variables were entered first into the regression analyses. In the Lepore et al. (1996) study, bereaved mothers reported that the frequency of intrusive thoughts about the traumatic event was positively correlated with the mothers' strained social support and inhibited ability to talk about their loss (termed social constraint). In ancillary analyses, we found surgency to be sufficient to eliminate the association between loneliness and avoidant thinking, suggesting that the individual differences in social constraint in Lepore et al. (1996) may reflect variations in extraversion.

According to our evolutionary model, loneliness is not simply a correlate of mood, anger, anxiety, optimism, self-esteem, and related states, it can play an instrumental role in these states. Surprisingly little is known about what occurs when feelings of loneliness change, however. As noted by Russell et al. (1980), “(e)mpirical research (on loneliness) has been hampered by a variety of problems... A major hindrance is that loneliness, unlike aggression, competition, and crowding, cannot be readily manipulated by researchers” (p. 472). To address this obstacle, Russell et al. (1980) developed a measure of loneliness to investigate differences among those who contrasted in terms of their feelings of loneliness. This approach has dominated the field with good effect, but it does not adequately address the possible causal role of loneliness. The aim in Study 4 was to examine whether loneliness could be manipulated experimentally using hypnosis and, if so, to investigate whether variables observed to differentiate lonely and nonlonely groups in Study 3 vary with the experimental manipulation of loneliness in Study 4.

5. Study 4

Hypnosis has been successfully employed in the past to manipulate a psychological state to measure the effect on dependent variables (Klein & Spiegel, 1989; Kosslyn, Thompson, Costantini-Ferrando, Alpert, & Spiegel, 2000; Nordby, Hugdahl, Jasiukaitis, & Spiegel, 1999; Spiegel & Barabasz, 1988; Williamson et al., 2001), and to intensify affective experience (Bower, 1981; Spiegel, 1992), although the value of hypnosis in this regard may be limited to high hypnotizable participants (Kosslyn et al., 2000). To manipulate loneliness within the same person, we used a procedure similar to that used by Kosslyn et al. (2000), who recruited highly hypnotizable participants for a study of picture processing. Following hypnotic induction, participants were exposed to color and gray scale pictures and patterns under the hypnotic suggestion that the stimulus would be presented in color or gray scale. Results revealed that the participants reported seeing a color pattern when they had been told one was being presented whether the pattern that was actually presented was a color or a gray scale pattern. Similarly, the participants reported seeing a gray scale pattern when they had been told a gray scale pattern was being presented whether the pattern that was actually presented was a color or a gray scale pattern.

Results in which hypnotized individuals have reported what the hypnotist instructed them to feel have been criticized in the past as not producing changes in psychological content or experience but only in producing compliance in terms of what the participants said they saw (i.e., role playing behavior; see Kirsch & Lynn, 1995). However, in the Kosslyn et al. (2000) study, the authors also performed positron emission tomography scanning by means of [^{15}O]CO $_2$ during the presentation of the pictures. Results of the PET data indicated that the classic color area in the fusiform or lingual region of the brain was activated when highly hypnotizable participants were asked to perceive color, whether the participant had actually been shown the color or the gray-scale stimulus, and these brain regions showed decreased activation when the high hypnotizable participants were told they would see gray scale, whether they were actually shown the color or gray-scale stimuli. In low hypnotizable participants, on the other hand, changes in brain activation in these regions was greater when color than gray-scale pictures were presented. Thus, observed changes in subjective experience achieved during hypnosis were reflected by changes in brain function similar to those that occur in perception, supporting the claim that hypnosis can produce actual changes in psychological *experience* in high but not low hypnotizable participants.

To manipulate loneliness within-participants, we recruited a sample of highly hypnotizable participants, used the same hypnotic induction procedure, and performed the hypnotic induction with the same experimenter/hypnotist as used by [Kosslyn et al. \(2000\)](#). We developed scripts that induced individuals to recall and re-experience a time when they felt lonely (e.g., a high sense of isolation, absence of intimacy or companionship, and feelings of not belonging), or nonlonely (e.g., a high sense of intimacy, companionship, friendships, and belonging). Following hypnotic induction, these scripts were used to induce feelings of high or low loneliness, and participants completed the measures used in Study 3 except for the Big 5 inventory.

We hypothesized that a person made to feel lonely will feel depressed affect (social pain) that, like physical pain, motivates them to repair the social disconnections even when their immediate self-interests are not served by the sharing of resources or defense. Furthermore, a person made to feel lonely also feels unsafe and activates an anachronistic survival mechanism that heightens sensitivity to threats, betrayals, and criticisms. Thus, we hypothesized that an experimental manipulation of loneliness would also affect mood, anxiety, anger, fear of negative evaluation, social support, self esteem, and optimism (pessimism). To determine whether participants were simply role-playing, we also included scales that could plausibly have varied as a function of loneliness but were not found to correlate with loneliness in Study 3 (i.e., intrusive thinking). If the hypnotic induction leads to differences in intrusive thinking, as well, then role-playing would provide a plausible alternative interpretation for any results.

5.1. Method

5.1.1. Participants

Thirty-four undergraduate students who were enrolled in general psychology or majoring in drama at Stanford University were initially assessed for hypnotizability using the 10-item version of Form A of the Harvard Group Scale of Hypnotic Susceptibility ([Shor & Orne, 1963](#)). General psychology students were assessed in a group setting during a class period, and drama students were assessed individually in a small office. After receiving a hypnotic induction and several suggestions, participants recorded their responses to the suggestions using an answer booklet. Participants' responses were scored on a scale of 0–10 with 10 indicating high hypnotic responsiveness.

Thirty-two participants receiving scores of 7 or higher were invited for a second assessment of hypnotizability. Participants were assessed individually using the 10-point scale of the Hypnotic Induction Profile (HIP; [Spiegel & Spiegel, 1978](#)) in a small office. The HIP is used to evaluate three phases of a single hypnotic experience—entering the hypnotic trance state, experiencing it, and exiting. Five items are used to rate cognitive and behavioral aspects of the participant's hypnotic experience. Participants could receive a score of 0–10 with 10 indicating high hypnotic responsiveness. Twenty-two of these participants scored 8 or above on the HIP and were eligible for participation in Study 4. One participant declined, leaving a study sample of 13 males and 8 females. Participants were paid \$10 per hour for their involvement in the experiment.

5.1.2. Psychological measures

The same emotional, social, and personality measures described in Study 3 were used in Study 4 with the exception of the Big 5 personality inventory. (Time limitations prevented us from employing this 100-item instrument.)

5.1.3. Procedure

After arriving at the laboratory, participants provided informed consent and completed the R-UCLA Loneliness Scale. The lights in the room were dimmed and participants were asked to close their eyes and complete a filler task (serial subtraction) for 4 min. A brief rest period then followed before the hypnotic induction was performed.

5.1.3.1. Hypnotic induction. Exploratory ($N = 1255$) and confirmatory ($N = 1276$) factor analyses of the responses to the UCLA Loneliness Scale from participants in the prescreening of Study 1 revealed three correlated but separable dimensions of the experience of loneliness: (a) a sense of isolation (e.g., “I feel isolated from others”), (b) a sense of connection (e.g., “There are people who really understand me”), and (c) a sense of belonging (e.g., “I feel part of a group of friends”) (Hawkley et al., 2005). The scripts for manipulating loneliness also included suggestions of the kind of affect and imagery that we found to differentiate lonely and nonlonely individuals. Hypnotic inductions were then developed based on the unique features of high and low feelings of loneliness, and in a within-participants experimental design, participants were hypnotized and were induced to feel high or low loneliness. The order of inductions was counterbalanced across participants.

Two experimenters tested participants individually. One experimenter, an experienced investigator of hypnosis (BN), performed the hypnotic induction, the boosters, and termination of the hypnotic state (see Spiegel & Spiegel, 1978).¹ The scripts were read without deviation. The second served as the experimenter for all other components of the study. Each participant was placed in a hypnotic state twice, once for the induction of feelings of high loneliness and once for feelings of low loneliness (e.g., socially embeddedness). A 5-min rest period separated the completion of the first hypnotic state and the induction of the second. The order of the induction of high or low feelings of loneliness was counterbalanced across participants.

Hypnotic induction began with the first experimenter guiding participants from relaxation to hypnosis (Spiegel & Spiegel, 1978). At this point, the participant was asked to close his or her eyes, and the first experimenter introduced the manipulation of loneliness. For the *high lonely suggestion*, participants were asked to think of a time during which they felt lonely and to re-experience those feelings. For example, participants were asked to “Think of a time in which you felt isolated. You felt lonely. Perhaps you felt like you just didn’t belong—that you had no friends.” For the *low lonely suggestion*, participants were asked to think of a time during which they felt a sense of belongingness and to re-experience those feelings. For example, participants were asked to “Think of a time in which you felt a sense of belonging. Perhaps you were a member of a group. Perhaps you had a best friend with whom you felt you could share anything.” Each suggestion provided participants with examples of events that might make them feel high or low in loneliness. Participants were asked to provide specific information about their memories. The first experimenter then incorporated this information into boosters (see below).

All but one of the participants were successfully induced to feel high or low levels of loneliness, as measured by the UCLA Loneliness Scale. The data from the individual for whom hypnotic manipulation of loneliness did not work were not included in analyses, leaving a final sample size of 20.

¹ The scripts for the hypnotic induction, loneliness suggestions, and boosters are available from the first author for interested readers.

5.1.3.2. Questionnaire administration with loneliness-related boosters. Following the manipulation of feelings of loneliness, participants completed a filler task (serial subtraction) before being reminded of features of the circumstance the participant had described (e.g., Thank-giving with loved ones). Participants were then given a set of surveys and were instructed that there were no correct answers and that they should answer the questions as completely and honestly as possible. The first block of surveys consisted of the R-UCLA as a manipulation check, and the anxiety, anger, and optimism scales. After completing these surveys, the experimenter again reminded them of the circumstance they had reported and asked them to complete a second set of surveys, which measured intrusive and avoidant thinking, social skills, and perceived social support. The experimenter again reminded them of the circumstance they reported when high or low feelings of loneliness were induced, and participants completed the measures of self-esteem, shyness and sociability, fear of negative evaluation, and positive and negative affect. Next, participants were instructed to close their eyes and to let go of their current feeling state and return to the feeling state they had before beginning the experiment. The experimenter then guided participants out of the hypnotic state.

5.1.3.3. Post-experiment treatment. At the end of the second hypnotic state, the lights were brightened to normal room lighting, and the participants were asked to complete the R-UCLA for the last time. Participants were then debriefed and thanked for their participation. Meanwhile, the second experimenter scored the R-UCLA scales that were given at the beginning and the end of the experiment. If the participant's loneliness score was more than three points higher post-experiment relative to pre-experiment, the experimenters discussed this with the participant and asked if they wanted to be re-hypnotized and given a suggestion for returning to their original feeling states. Only one participant was more than three points higher post-relative to pre-experiment. This participant declined to be re-hypnotized, saying that his or her feelings were fine. All participants were given the name and contact information of the experimenters and were asked to telephone or e-mail the experimenters if they felt any negative after-effects. During debriefing, most participants reported that the study was very interesting, and all reported that, if given the opportunity, they would willingly participate in the study a second time. No negative after-effects were reported or discerned.

5.1.4. Data analysis

The primary aim of Study 4 was to determine whether, and if so which, individual difference variables associated with loneliness would be modulated by an experimental manipulation of loneliness. Because of the small sample size (i.e., limited degrees of freedom), we used a series of within-participant (high loneliness suggestion, low loneliness suggestion) ANOVAs to examine the influence of the hypnotic suggestion on each of the personality and socioemotional variables. Given time constraints, the personality assessments were limited to shyness and sociability.

5.2. Results

The first aim of Study 4 was to examine whether loneliness could be manipulated in high hypnotizable participants using hypnosis. To test this hypothesis, we analyzed responses to the R-UCLA Loneliness Scale. Consistent with this hypothesis, the mean levels of loneliness after the hypnotic inductions were significantly different, $F(1,19) = 109.56$,

Table 3

Means (standard deviations), significance tests, and effect sizes for psychosocial variables as a function of loneliness suggestion condition

Variable	Low lonely	High lonely	$F(1, 19)$	Cohen's d
<i>Personality variables</i>				
Shyness	12.05 (5.47)	21.05 (6.31)	37.35 ^a	2.80
Sociability	16.20 (2.95)	12.40 (4.68)	15.62 ^a	1.81
<i>Socioemotional variables</i>				
Negative Mood	21.05 (6.91)	30.42 (9.29)	20.67 ^a ($df = 1, 18$)	2.14
Positive Mood	36.32 (7.42)	29.16 (9.28)	11.54 ^a	1.56
Anxiety	16.35 (3.72)	25.30 (5.84)	42.69 ^a	3.00
Anger	16.84 (5.25)	21.30 (6.74)	16.50 ^a	1.86
Optimism	18.70 (3.23)	12.80 (5.04)	23.38 ^a	2.22
Self-Esteem	35.80 (3.74)	27.05 (6.26)	39.87 ^a	2.90
Fear of Negative Evaluation	35.61 (10.73)	44.10 (9.40)	21.38 ^a	2.12
Social Skills	41.40 (6.96)	34.90 (8.26)	41.70 ^a	2.96
Social Support	21.25 (2.17)	16.07 (4.19)	28.84 ^a	2.46
Intrusive Thoughts	16.35 (8.92)	19.05 (9.56)	3.33	0.84
Avoidant Thoughts	15.80 (9.76)	19.85 (8.60)	3.04	0.80

^a $p < .05$.

$p < .05$. In addition, t tests indicated that the mean baseline (pre-hypnosis) level of loneliness ($M = 36.10$, $SD = 6.87$) differed from the high loneliness induction level, $t(19) = 9.40$, and from the low loneliness induction level, $t(19) = 6.38$, p 's $< .001$. Moreover, the baseline level observed in Study 4 was similar to the mean for the average group observed in Study 3 ($M = 35.66$), the mean for low loneliness in Study 4 ($M = 29.55$, $SD = 6.09$) approached the levels observed in the lowest quintile in Study 3 ($M = 26.76$), whereas the mean for high loneliness in Study 4 ($M = 58.39$, $SD = 11.84$) exceeded substantially the level observed in the highest quintile in Study 3 ($M = 40.01$). Together, these results suggest that hypnosis can be an effective means of experimentally manipulating feelings of loneliness, at least for highly hypnotizable participants.

The experimental manipulation of loneliness was found to influence all of the variables with which it correlated in Study 3 except avoidant thinking (p 's $< .05$). Importantly, no differences were found on the measures of intrusive thinking. The summary statistics are provided in Table 3.

5.3. Discussion

The results of Study 3 showed that the association between loneliness and negative mood, anxiety, anger, optimism (pessimism), self-esteem, and social support remained statistically significant even after controlling for the personality dimensions of surgency, emotional stability, agreeableness, conscientiousness, shyness, and sociability. Study 4 was designed to extend this work by examining whether changes in loneliness influenced related socioemotional states. As hypothesized, individuals reported significantly greater negative mood, anxiety, and anger and significantly less optimism, self-esteem, and social support when induced to feel high compared to low loneliness.

The results of Study 3 also suggested that the set of six personality factors could plausibly explain the associations between loneliness and positive affect, fear of negative

evaluation, social skills, and avoidant thinking. The fact that one or more of these personality factors might parallel the association between loneliness and these variables does not mean that loneliness might not also play a causal role. The results of Study 4 suggest that the participants reported greater fear of negative evaluation, lower positive mood, and lower social skills when induced to feel high compared to low loneliness. Avoidant thinking was not altered significantly by the experimental manipulation of loneliness.

In Study 4, we included two personality measures found in Study 3 to correlate with loneliness: shyness and sociability. The results of Study 4 indicated that the participants rated themselves as shyer and less sociable when induced to feel high compared to low loneliness. Although this result was unexpected, two explanations warrant comment. First, feelings of social isolation, we have posited, lead people to not only feel unhappy but to feel insecure about their environment and about the intentions of other people. Although conjecture at this point, it is possible that such feelings directly affect people's self-descriptions of their sociability and shyness. Alternatively, it may be that the hypnotic induction triggered role playing, and that our participants were responding to the dependent variables in ways they believed to be consistent with the roles of lonely and nonlonely individuals. Although the account cannot be ruled out, several observations lessen the plausibility of this account. First, manipulation checks following each loneliness manipulation not only confirmed that loneliness as measured by the R-UCLA was higher than basal levels in the high loneliness condition and lower than basal levels in the low loneliness condition, but the absolute values on the UCLA scale were similar to those found in the between-participants design in Study 3. Second, the null effects for intrusive thinking suggest that the loneliness manipulation did not simply evoke role-playing or demand characteristics. Convergent evidence using other means of manipulating loneliness is clearly needed.

Finally, concerns about external validity arise when using a specialized population such as highly hypnotizable individuals. Less than 15% of the population is highly hypnotizable, and brain imaging studies indicate that high, but not low, hypnotizable individuals both report and show activation in brain regions correspondent to the induced experience rather than the physical reality (Kosslyn et al., 2000). Decades of hypnosis research have shown little or no correlation between hypnotizability and the Big 5 or other major personality constructs (Hilgard, 1965). Rather, modest correlations have been found with more closely-related attributes, such as a history of imaginative involvements and punishment (Hilgard, 1970) and a tendency to spontaneous absorption of self-altering experiences (Tellegen, 1981; Tellegen & Atkinson, 1974). It is not apparent why such individual differences would limit the generalizability of the current findings.

6. General discussion

Loneliness is a word that makes all of us feel uneasy. We hesitate to admit the deep fear we have of facing life alone, strengthened only by our individual self-confidence and personal faith in what we are about. The young search for warmth and security in the strong hand of a father and the warm embrace of a mother. Adolescents move cautiously out of the family into a world of their own—a place of challenges and uncertainties where group acceptance means so much and being left out fills one with emptiness that is too painful for tears. Adults who have been fortunate enough to

establish warm relationships of love and concern in their lives realize the constant risks that threaten them on every side—separations that ultimately force us all to face the reality of death itself (Burke, 1970, Preface).

Social isolation is a risk factor for broad based morbidity and mortality across the adult lifespan (Berkman & Syme, 1979) comparable in strength to smoking, high blood pressure, obesity, and low physical activity even after statistically controlling for known biological risk factors, socioeconomic status, and baseline measures of health (e.g., see review by House, Landis, & Umberson, 1988). Given the deleterious effects associated with loneliness on health and well-being (Seeman, 2000; Cacioppo, Hughes, Waite, Hawkey, & Thisted, *in press*), what function might it serve? We have posited that loneliness evolved to foster the reproductive success of human offspring who must survive a lengthy period of abject dependency. In conditions of hardship, hunter-gatherers who had a genetic predisposition to suffer distress from social disconnections and social reward from connections may have been more likely to return to share their food, shelter, or defense with their family and allies than those without such a predisposition. Although the latter individuals may well have roamed the earth better nourished than those who were distressed by social isolation, the abandoned offspring—and the genetic predisposition to thrive in social isolation—would have been less likely to survive.

Even as adults, the rather limited size, speed, strength, and perceptual ability of humans compared to other species in the animal kingdom placed a premium on genetic features of individuals who were inclined to think, cooperate with others, hunt in packs, and form defensive alliances for protection. Perhaps it should not be so surprising, therefore, that feelings of social isolation and rejection are punishing and have an influence on our brain and physiological functioning as well as on our long-term health (Cacioppo, Hawkey, Berntson, et al., 2002, 2002; Eisenberger et al., 2003). Social separation, rejection, or loss not only highlights an individual's lack of personal control but it places the individual at risk. We, therefore, posited that lonely individuals are not only unhappy, they have a heightened sensitivity to threats and attacks. Defensive behaviors such as preventative rejection of others may help fend off treachery, rejections or attacks. Thus, although this self-protective focus may be paradoxically self-defeating in the long-term, it can serve to lessen the short-term damage of the negative social interactions lonely individuals are more likely to expect (Cacioppo et al., 2000) and to perceive in ambiguous interactions (e.g., Rotenberg, 1994). Indeed, Cacioppo et al. (2000) found that lonely individuals showed *smaller* heart rate increases to a series of evaluative social stressors (e.g., speech stressors) than nonlonely individuals.

The results of the current series of studies provided additional evidence bearing on this model of loneliness. Our first aim was to determine whether loneliness and dysphoria could be statistically disentangled. The results of Studies 1 and 2 replicated prior research showing that loneliness and depressed affect were correlated, but the results further provided evidence that loneliness and depressed affect were distinct constructs. For instance, the items measuring depressed affect and loneliness loaded uniquely on separate factors in both studies, and no factors showed a combination of loneliness and depressed affect items that might indicate overlapping constructs. Ancillary analyses argued against the factor structure in Studies 1 and 2 being due to differences in temporal perspective in ratings of loneliness and depressed affect or to overarching differences in neuroticism.

Study 3 further examined the extent to which the effects attributed to loneliness might be explicable to a broader personality factor. We replicated and extended prior studies showing that loneliness was associated with mood, anxiety, anger, optimism, self-esteem, fear of negative evaluation, social skills, low social support, and avoidant (but not intrusive) thinking. Furthermore, the results revealed a simple linear association rather than a categorical step-function such as that found in studies of temperament and social inhibition (Cole et al., 1997; Kagan et al., 1994). These results argue against the notion that lonely individuals are somehow different than most other people, or that loneliness simply reflects an inhibited temperament. Study 3 further showed that loneliness was associated with the personality factors of emotional stability, surgency, agreeableness, conscientiousness, shyness, and sociability. Even when all six personality factors were entered first in regression analyses, however, loneliness remained uniquely and significantly associated with negative mood, anxiety, anger, optimism (pessimism), self-esteem, and low social support. These results are consistent with the notion that feeling lonely does more than make one feel unhappy, it also heightens feelings of insecurity and the sensitivity to threats and rejection. Finally, no evidence was found in Study 3 for the possibility that intrusive thinking about traumatic events might be responsible for the finding in the literature that lonely individuals feel less control and more depressed affect, anxiety, anger, and pessimism than nonlonely individuals.

One possible limitation is that the participants in Study 3 were high functioning young adults who were enrolled in college. Perhaps the results do not generalize to a more representative sample. To investigate this, we repeated many of the analyses of Study 3 using data from our population-based urban sample of adults 50–67 years of age from our Chicago Health, Aging, and Social Relations Study (CHASRS). Elsewhere, we have demonstrated that this sample is representative of a national sample of urban adults born between 1935 and 1952 (Hughes, Waite, Hawkey, & Cacioppo, 2004). In these analyses, too, we found linear associations between loneliness and both personality and socioemotional variables and very little in the way of higher order trends.

Another possible concern about the results of Study 3 given that individuals who scored high on the BDI were not selected for participation is that the group labeled as “lonely” may not be as lonely as individuals in the population at large. Our use in Study 3 of a BDI cutoff was done to study loneliness without co-morbid clinical depressed affect. Less than 5% of the 2531 potential participants were excluded based on the BDI cutoff. Furthermore, the range of scores that defined the lonely (top quintile) group in Study 3 was not changed by this exclusion criterion. Finally, the BDI was not used to screen participants in CHASRS, yet the cutoff for the top (high lonely) group in this population-based study proved to be exactly the same as that used in Study 3 (UCLA total scores ≥ 44). It is unlikely, therefore, that the lonely group in Study 3 was biased to be more average than lonely based on the BDI cutoff that was used. Moreover, our analyses of the data from CHASRS further support the suggestion that the results of Study 3 generalize to lonely individuals in the population who are not also clinically depressed.

According to our evolutionary model, loneliness is not simply a correlate of mood, anger, anxiety, optimism, self-esteem, and related socioemotional states, it can play an instrumental role in activating these states. The major aim of Study 4 was to examine whether loneliness could be manipulated experimentally using hypnosis and, if so, to investigate whether variables observed to differentiate lonely and nonlonely groups in

Study 3 vary with the experimental manipulation of loneliness in Study 4. Results showed that loneliness could be manipulated experimentally, at least within limits. Using a within-participants design, we found that individuals induced to feel lonely took on many of the characteristics and attributes that we found to characterize individuals high in loneliness in Study 3, whereas the same individuals induced to feel low in loneliness took on many of the characteristics and attributes that we found to characterize the individuals low in loneliness in Study 3. These results suggest that loneliness can serve as a central individual difference characteristic, and that changes in loneliness can affect a wide range of related attributes ranging from shyness and social skills to self-regulation, optimism, and self-esteem.

The results of Study 4 are also entirely compatible with recent research suggesting that loneliness is approximately 50% heritable because both McGuire and Clifford (2000) and Boomsma, Willemsen, Hawkey, Cacioppo, & Posthuma (2004) found the environmental influences on loneliness to be approximately as strong. That is, 50% heritable does not mean invariant. Indeed, Weiss (1973) found that a spouse following his or her partner through a series of job transfers may be low in loneliness and well adjusted in one town but lonely and poorly adjusted in another. As demonstrated experimentally in Study 4, the same person who seems unpleasant when feeling high in loneliness may appear pleasant and optimistic when feeling low in loneliness. In this context, the results of the experimental manipulation of loneliness in Study 4 are encouraging for those in the throes of loneliness, as personality measures such as shyness and sociability, affective states and orientations such as anger and optimism, and social dispositions such as self-esteem and fear of negative evaluation were affected in Study 4 in much the same way as observed between-participants in Study 3. Although high lonely individuals may be at risk for developing a pattern of social cognition and behavior that provides short term protection at a long-term cost, the present studies suggest loneliness is not a predestined fate.

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