

Loneliness

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Loneliness

CONCEPTUALIZATION

Although the nature and purpose of loneliness have long been discussed in philosophy, theology, and literature, the scientific study of loneliness has a relatively short history. The first scientific paper on loneliness can be traced back just five decades to the now classic psychoanalytic treatise by Frieda Fromm-Reichmann (1959), and phenomenological and existential perspectives followed soon afterwards (Moustakas, 1961; Rogers, 1961). The work of John Bowlby on attachment bonds (Bowlby, 1973) heralds the beginning of theoretical conceptualizations of loneliness. Robert S. Weiss (1973) delineated an attachment theory of loneliness in which deficiencies in social relationships serving specific functions (e.g., attachment, social integration, nurturance) were posited to contribute to feelings of loneliness. Weiss described loneliness as “a chronic distress without redeeming features” (Weiss, 1973, p. 15) and he further distinguished between social loneliness (e.g., lack of social integration), and emotional loneliness (e.g., absence of a reliable attachment figure). This theoretical perspective, also called the “social needs” approach, continues to motivate loneliness research (Dykstra & Fokkema, 2007).

A second conceptual approach to loneliness has focused on social skill deficits and personality traits that impair the formation and maintenance of social relationships. Research in the social skills area has shown that loneliness is associated with more self-focus, poorer partner attention skills, a lack of self-disclosure to friends, especially among females, and less participation in organized groups, especially among males (reviewed in Marangoni & Ickes, 1989). Personality research has shown that loneliness is associated with depressive symptoms, shyness, neuroticism, and low self-esteem, optimism, conscientiousness and agreeableness (Marangoni & Ickes, 1989). Early studies suggested that behavioral and personality correlates of

loneliness tend to be true only for chronically lonely individuals, not for “state-lonely” individuals whose loneliness is adequately explained by potent situational factors (e.g., widowhood, geographical relocation) (reviewed in Marangoni & Ickes, 1989). More recently, however, loneliness has been observed to operate like a trait even when induced in an acute fashion. Under hypnotic suggestion, young adults were made to feel lonely and then socially connected (or vice versa, in a counterbalanced order) by recalling a time when they felt rejected and like they didn’t belong, or accepted and like they belonged. Measures of affect, social factors, and even personality traits mirrored and tracked the acute changes in loneliness induced by the hypnotic manipulation. Relative to their baseline levels of loneliness, individuals made to feel lonely reported significantly more negative mood and lower self-esteem, optimism, social skills, social support, sociability, extraversion, and agreeableness, and greater shyness, anxiety, anger, fear of negative evaluation, and neuroticism (Cacioppo, Hawkley, et al., 2006). These results place loneliness as a potential causal factor in characteristics such as self-esteem, depressive symptomatology, shyness, and so forth.

A third conceptual approach to loneliness is represented by cognitive discrepancy theory, which specifies loneliness as the consequence of altered social perceptions and attributions. Specifically, loneliness is defined as the distress that occurs when one’s social relationships are perceived as being less satisfying than what is desired (Peplau & Perlman, 1982). From a cognitive discrepancy perspective, it is clear that loneliness is not synonymous with being alone, nor does being with others guarantee protection from feelings of loneliness (Peplau & Perlman, 1982). Rather, discrepancies between ideal and perceived interpersonal relationships produce and maintain feelings of loneliness.

A fourth approach derives from an evolutionary analysis of loneliness, with an emphasis on inclusive fitness (Cacioppo, Hawkley, et al., 2006). This approach calls into question the conceptualization of loneliness as an aversive condition without redeeming features but instead conceptualizes loneliness as an aversive condition that promotes inclusive fitness by signaling ruptures in social connections that motivate the repair or replacement of these connections. For many species, offspring need little or no parenting to survive and reproduce. *Homo sapiens*, however, are born to the longest period of abject dependency of any species. Simple reproduction, therefore, is not sufficient to ensure that one's genes make it into the gene pool. For one's genes to make it to the gene pool, the offspring must survive to reproduce. Moreover, social connections and the behaviors they engender (e.g., cooperation, altruism, alliances) enhance the survival and reproduction of those involved, increasing inclusive fitness.

Humans walked the earth as hunter-gatherers for tens of thousands of years, often under conditions of privation. Hunter-gatherers who chose not to return to share their food and offer protection to mother and child (i.e., who felt no loss severing social/family bonds) may have survived to reproduce again, but their offspring and, with them their genes, would have been unlikely to survive to reproduce. In contrast, hunter-gatherers whose genetic predisposition inclined them to share food with their family may have lowered their own chances of survival but increased the survival odds of their offspring, thereby propagating their genes. Of course, a hunter-gatherer who survives a famine may then live to have another family another day, suggesting that no single strategy is necessarily best. Such an evolutionary scenario suggests that humans might inherit differing tendencies to experience loneliness. Adoption and twin studies among children and adults have confirmed that loneliness has a sizeable heritable component (Boomsma, et al., 2005; McGuire & Clifford, 2000).

Measures

Individual differences in loneliness are typically measured using paper-and-pencil questionnaires, a number of which are reviewed in Cramer and Barry (1999). Among the multidimensional scales tapping emotional and social loneliness are the De Jong Gierveld Loneliness Scale (De Jong Gierveld & Kamphuis, 1985) and the Social and Emotional Loneliness Scale for Adults (SELSA; DiTommaso & Spinner, 1993). These two scales probe social relational deficits with items such as “I have friends to whom I can talk about the pressures in my life,” and “There are plenty of people I can rely on when I have problems.” De Jong Gierveld’s Loneliness Scale probes emotional relational deficits with items such as “I experience a general sense of emptiness,” whereas the SELSA distinguishes between relational deficits in family relationships (e.g., “I feel close to my family”) and romantic relationships (e.g. “I have someone who fulfills my needs for intimacy”).

The most frequently used instrument is the UCLA Loneliness Scale developed at the University of California at Los Angeles (version 3; Russell, 1996). Items probe the frequency and intensity of loneliness-related experiences (e.g., “How often do you feel alone?”, “How often do you feel part of a group of friends,” and “How often do you feel that there are people who really understand you?”). To avoid response bias, the terms “lonely” and “loneliness” do not appear in any of the items. Although conceptualized as a unidimensional scale, factor analyses of the UCLA Loneliness Scale have revealed anywhere from two to five dimensions. Second-order factor analyses, however, have shown a single overarching loneliness construct (Hawkley, Browne, & Cacioppo, 2005; Russell, 1996) that supports its use as a unidimensional bipolar measure of loneliness. An abbreviated 3-item version of this scale has been validated for use in large population surveys (Hughes, Waite, Hawkley, & Cacioppo, 2004).

Stability. Temporal stability of loneliness scores is relatively high, with test-retest reliabilities of .69, .57, and .51 across two, three, and five years, respectively, in children between 7 and 12 years of age (Bartels, Cacioppo, Hudziak, & Boomsma, in press), .74 across a 2-week to 2-month time period in young adults (Cacioppo, Hawkley, et al., 2006), and from .73 to .84 across one to two years in middle-age and elderly adults (Cacioppo, Hughes, Waite, Hawkley, & Thisted, 2006; Russell, 1996).

Antecedents

1. Heritability

If the motivation to form and maintain social bonds has evolutionary origins, one might expect significant genetic contributions to loneliness. In a study of adoptive families, loneliness data were obtained from 69 biologically related sibling pairs and 64 unrelated pairs when the children 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 (McGuire & Clifford, 2000).

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. To address this question, data from young adult and adult Dutch twins (average age 24 years) in the Netherlands Twin Register Study were analyzed with genetic structural equation models, which provide estimates of the shared environmental and unique environmental contributions as well as the genetic contributions (Boomsma, Willemsen, Dolan, Hawkley, & Cacioppo, 2005). The estimate of genetic contributions to variation in loneliness in adults was 48%, with the remaining variance explained by unique environmental factors. Thus, the heritability estimates in

adults were similar to those found previously in children. Moreover, no evidence was found for sex or age differences in genetic architecture or for nonadditive genetic effects.

A follow-up longitudinal study of young Dutch twins at ages 7, 10, and 12 years found that the influence of shared family environment increased from .06 and .08 at ages 7 and 10, to .35 at age 12, paralleling a reduction in heritability estimates from .58 and .56 at ages 7 and 10, to .26 at age 12 (Bartels et al., in press). As these children move through adolescence and adapt to new biological and social challenges, environmental influences are expected to decline and heritable dispositions to re-emerge to levels observed in the young adult and adult twins.

2. *Predictors*

Research on the predictors of loneliness is predominantly cross-sectional, and longitudinal studies have tended to focus on older adults. These limitations notwithstanding, a sizeable body of research indicates that sociodemographic factors, social roles, social contact quantity and quality, health, and dispositions contribute to individual differences in feelings of loneliness.

Sociodemographics. Structural factors such as age, gender, race/ethnicity, education, and income constrain opportunities for integration into meaningful groups and social roles, and these factors contribute to individual differences in loneliness. Age has been associated with loneliness, but the shape of that association is a flattened U, not linear as conventional wisdom might suggest. Prevalence and intensity of lonely feelings are greater in adolescence and young adulthood (i.e., 16-25 years of age) than in any other age group except the oldest old (i.e., >80 years) (Pinquart & Sörensen, 2003). Findings in longitudinal studies are consistent with those in cross-sectional studies, and cohort effects have been largely ruled out as an explanation for age effects (Pinquart & Sörensen, 2003). Indeed, in the Americans' Changing Lives study of adults

24 years of age and older, age was inversely associated with loneliness even when the loneliness-augmenting effect of lost social roles (e.g., marriage, work) was held constant (Schnittker, 2007).

Females tend to report slightly greater loneliness than males, but only when the measure includes terms such as “lonely” or “loneliness” (Pinquart & Sörensen, 2003). When examined as a function of marital status, however, nonmarried men are lonelier than nonmarried women (Pinquart, 2003).

In the U.S., African Americans tend to be lonelier than Whites (Barg et al., 2006), although single African American women were less lonely than Latina and White women in the Southern California Social Survey (Tucker & Mitchel-Kernan, 1998). Cultural differences in loneliness levels have also been observed. Chinese students at an American university reported greater loneliness than their U.S. counterparts (Anderson, 1999), an effect that some have argued is attributable to the Asian collectivist perspective in the context of an individualistic American society (Goodwin, Cook, & Yung, 2001).

Greater educational attainment and higher income are associated with less loneliness (Pinquart & Sörensen, 2003), but this effect is predominantly indirect and has been attributed to larger social networks (Dykstra & de Jong Gierveld, 1999; Lauder, Mummery, & Sharkey, 2006). Holding social network size constant, however, the attainment of a high school diploma continued to protect against loneliness in our population-based sample of middle age adults in the Chicago Health, Aging, and Social Relations Study (CHASRS), possibly indicating the relationship-enhancing benefit of higher social status and self-esteem associated with this accomplishment (Hawkey, Hughes, et al., 2007).

Social roles. Marriage is well-known to protect against loneliness, and loneliness is greater among those who are divorced or never-married (Dykstra & Fokkema, 2007; Pinquart, 2003).

Retirement and unemployment also represent loss of social roles, and both groups are lonelier than the employed (Hansson, Briggs, & Rule, 1990; Viney, 1985). Voluntary group membership (e.g., social club, athletic team) (Cattan, White, Bond, & Learmouth, 2005) and religious/church membership (Johnson & Mullins, 1989) are other roles that have been observed to protect against loneliness.

Social contact quantity and quality. Smaller social networks and less frequent interactions with friends and family promote loneliness (Dykstra, van Tilburg, & de Jong Gierveld, 2005; Pinquart & Sörensen, 2003). Accordingly, situational factors that influence the availability of social opportunities have also been associated with loneliness. For instance, geographic relocation predicts loneliness in first year university students (Shaver, Furman, & Buhrmester, 1985). Conversely, participation in senior center activities protects against loneliness in older adults living alone (Aday, Kehoe, & Farney, 2006). Contact with friends is more important than contact with adult children and other family members in preventing loneliness (Pinquart & Sörensen, 2003), and the chronic unavailability of social partners with whom to enjoy social activities has been associated with greater loneliness (Rook, 1984).

Social relationship quality is a more potent predictor of loneliness than quantity of social contacts, and this is true of relationships with friends, family, and adult children (Pinquart & Sörensen, 2003). In addition, although marriage is generally protective, only marriages that are close and satisfy a need for a confidant serve to reduce loneliness (Olson & Wong, 2001).

Health. Health-related factors impose another constraint on social contact quantity and quality. For instance, sensory impairment, particularly the challenge to effective communication posed by impaired hearing, contributes to loneliness (Savikko, Routasalo, Tilvis, Strandberg, & Pitkälä, 2005; Wallhagen et al., 2001). In addition, loneliness is associated with impaired

mobility as evident in greater functional limitations and restrictions in the activities of daily life (Bondevik & Skogstad, 1998; Dykstra & de Jong Gierveld, 1999), and with physical symptoms of chronic health conditions (Pinquart & Sörensen, 2003). In late life, institutionalized adults are lonelier than their community-dwelling counterparts (Pinquart & Sörensen, 2003), but loneliness also influences the likelihood of institutionalization (Russell, Cutrona, de la Mora, & Wallace, 1997), suggesting a bidirectional causal association.

Dispositional. Personality characteristics related to loneliness include traits from the “Big Five” such as greater neuroticism, less conscientiousness and less agreeableness, as well as lower self esteem and greater shyness, hostility, insecure attachment styles, anxiety, pessimism, and fear of negative evaluation. Loneliness, however, is distinct stochastically and functionally from these dispositions (DiTommaso et al., 2003; Cacioppo, Hawkley, et al., 2006; Ernst & Cacioppo, 1998; Marangoni & Ickes, 1989; Shaver & Brennan, 1991).

Loneliness is sometimes confused with depressed affect and poor social support, a confusion that exists despite theoretical and empirical distinctions among these related constructs (Cacioppo, Hawkley, et al., 2006; Russell, 1996). For instance, empirical work has shown that companionship is a stronger predictor of loneliness than social support (Rook, 1987). These distinctions highlight the difficulty of finding the language to speak about the core experience of human sociality (Dunbar & Shultz, 2007). Just as there are no single terms for the opposite of pain and thirst, there is no simple, precise term that means the opposite of loneliness. We have used “social connection” and “social contentment,” and “social bondedness” has recently been suggested (Dunbar & Shultz, 2007), but all fall short for lack of precision. The absence of a term for “not lonely” suggests that this is the normal or default state required to maintain a healthy and balanced life, and that loneliness is the problematic state. Indeed, people’s mental

representations of their sociality conform to the importance of social bonds at every level of human endeavor.

3. Social cognition.

Mental representations. Theories of the self have underscored the importance of individual, relational, and collective aspects (Brewer & Gardner, 1996). To the extent that we define ourselves in terms of our interactions with and relationships to others, the mental representation of these connections may similarly be characterized by individual/intimate, relational, and collective dimensions. Factor analytic studies of items from the UCLA loneliness scale in young (18-25 yrs) and middle age (50-68 yrs) adults, and replications using items from other scales designed to gauge oneself in relation to others (Hawkley, Browne, & Cacioppo, 2005) provided support for this reasoning. Moreover, in our CHASRS sample of middle-age men and women, marital status predicted intimate connectedness, frequency of contact with friends and family predicted relational connectedness, and voluntary group membership predicted collective connectedness (Hawkley et al., 2005). This three-dimensional representation of loneliness held in young adults and across gender and racial/ethnic lines in middle age adults, suggesting a universality to this representational structure of the social self (Hawkley et al., 2005).

Mental processes. Chronic loneliness is the result of an interaction between a genetic bias and life circumstances that are in part beyond our control. However, once loneliness is triggered, the defensive form of thinking that it generates—a “lonely” social cognition—can make every social molehill look like a mountain. The lonely not only react more intensely to the negatives, they experience less of a soothing uplift from the positives (Hawkley, Preacher, & Cacioppo, 2007). Even when they succeed in eliciting nurturing support from a friend or loved one, they tend to perceive the exchange as less fulfilling (Hawkley, et al., 2003).

The lonely are aware that their social needs are not being met, but they perceive that they do not have a great deal of control over their ability to fulfill those needs (Solano, 1987). Tending to be more anxious, pessimistic, and fearful of negative evaluation than people who feel good about their social lives, lonely people are more likely to act and relate to others in ways that are anxious, negative, and self-protective, which leads paradoxically to self-defeating behaviors (Cacioppo & Hawkley, 2005). For instance, Rotenberg (1994) found that lonely and nonlonely individuals were equally likely to cooperate with a stranger at the outset and during the early trials of a prisoner's dilemma game in which the stranger was playing a tit-for-tat strategy. As play continued and they betrayed their partner, only to find their partner then betray them, the lonely individuals were especially likely to escalate the betrayals than nonlonely individuals.

Not only do the lonely contribute to their own negative reality, but others begin to view them more negatively and begin to act accordingly (Lau & Gruen, 1992). One study showed that individuals told that an opposite gender partner they were about to meet was lonely, subsequently rated that partner as being less sociable. The individuals primed to have these expectations also behaved toward their partners in a less sociable manner than they did toward partners whom they expected to be nonlonely (Rotenberg, Gruman, & Ariganello, 2002). Once this negative feedback loop starts rolling, the cycle of defensive behavior and negative social results spins even further downhill. In essence, lonely individuals inhabit an inhospitable social orbit that repels others or elicits their negative responses.

Expecting social rejection, the lonely are keenly attuned to cues of social acceptance in their environment. In a test of social monitoring, lonely participants remembered a greater proportion of information related to interpersonal or collective social ties than did nonlonely participants. It made no difference whether the detail, which was presented in diary format, was emotionally

positive or negative (Gardner, Pickett, Jeffries, & Knowles, 2005). In another study, participants asked to “relive” a rejection experience showed greater attention to vocal tone in a vocal Stroop task than did participants asked to relive an academic failure experience or a neutral experience (the walk to campus that morning) (Pickett, Gardner, & Knowles, 2004).

Greater attention to social cues does not ensure greater social sensitivity, however. We have noted that lonely individuals are less accurate at decoding facial and postural expressions of emotion (Pickett & Gardner, 2005; Pitterman & Nowicki, 2004). In addition, the participants who relived a rejection experience were less accurate in decoding the meaning of the words in the vocal Stroop task (Pickett et al., 2004).

A lack of correspondence between attention and accuracy in responses to social cues has also been demonstrated in a brain imaging study of lonely and nonlonely young adults. When presented with equally arousing positive and negative pictures of scenes and objects (nonsocial stimuli) and people (social stimuli), a set of brain regions often associated with visual attention and perspective taking varied in response to negative social (in contrast to matched nonsocial) pictures. Relative to the nonlonely, lonely individuals showed greater visual cortical activation (consistent with greater attention to the negative social than nonsocial pictures) and less activation of the temporo-parietal junction (consistent with less attention devoted to the other person’s perspective). Another set of brain regions, associated with reward systems (i.e., ventral striatum), was found to be down-regulated in lonely, compared to nonlonely, individuals when viewing positive social (in contrast to matched nonsocial) pictures – results consistent with lonely individuals deriving less pleasure from viewing positive social circumstances than nonlonely individuals (Cacioppo, Norris, et al., 2007). This latter finding in the scanner may bear

on the finding that lonely individuals find positive social interactions during the course of a normal day less satisfying than nonlonely individuals (Hawkley, Preacher, & Cacioppo, 2007).

One might expect that a lonely person, hungry to fulfill unmet social needs, would be very accepting of a new acquaintance, just as a famished person might take pleasure in food that was not as tasty as their usual fare. Indeed, experimentally increasing individuals' feelings of social isolation leads to an increase in anthropomorphism that reflects increased efforts to reconnect (Epley, Waytz, & Cacioppo, 2007). However, when confronted with an opportunity to form a social connection, studies show that the lonely are actually far less accepting of potential new friends than are the nonlonely (Rotenberg & Kmill, 1992). Similarly, lonely students were less responsive to their classmates during class discussions, and provided less appropriate and less effective feedback than nonlonely students (Anderson & Martin, 1995). Lonely undergraduates also held more negative perceptions of their roommates than did the nonlonely (Wittenberg & Reis, 1986), and this perceptual divide widened as one moved from roommates to suitemates to floor mates to dorm mates (Cacioppo & Hawkley, 2005).

Time also plays a role in constructing these negative "realities." Researchers asked participants to interact with a friend, and to rate the quality of the relationship and the communication immediately, after watching a videotape of the same social exchange, a few weeks later after being reminded of the interaction, and after again watching the videotape. At all four measurement points, lonely individuals rated relationship quality more negatively than did nonlonely individuals. Interestingly, the further in time they were removed from the social exchange, the more negatively they rated it. They were especially negative after the second videotape viewing (Duck, Pond, & Leatham, 1994). When lonely individuals rated the interaction soon after it happened, it appears that their negative social cognition was reined in by

a better understanding of the reasons for their friend's behavior. The more time that passed, the more objective reality succumbed to the “reality” constructed by the lonely individual’s negative social cognition.

In sum, lonely individuals are more likely to construe their world as threatening, hold more negative expectations, and interpret and respond to ambiguous social behavior in a more negative, off-putting fashion, thereby confirming their construal of the world as threatening and beyond their control. These cognitions, in turn, activate neurobiological mechanisms that, with time, take a toll on health.

Consequences

1. Self-regulation

Self-regulation refers to the capacity to change one’s cognitions, emotions, and/or behavior to better meet social standards and personal goals. Evidence from young adults who performed a dichotic listening task indicates that self-regulatory processes are impaired in lonely individuals (Cacioppo et al., 2000). In the dichotic listening task, participants are asked to identify the consonant-vowel pair presented in the left or right ear. Typically, performance shows a right-ear advantage. In addition, performance is generally better for the ear to which participants have been instructed to attend. In our study of lonely and nonlonely young adults, we observed a right-ear advantage and an attentional instruction advantage, but an interaction between these effects revealed that although lonely and nonlonely individuals showed a large attentional shift to the right ear when so instructed, lonely but not nonlonely participants failed to show a left-ear advantage when instructed to attend to this ear (Cacioppo et al., 2000).

Experimental manipulations that lead people to believe they face a future in social isolation also increases the challenge of self-regulation (Baumeister & DeWall, 2005) and this impaired

self-regulation has consequences for mental functioning. Undergraduate volunteers were provided with feedback to induce in them the possibility that they would experience a Future Alone (e.g., “You’re the type who probably will end up alone. Relationships just won’t last for you...”), a Future Belonging (e.g., “You’re the type who’ll have rewarding relationships throughout your life. Most likely you’ll have lifelong friendships and a long and happy marriage...”), a Future of Misfortunes (e.g., “You’re inherently accident prone. Even if this has not manifest itself in your life so far, you can count on breaking an arm or a leg fairly often...”), or no feedback at all. The Future Alone group showed significantly greater impairment in both speed and accuracy on the subsequent Reading Comprehension Test of the Graduate Record Exam than either the Future Belonging group or the Misfortune Control group. Bad news itself, then, was not enough to cause the disruption, only bad news about social connection. In addition, the mood measure for the Future Alone group showed no indication of emotional distress, suggesting that any decline in cognitive ability was not a simple matter of being flustered (Baumeister, Twenge, & Nuss, 2002).

2. Stress-related processes and outcomes

Stress exposure. Surveys of undergraduate students showed that lonely and nonlonely young adults do not differ in their exposure to major life stressors, or in the number of major changes they endured in the past twelve months (Cacioppo et al., 2000). A “beeper study,” in which these students were asked to sit down and record their thoughts and experiences at various times during the day, also showed that there was no difference in the reported frequency of hassles or uplifts they experience on an average day, or in the number of minor irritants they were confronting when their beeping wristwatch randomly interrupted them (Hawkey, Burleson, Berntson, & Cacioppo, 2003). At least for young adults, then, there was no evidence that

loneliness increased exposure to objective causes of stress. However, the number of objective stressors described as “current” had indeed increased among the middle age adults in CHASRS, and the lives of chronically lonely adults involved more objective chronic stressors than the lives of the nonlonely (Hawkley, Hughes, et al., 2007). Moreover, the increasing stress load over the course of a lifetime is aggravated by having fewer meaningful relationships to provide relief. Loneliness is an “added” stress.

Stress perceptions and coping. Even setting aside the greater number of objective stressors in their lives, the lonely express proportionately greater feelings of helplessness and threat. The lonely, both young and old, perceived the hassles and stresses of everyday life to be more severe than did their non-lonely counterparts. Compounding the problem, the lonely found the small, social uplifts of everyday life to be less intense and less gratifying (Hawkley et al., 2003). The presence of and interaction with other people did not lessen their ratings of the severity of their everyday stressors.

Stress is not uniformly “bad,” but can foster growth and motivate better performance. Lonely individuals, however, are far less likely than non-lonely individuals to see any given stressor as an invigorating challenge. Instead of responding with optimism and active engagement, they tend to respond with pessimism and avoidance, a passive coping strategy that carries its own costs. Among young adults, the greater the degree of loneliness, the more the individual withdrew when faced with stressors. Similarly, the greater the loneliness, the less the individual sought out emotional support, as well as instrumental (practical) support (Cacioppo, Hawkley, Crawford, et al., 2002). Behavioral withdrawal and failure to seek emotional support are common among lonely older adults as well (Hawkley & Cacioppo, 2007).

3. Health behaviors

Poor health behaviors are appealing mechanistic candidates for associations between loneliness and health. High-calorie, high fat diets and sedentary lifestyles, for example, contribute to being overweight or obese, major risk factors for disease in Western society. In a large cross sectional survey of 1,289 adults 18 years and older (mean age = 46.3 years), the lonely group had a higher mean BMI and a greater proportion of overweight/obese individuals than the nonlonely group did (Lauder, Mummery, Jones, & Caperchione, 2006).

Loneliness differences in physical activity have not been observed in studies of young adults (Hawkey et al., 2003) or in samples that cover a wide age-range from young to elderly adults (Lauder et al., 2006). However, in our CHASRS sample of middle-age adults, loneliness was associated with a significantly reduced odds of physical activity (OR=0.65 per SD of loneliness) (Hawkey, Thisted, & Cacioppo, 2007). This association was independent of sociodemographic variables (age, gender, ethnicity, education, income), psychosocial variables (depressive symptoms, perceived stress, hostility, social support), and self-rated health. Moreover, deficits in self-regulation, in this case the diminished tendency of lonely individuals to optimize positive emotions (i.e., poor hedonic emotion regulation), explained the association between loneliness and physical activity likelihood. Longitudinal analyses revealed that loneliness also predicted diminished odds of physical activity in the next two years (OR=0.61), and greater likelihood of transitioning from physical activity to inactivity (OR=1.58). These data suggest that age-related decreases in physical activity among the lonely may exacerbate risk for cardiovascular disease onset and progression, and contribute to an accelerated physiological decline.

4. Physiological functioning

Cardiovascular functioning. Blood pressure is a function of cardiac output (CO) and total peripheral resistance (TPR). In young adults, we found that loneliness was related to differential

regulation of systolic blood pressure (SBP). Although lonely and nonlonely individuals did not differ in blood pressure levels, maintenance of blood pressure was attributable to higher vascular resistance and lower cardiac output among lonely relative to nonlonely individuals (Cacioppo, Hawkley, Crawford, et al., 2002; Hawkley et al., 2003). Results from the Framingham Study indicate that changes in TPR play a dominant role in determining SBP from age 30 until approximately age 50 (Franklin et al., 1997). Given the temporal stability of loneliness and its substantial heritable component, it is plausible that loneliness-related elevations in TPR in early to middle-adulthood may lead to higher blood pressure in middle and older age. Consistent with this hypothesis, loneliness was associated with elevated SBP in a population-based sample of older adults in the Chicago Health, Aging, and Social Relations Study (CHASRS). Moreover, the association between loneliness and elevated SBP was exaggerated in older relative to younger lonely adults in this sample (Hawkley et al., 2006), consistent with our hypothesis of accelerated physiological decline in lonely relative to nonlonely individuals.

Neuroendocrine functioning. Activity of the hypothalamic-pituitary-adrenocortical (HPA) axis is critical to immune functioning and inflammatory processes, and dysregulation of HPA activity has been associated with loneliness and related psychosocial variables (Hawkley, Bosch, et al., 2007). Evidence for a loneliness difference in activity of the HPA axis was first reported by Kiecolt-Glaser et al. (Kiecolt-Glaser, Ricker, et al., 1984), who observed that lonely nonpsychotic psychiatric inpatients excreted significantly greater amounts of urinary cortisol than did nonlonely inpatients. More recently, Steptoe et al. found that lonely individuals showed a greater 30-min post-awakening increase in salivary cortisol (Steptoe, Owen, Kunz-Ebrecht, & Brydon, 2004), and Pressman et al. (2005) found that loneliness was associated with higher early morning and late night levels of circulating cortisol in young adult university students.

In our study of young adults, we measured catecholamines, ACTH, and cortisol in blood samples collected in the morning and again in the late afternoon. Analyses revealed that only morning levels of ACTH were significantly higher among lonely than nonlonely students (Cacioppo et al., 2000). We found no loneliness differences in the diurnal pattern of cortisol secretion or in mean daily levels of salivary cortisol, nor did we find differences in HPA reactivity to acute stressors in lonely and nonlonely individuals (Cacioppo et al., 2000).

Among older adults in CHASRS, however, HPA activity across a 3-day period in participants' everyday lives showed an effect consistent with a causal role for loneliness. Diary reports of daily psychosocial, emotional, and physical states were completed at bedtime on each of three consecutive days. Salivary cortisol levels were measured at wakeup, 30 min after awakening, and at bedtime each day. Multilevel models revealed that prior-day feelings of loneliness and related feelings of sadness, threat, and lack of control were associated with a higher cortisol awakening response the next day, but morning cortisol awakening responses did not predict experiences of these psychosocial states later the same day (Adam et al., 2006). The relevance of this association is particularly noteworthy given recent evidence that loneliness-related alterations in HPA activity may occur at the level of the gene.

5. DNA transcription regulation

Cortisol can regulate a wide variety of physiological processes via nuclear hormone receptor-mediated control of gene transcription. Cortisol activation of the glucocorticoid receptor (GR) exerts broad anti-inflammatory effects by inhibiting pro-inflammatory signaling pathways.

Social isolation, however, is associated with increased risk of inflammation-mediated diseases. One possible explanation for inflammation-related disease in individuals with high cortisol levels involves impaired GR-mediated signal transduction that prevents the cellular

genome from effectively 'hearing' the anti-inflammatory signal sent by circulating glucocorticoids (Cole et al., 2007). Consistent with this hypothesis, a systematic examination of genome-wide transcriptional alterations in circulating leukocytes showed increased expression of genes carrying pro-inflammatory elements, and decreased expression of genes carrying anti-inflammatory glucocorticoid response elements in lonely relative to nonlonely middle age adults (Cole et al., 2007). Impaired transcription of glucocorticoid response genes and increased activity of pro-inflammatory transcription control pathways provide a functional genomic explanation for elevated risk of inflammatory disease in individuals who experience chronically high levels of loneliness.

6. Cognitive functioning and depression

Social isolation increases the risk of developing dementia, and this risk extends to those who perceive themselves to be socially isolated or lonely. In a 4-year prospective study of initially dementia-free older adults (mean age = 80.7 years), the risk of Alzheimer's Disease was more than twice as great in lonely than in nonlonely individuals (RR scores of 3.2 vs. 1.4, respectively), and this effect was independent of functional physical impairments and vascular risk factors and conditions (Wilson et al., 2007). In addition, loneliness was associated with lower cognitive ability at baseline and with a more rapid decline in cognition during the 4-year follow-up (Wilson et al., 2007). Loneliness has been associated with poorer self-reported memory among older Black adults (Bazargan & Barbre, 1992), and predicted more rapid cognitive decline over a 10-year period in a Finnish sample of adults 75 years of age and older (Tilvis et al., 2004).

Depression. We have noted that loneliness and depressive symptoms are conceptually and empirically distinct (Cacioppo, Hawkley, et al., 2006). Nevertheless, levels of loneliness and

depressive symptoms covary across the life span. Moreover, despite age group differences in loneliness, the association between loneliness and depressive symptoms appears stable (i.e., moderately and equivalently positive) across age (Nolen-Hoeksema & Ahrens, 2002).

Loneliness has been identified as a risk factor for depressive symptoms in longitudinal studies of older adults (Heikkinen & Kauppinen, 2004). However, as has been noted, loneliness is associated with a constellation of demographic and psychosocial risk factors (e.g., hostility, low social support, perceived stress) for depressive symptoms that could explain the association between loneliness and depressive symptoms (e.g., Cacioppo, Hawkley, et al., 2006). Recent evidence from a nationally representative sample of adults 54 years and older revealed that loneliness was associated with more depressive symptoms independent of demographic factors (age, gender, ethnicity, socioeconomic status, marital status) and related feelings of hostility, perceived stress, and poor social support (Cacioppo, Hughes, et al., 2006). Extending these findings, longitudinal data from a population-based sample of 50-67 year old adults in CHASRS showed reciprocal influences between loneliness and depressive symptoms over a 3-year period that again were independent of demographic and psychosocial risk factors (Cacioppo, Hughes, et al., 2006). The mutually synergistic effects of loneliness and depressive symptoms are consistent with a downward spiral of negativity in lonely and depressed individuals, and suggest that interventions at either or both fronts could reduce emotional suffering and improve well-being.

7. Sleep salubrity

Sleep deprivation has been associated with reduced glucose tolerance, elevated evening cortisol levels, and increased sympathetic nervous system activity (Spiegel, Leproult, & Van Cauter, 1999). However, sleep quality is as at least as important as sleep duration in accomplishing its restorative effects. Nonrestorative sleep (i.e., sleep that is non-refreshing

despite normal sleep duration) results in daytime impairments such as physical and intellectual fatigue, role impairments, irritability, and cognitive and memory problems (Ohayon, 2005).

Prior research has shown that poor social relations and loneliness are associated with poor sleep quality and daytime dysfunction (Cacioppo, Hawkley, Crawford, et al., 2002; Friedman et al., 2005). Prior research also has shown that the greater daytime dysfunction reported by lonely young adults is accompanied by more nightly micro-awakenings and not by differential sleep duration (Cacioppo, Hawkley, Berntson, et al., 2002). In an extension of these findings, loneliness was associated with greater daytime dysfunction in a 3-day diary study completed by the CHASRS sample of middle-age adults, an association that was independent of age, gender, race/ethnicity, household income, health behaviors, BMI, chronic health conditions, daily illness symptom severity, and related feelings of stress, hostility, poor social support, and depressive symptoms. Moreover, cross-lagged panel analyses supported a causal role for loneliness: lonely feelings predicted daytime dysfunction the following day, but daytime dysfunction was not a significant predictor of lonely feelings the following day (Hawkley, Preacher, Waite, & Cacioppo, 2007). These results were independent of sleep duration, and suggest that the same amount of sleep is less salubrious in individuals who feel more socially isolated.

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