

Meaningful connections matter for loneliness in older adults: An Associational Variable Analysis of factors contributing to loneliness

Sophie R. White

University of the Sunshine Coast

Helen K. Hall

University of the Sunshine Coast

Mathew J. Summers

msummers@usc.edu.au

University of the Sunshine Coast

Research Article

Keywords: Loneliness, Older Adults, Mental Health, Social Networks, Depression, Avoidance

Posted Date: September 28th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10311748/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

This study examined the Cacioppo and Hawkley (2009) theoretical model of loneliness in older adults while introducing social network strength as a key associational variable. Data from an Australian community-based sample of 193 adults aged 65–91 years was analysed using Associational Variable Analysis. The initial theory-derived path model linking hypervigilance, cognitive confirmation bias, behavioural confirmation processes, and negative displays, social interaction and affect accounted for 48% of the variance in loneliness in older adults. The introduction of familial and friendship social network strength as an associational variable increased explained variance to approximately 93% of the variance in loneliness. Social network variables accounted for the largest unique portions of variance in loneliness in the semi-partial regression. Stronger social networks were associated with lower loneliness in older adults indicating that meaningful relationships with family and friends matter for understanding loneliness in older adults.

Introduction

Meaningful social connections are widely recognised as a fundamental human need (Baumeister & Leary, 1995; Cacioppo, Grippo, et al., 2015) and play a critical role in psychological wellbeing (Holt-Lunstad, 2024), physical health (Cacioppo, Grippo, et al., 2015) and longevity (Susanty et al., 2025). There is evidence of a decline in meaningful social connection, with loneliness now affecting an estimated one in four Australians (Lim, 2018). Despite gains in healthcare leading to improved longevity, living in an increasingly technologically connected society may have led to an increase in social isolation and resulting loneliness, especially in adults over 60 years old where rates of loneliness increase with age (Aylaz et al., 2012). Loneliness is a subjective experience tied to unmet personal social needs and emotional disconnection (Seemann, 2022). It is independent of the number of social relationships (i.e., number of friends) but dependent on quality of the connection (Cacioppo et al., 2014). Loneliness can arise in response to situational factors (Shiovitz-Ezra & Ayalon, 2010) (e.g., bereavement), but can reduce if social connections are restored. If loneliness persists and develops into a chronic state, the individual's perception of the social world becomes distorted, viewing social interaction as potentially threatening (Cacioppo & Hawkley, 2009).

Cacioppo and Hawkley (Cacioppo & Hawkley, 2009) proposed a model of loneliness in which a cycle of cognitive and behavioural responses to social isolation result in maladaptive coping mechanisms that act to maintain and accentuate loneliness. This cycle is triggered within the individual who perceives being socially isolated. Feelings of social isolation initiate a feeling of being unsafe which then trigger a cognitive response bias and hypervigilance toward social threats. This cognitive orientation towards detection of social threats leads to strong negative impacts on social perceptions, cognitions, and behaviours which then lead to an exacerbation of social isolation. For the lonely individual, unconscious biased monitoring of the environment for social threats triggers the development of maladaptive cognitive biases such as anticipating negative social interactions and a propensity to recalling prior negative social experiences. These cognitive biases then lead to the initiation of behavioural responses that promote social disengagement, which in turn provide confirmation of the cognitive biases and beliefs, creating a self-perpetuating cycle of loneliness. As a result, lonely people tend to withdraw from potential social connections, while externally attributing the cause of this distance to others and not internally attributing to themselves. Consequently, while lonely individuals may perceive themselves as passive victims in their social environment, they are often unwitting active participants through their self-protective behaviours in interactions with others (Cacioppo & Hawkley, 2009).

A complex interplay of psychosocial risk factors including intrapersonal, interpersonal relationships, community and societal factors are associated with loneliness. With advancing age, developmental and lifespan related changes increase susceptibility to loneliness, such as retirement from the workforce, geographic relocation of children and other family, reduced mobility and the death of partners, friends, and family members (Andrew & Rockwood, 2010; Aylaz et al., 2012; Ogrin et al., 2021). Extended periods of loneliness are associated with negative self-concept and maladaptive cognitive processes which can present as symptoms of depression and anxiety. Loneliness in older adults is associated with higher rates of cognitive decline and dementia (Andrew & Rockwood, 2010; Shankar et al., 2013; Susanty et al., 2025) as well as multiple health complications including a 29% increased likelihood of heart disease, 32% increase in risk of stroke (Cacioppo, Grippo, et al., 2015) and a significantly increased risk of premature death (Susanty et al., 2025).

Loneliness is the subjective experience of a lack of emotional supportive connection to others, whereas social isolation refers to the number and type (e.g., familial, friend, social) of relationships in a person's social network. While social isolation is a quantifiable construct and often used as a proxy for loneliness, in the absence of direct measurement of the subjective experience of loneliness there is a risk of assuming that the socially isolated individual is lonely or vice versa. Social contact is inversely related to loneliness (Pinquart & Sörensen, 2003; Routasalo et al., 2006) with the quality of social interactions having a greater impact than the quantity of interactions. A meta-analysis (Susanty et al., 2025) examining loneliness and associated risk factors in older adults (aged 60 + years) across six continents demonstrated that individuals with poor-quality relationships are more likely to experience loneliness. This research highlights that older adults may be particularly vulnerable to loneliness as a result of age-related changes to social networks.

As a lonely individual becomes aware of their proximity to the social perimeter, they subconsciously engage in self-preservation to promote short term survival from external social threats. In lonely young adults, eye-tracking research (Bangee et al., 2014) indicates there is an elevated vigilance toward socially threatening and rejecting stimuli. This hypervigilance to negative social events and stimuli (Bangee et al., 2014; Cacioppo et al., 2009; Cacioppo, Balogh, et al., 2015; Cacioppo, Grippo, et al., 2015; Pickett et al., 2004) results in the individual overlooking cues for social

reconnection opportunities (Cacioppo & Hawkley, 2009) leading to an exacerbation of loneliness. Research demonstrates that higher rejection sensitivity is positively related to social avoidance and negatively related to self-esteem and social self-efficacy (i.e., people with high rejection sensitivity are likely to have low self-esteem and low confidence in social skills) (Watson & Nesdale, 2012). As a result, the lonely individual feels more anxious, typically subconsciously acting indifferent toward others and perpetuating the self-defeating cycle of social withdrawal and negative behaviour (Cacioppo et al., 2006).

To date, the body of research into loneliness has been undertaken with populations of young undergraduate students from westernised university settings (Bangee et al., 2014; Cacioppo et al., 2009; Pickett et al., 2004; Watson & Nesdale, 2012). This study adopts an Associational Variable Analysis (AVA; Weems, 2025) approach with the aim of testing observed patterns of association between components of the Cacioppo and Hawkley (Cacioppo & Hawkley, 2009) model of loneliness in older adults across Australia. It was hypothesised that, consistent with the Cacioppo and Hawkley (2009) model of a loneliness, a theory-derived associational pattern would be observed among hypervigilance, cognitive and attentional biases, behavioural confirmation bias, negative social interactions, negative affect, and loneliness. Specifically, hypervigilance was expected to be associated with stronger cognitive and attentional biases, which would be associated with behavioural confirmation bias and greater negative social interactions/affect. These variables were expected to account for substantial shared variance in loneliness in older adults. It was further hypothesised that social network quality would operate as a key associational variable, accounting for shared variance between negative cognition-behaviour-interaction/affect patterns and loneliness.

Materials and Methods

Participants

An Australian community-based sample of 249 older adults volunteered to participate in an anonymous online survey in response to targeted Facebook (Meta) advertising. Participants provided fully informed consent prior to commencing the online survey. After excluding 56 incomplete responses, a final sample of 193 adults (full demographics provided in Supplementary Table A) aged between 65–91 years ($M = 72.82$, $SD = 5.43$), 76.2% female, 21.8% male and 2.1% non-binary was retained. All participants resided in Australia with 64.8% residing in metropolitan areas and 45.1% living alone. Of the sample, 26.9% reported having depression, 10.4% reported an anxiety-related diagnosis and 5.7% reporting psychosis or another mental health condition. Ethical approval was granted by a regional University's Human Research Ethics Committee (S242029).

Materials

The survey comprised of eight validated questionnaires assessing loneliness, social networks, hypervigilance, fear of negative evaluation, cognitive and behavioural processes, negative social interactions, depression and anxiety. In addition, eleven demographic items were used to assess individual factors that may contribute to loneliness (e.g., mobility impairment).

The online survey consisted of eight standardised questionnaires. The UCLA Loneliness Scale – Revised (UCLA-R) (Russell et al., 1980) is a 20-item scale using a four-point Likert scale with established reliability and validity (Ausín et al., 2019). The Lubben Social Network Scale – Revised (LSNS-R) (Lubben & Gironde, 2003), a 12 item, five-point Likert scale, self-report questionnaire assessing the number of relationships, frequency of contact and intimacy for family and friends with established high cross-cultural reliability and validity (Kuru Alici & Kalanlar, 2021). The Brief Hypervigilance Scale (BHS) (Bernstein et al., 2015), a five-item self-report questionnaire which assesses the individual's perception of potential external threats over the previous month with evidence of reliability and validity (Bernstein et al., 2015). The Brief Fear of Negative Evaluation Scale (BFNE) comprises 12 items assessing a participant's fear and worry about being negatively appraised by others with generally good reliability in nonclinical and nonstudent populations (Duke et al., 2006). The Cognitive Behavioural Processes Questionnaire (CBPQ), a 15-item self-report measure using a nine-point Likert scale (Patel et al., 2015) is comprised of two parts; Part A (CBPQ-A) captures cognitive components of rumination, worry and threat monitoring; whereas Part B (CBPQ-B) captures behavioural components of avoidance and safety behaviours. The CBPQ demonstrates good internal consistency and test–retest stability in both clinical and nonclinical populations (Patel et al., 2015). The Negative Interactions Questionnaire (NIQ) (Krause, 1995) is a five-item self-report tool used to assess the frequency and impact of negative social interactions particularly in close relationships. Limited published information on reliability and validity of the NIQ is available. The Generalised Anxiety Disorder Questionnaire (GAD-7) (Spitzer et al., 2006) is a seven-item self-report measure of anxiety symptoms in the preceding two weeks and is an established reliable and valid measure across both clinical and research settings (Beard & Björgvinsson, 2014; Spitzer et al., 2006). The Patient Health Questionnaire (PHQ-9) (Spitzer et al., 1999) is a widely used nine-item self-report measure of clinical symptoms of depression in preceding two weeks with established validity and reliability in elderly populations (Phelan et al., 2010).

Procedure

Participants were recruited to participate in a study to better understand how relationships and social interactions impact the well-being of older adults using a social media study page on Facebook (Meta), posts on relevant community group Facebook (Meta) pages, targeted national Facebook (Meta) advertisement campaign, as well as email notifications to age-relevant community groups and organisations. Participants

completed the anonymous informed consent process and survey via Qualtrics. The entire survey took participants an average of 28 minutes to complete. On completion or discontinuation, participants were taken to a debriefing page at which stage participants were provided an option to provide their email address to access the final results of the study upon its completion. The email addresses were stored separately to the survey results to maintain anonymity and were deleted after sending the results.

Statistical analysis

All analyses were conducted using IBM SPSS Statistics v28 and AMOS v29, with data screened for missing entries, input errors, distributional assumptions, and multivariate outliers prior to analysis. This study used a cross-sectional survey design analysed with structural equation modelling (SEM) and simultaneous multiple regression to examine unique contributions (semi-partials) within an Association Variable Analysis (AVA) framing (Weems, 2025). To test the hypothesis of this study, a path analysis was performed to investigate patterns of shared and unique variance among hypervigilance, cognitive bias, behavioural confirmation, negative interactions, anxiety, depression, and loneliness, without implying mediation, temporal sequencing or causality. AVA proceeded in four stages. Step 2 tested the theory-derived multivariate associational model in AMOS using maximum likelihood estimation. Cognitive bias was specified as a latent construct indicated by cognitive bias, measured using the CBPQ-A, and attentional bias, measured using the BFNE. Negative social interactions/affect was specified as a latent construct indicated by negative interactions, measured using the NIQ, anxiety symptoms, measured using the GAD-7, and depressive symptoms, measured using the PHQ-9. Social network quality was specified as a latent construct indicated by LSNS family and LSNS friends subscales. Step 3 descriptively examined model-implied indirect associations using bias-corrected bootstrapping with 5000 resamples and 95% confidence intervals. These indirect associations were interpreted as associational pathways only, not as mediation effects or evidence of causal transmission (Weems, 2025). Step 4 tested alternative and sensitivity models to examine the specificity of the proposed associational structure, including trimmed models, reversed-placement models, and recursive models removing the nonrecursive feedback loop.

Model fit was evaluated using the goodness-of-fit index (GFI), comparative fit index (CFI), normed fit index (NFI), root mean square error of approximation (RMSEA) with 90% confidence intervals, adjusted goodness-of-fit index (AGFI), and information criteria where relevant. Values of .90 or higher were considered acceptable for GFI, CFI, NFI, and AGFI, while RMSEA values of .08 or lower were considered preferable; RMSEA confidence intervals exceeding .10 were interpreted as indicating poor fit (Byrne, 2012; Hair et al., 2019; Kline, 2016; McDonald & Ho, 2002). Model evaluation considered the overall pattern of fit indices, parameter estimates, parsimony, theoretical interpretability, and stability of explained variance across plausible specifications.

Standardised path coefficients, standard errors, critical ratios, and two-tailed significance values were examined to evaluate the relative strength and reliability of associations between variables. Standardised path coefficients were reported to allow comparison of the relative magnitude of associations across paths (Hair et al., 2019). Where effect-size language was used, standardised coefficients were interpreted as mild around $\beta = .20-.30$, moderate around $\beta = .30-.50$, and strong above $\beta = .50$ (Holmes-Smith et al., 2006; McDonald & Ho, 2002). Squared multiple correlations were interpreted as the proportion of variance accounted for in endogenous variables, with values of approximately .02, .15, and .35 interpreted as small, medium, and large, respectively (Cohen, 1988).

Finally, to complement the AVA path models, a simultaneous multiple regression was conducted with loneliness as the dependent variable. Hypervigilance, attentional bias, cognitive bias, behavioural confirmation bias, negative interactions, anxiety, depression, and LSNS family and friends scores were entered simultaneously. Semi-partial correlations were squared to estimate each variable's unique contribution to loneliness after controlling for shared variance with the broader predictor set (Weems, 2025). Collinearity diagnostics were inspected to support interpretation of these unique associations (Kline, 2016).

Results

Data from the final sample of 193 adults were complete, with no missing data identified. Assumptions were examined prior to analysis. Although several variables showed non-normality, models were estimated using maximum likelihood estimation with bias-corrected bootstrapping. Collinearity statistics and examination of the correlation matrix did not indicate severe multicollinearity.

Table 1 presents the descriptive statistics (means, standard deviations, and ranges) for loneliness (UCLA-R), social network strength and quality (LSNS-R), hypervigilance (BHS), attentional bias (BFNE), cognitive confirmation bias (CBPQ-A), behavioural confirmation bias (CBPQ-B), negative interactions (NIQ), anxiety (GAD-7), and depression (PHQ-9). Table 2 reports the proportion of participants meeting published cut-point criteria for high loneliness on the UCLA-R (Lee et al., 2021), moderate or greater anxiety on the GAD-7 (Spitzer et al., 2006), or moderate or greater depression on the PHQ-9 (Kroenke et al., 2001).

Table 1
Descriptive statistics for loneliness, social networks, hypervigilance, attentional bias, cognitive bias, behavioural confirmation, negative interactions, anxiety and depression.

Variable	N	M	SD	Minimum	Maximum
Loneliness (UCLA-R)	193	46.52	13.75	20	76
Family networks (LSNS-R Family)	193	12.86	6.76	0	27
Friend networks (LSNS-R Friends)	193	11.93	6.24	0	24
Hypervigilance (BHS)	193	7.84	3.50	5	25
Attentional Bias (BFNE)	193	31.79	10.14	13	57
Cognitive Bias (CPBQ-A)	193	27.40	13.20	0	57
Behavioural Confirmation (CBPQ-B)	193	19.87	10.57	0	56
Negative Interactions (NIQ)	193	8.37	2.77	5	18
Anxiety (GAD-7)	193	5.59	5.54	0	21
Depression (PHQ-9)	193	7.28	6.67	0	27

Table 2
Descriptive Statistics for participants meeting clinical cutoff for loneliness, moderate or greater anxiety, or moderate or greater depression.

Variable	N	n (%)	
		below cutoff	above cutoff
High Loneliness (UCLA-R > 43) (Lee et al., 2021)	193	86 (44.6)	107 (55.4)
GAD-7 Anxiety (≥ 10 moderate) (Spitzer et al., 2006)	193	150 (77.7)	43 (22.3)
PHQ-9 Depression (≥ 10 moderate) (Kroenke et al., 2001)	193	138 (71.5)	55 (28.5)

[INSERT Table 1 HERE]

[INSERT Table 2 HERE]

Associational Variable Analysis (AVA)

Analyses were organised according to the Associational Variable Analysis framework (Weems, 2025). Given the cross-sectional design, paths were interpreted as associational specifications rather than evidence of mediation, temporal ordering, or causality.

AVA Step 1: Zero-order Associations

Zero-order correlations were examined to determine whether significant relationships existed between the focal variables consistent with the proposed associational structure derived from the Cacioppo and Hawkley (2009) theory of loneliness. As shown in Table 3, all variables were significantly associated in the predicted direction and thus satisfy Condition 1 of AVA where the proposed associational, independent and outcome variables are all significantly correlated (Weems, 2025). Loneliness was positively associated with hypervigilance, attentional bias, cognitive confirmation bias, behavioural confirmation bias, negative interactions, anxiety, and depression, and negatively associated with social network family and social network friends.

Table 3

Zero-order correlations for loneliness, perceived social isolation, hypervigilance, attentional bias, behavioural confirmation, negative interactions, anxiety and depression.

Variable	Family networks (LSNS-R Family)	Friend networks (LSNS-R Friends)	Hypervigilance (BHS)	Attentional Bias (BFNE)	Cognitive bias (CBPQ-A)	Behavioural Confirmation (CBPQ-B)	Negative Interactions (NIQ)	Anxiety (GAD-7)	Depression (PHQ-9)
Loneliness (UCLA-R)	– .657**	– .748**	.449**	.468**	.612**	.582**	.252**	.608**	.661**
Family networks (LSNS-R Family)		.535**	– .382**	– .265**	– .314**	– .359**	– .172**	– .402**	– .414**
Friend networks (LSNS-R Friends)			– .309**	– .337**	– .437**	– .419**	– .183*	– .421**	– .491**
Hypervigilance (BHS)				.494**	.499**	.588**	.428**	.620**	.509**
Attentional Bias (BFNE)					.610**	.551**	.361**	.583**	.533**
Cognitive bias (CBPQ-A)						.780**	.433**	.755**	.713**
Behavioural Confirmation (CBPQ-B)							.468**	.734**	.713**
Negative Interactions (NIQ)								.473**	.451**
Anxiety (GAD-7)									.818**
Note. * $p < .01$. ** $p < .001$									

[INSERT Table 3 HERE]

AVA Step 2: Multivariate/Unique Associations

The first path model tested the theory-derived associational loop between hypervigilance, cognitive bias, behavioural bias, negative interaction and affect, and loneliness (Fig. 1). Examination of the standardised effects (Table 4) indicated that each of the specified paths in the model were significant with the overall model explaining 48% of the variance in loneliness. However, global model fit was mixed-to-poor, $\chi^2 = 105.53$, $df = 18$, $p < .001$; GFI = .893, CFI = .911, NFI = .896, AGFI = .785, and RMSEA = .159 with a 90% CI [.131, .189]. Therefore, the path pattern, while consistent with the theoretical model, did not reproduce the overall covariance structure well.

Table 4
Summary of Model 1 path results

Paths	β	SE	95% bias corrected CI	p.
Loneliness → Hypervigilance	.24	.07	[.10, .36]	.003**
Hypervigilance → Cognitive bias	.55	.07	[.41, .68]	< .001***
Cognitive bias → Behavioural bias	.86	.04	[.78, .93]	.001***
Behavioural bias → Negative displays/interaction/affect	.78	.04	[.70, .84]	.001***
Negative displays/interaction/affect → Loneliness	.65	.04	[.55, .73]	.001***
Note. N = 193, Estimates are based on 5,000 bias-corrected bootstrap samples. B = standardised regression weights; SE = standard error; CI = confidence interval; * p. < .05, ** p. < .01, *** p. < .001.				

[INSERT FIGURE 1 HERE]

[INSERT Table 4 HERE]

A second path model added social network quality and strength as an associational variable between negative displays/interactions/affect and loneliness.

[INSERT FIGURE 2 HERE]

Model 2 showed improved explanatory capacity relative to Model 1 and accounted for approximately 93% of the variance in loneliness. Fit remained mixed, $\chi^2(31) = 119.11$, $p < .001$, GFI = .900, CFI = .929, NFI = .908, AGFI = .823, RMSEA = .122, 90% CI [.099, .145]. Negative displays/interactions/affect was strongly negatively associated with social networks, $\beta = -.594$, $p < .001$, and social networks were strongly negatively associated with loneliness, $\beta = -.871$, $p < .001$. Once social networks were included, the direct association between negative displays/interactions/affect and loneliness was no longer significant, $\beta = .129$, $p = .246$.

As shown in Table 5, negative displays/interactions/affect was significantly associated with social networks and social networks were significantly associated with loneliness. The indirect path from negative displays/interactions/affect to loneliness was not significant. These paths were therefore used to describe the model-implied indirect association in AVA Step 3.

Table 5
Summary of Model 2 path results

Paths	β	SE	95% bias corrected CI	p.
Loneliness → Hypervigilance	.24	.07	[.10, .36]	.003**
Hypervigilance → Cognitive bias	.55	.07	[.41, .68]	< .001***
Cognitive bias → Behavioural bias	.86	.04	[.78, .93]	.001***
Behavioural bias → Negative displays/interaction/affect	.78	.04	[.70, .84]	.001***
Negative displays/interaction/affect → Loneliness	.13	.11	[-.12, .29]	.246
Negative displays/interaction/affect → Social networks	-.59	.07	[-.73, -.46]	< .001***
Social networks → Loneliness	-.87	.10	[-1.11, -.72]	< .001***
Note. N = 193, Estimates are based on 5,000 bias-corrected bootstrap samples. B = standardised regression weights; SE = standard error; CI = confidence interval; * p. < .05, ** p. < .01, *** p. < .001.				

This pattern suggests that social network quality and strength accounted for substantial shared variance in the association between negative displays/interactions/affect and loneliness. This should be interpreted as an associational pattern rather than evidence of mediation or causal protection.

[INSERT Table 5 HERE]

AVA Step 3: Follow-up Probing of the Associational Pathway

Due to Step 1 indicating Condition 1 of AVA had been met (Weems, 2025), and Step 2 indicated attenuation of the direct negative displays/interactions/affect – loneliness path after social networks were added, Step 3 examined the nature and size of the social-network associational path.

In the trimmed model, negative displays/interactions/affect was strongly negative associated with social networks, $\beta = -.65$, and social networks were strongly negatively associated with loneliness, $\beta = -.99$. The resulting model-implied associational pathway was $\beta = .65$. This indicates that greater negative displays/interactions/affect was associated with higher loneliness through its association with weaker social networks. Consistent with AVA, this is interpreted as a descriptive associational effect.

AVA Step 4: Alternative and Sensitivity Models

Alternative and sensitivity models were tested to examine whether the proposed associational structure was robust to plausible alternative specifications. The trimmed model, M2a, removed the non-significant direct path from negative displays/interactions/affect to loneliness. Fit was comparable to Model 2, $\chi^2(32) = 120.88, p < .001$, and the same substantive pattern was retained. This supported M2a as a more parsimonious version of the primary social-network AVA model.

Reverse-placement and alternative models were also examined. M2b and M2c showed poorer fit than M2 and M2a, suggesting weaker support for these alternative specifications. However, M2d, which placed loneliness upstream of social networks while retaining the association between negative displays/interactions/affect and loneliness, showed competitive fit, $\chi^2(32) = 119.47, p < .001$. This indicates that the strong association between loneliness and social networks was robust, but that its direction could not be resolved using cross-sectional data.

Recursive sensitivity models were also tested. M2e removed the nonrecursive feedback loop and treated loneliness only as the outcome. This model retained the core social-network pattern, although fit was slightly weaker than the primary model. M2f added a direct path from hypervigilance to loneliness, but this path was non-significant, $\beta = -.01, p = .869$, and did not improve interpretation.

Semi-partial Regression: Unique Associations with Loneliness

To complement the AVA path models, a simultaneous regression was conducted to examine the unique contribution of each observed variable to loneliness. The full model was significant, $F(9, 183) = 62.83, p < .001$, explaining 75.6% of the variance in loneliness, adjusted $R^2 = .743$. Social Network-Friends accounted for the largest unique share of variance, followed by Social Network-Family. Depression and cognitive bias also accounted for small but significant unique portions of variance.

Hypervigilance, attentional bias, negative interactions, anxiety, and behavioural confirmation bias did not explain meaningful unique variance once the broader predictor set was entered simultaneously. Tolerance values ranged from .23 to .71, and VIF values ranged from 1.41 to 4.32, indicating that multicollinearity was not severe.

Supplementary Group Comparisons

Further analysis explored whether differences existed in the key predictor variables between lonely and non-lonely older adults. Using established cutoff criteria of a UCLA-R total score > 43 to indicate high levels of loneliness (Lee et al., 2021), the sample was classified into non-lonely ($n = 86$) and lonely ($n = 107$) groups. Group differences across study variables in the path analysis model were examined by independent-samples t-test (Table 6), with Bonferroni corrected $p < .005$ as the required significance level to correct for potential multiple-comparisons Type I error inflation.

Table 6
Independent samples t-test comparing lonely and non-lonely older adults on key predictor variables

Variable	Non-Lonely (n = 86)		Lonely (n = 107)		t.	p.	Effect size (d)
	Mean	(SD)	Mean	(SD)			
Age	72.34	(5.24)	71.08	(4.95)	1.704	.090	.247
Family network (LSNS-R Family)	17.26	(5.55)	9.33	(5.45)	9.961	< .001*	1.443
Friend networks (LSNS-R Friends)	16.88	(3.83)	7.95	(4.79)	14.390	< .001*	2.034
Hypervigilance (BHS)	6.54	(1.56)	8.89	(4.21)	5.337	< .001*	.711
Attentional bias (BFNE)	27.43	(7.15)	35.29	(10.85)	6.040	< .001*	.838
Cognitive bias (CBPQ-A)	19.91	(10.09)	33.42	(12.33)	8.196	< .001*	1.187
Behavioural confirmation (CBPQ-B)	14.07	(6.92)	24.52	(10.71)	7.832	< .001*	1.134
Negative interactions (NIQ)	7.65	(2.09)	8.95	(3.10)	3.474	< .001*	.483
Anxiety (GAD-7)	2.58	(3.00)	8.01	(5.93)	8.244	< .001*	1.119
Depression (PHQ-9)	3.23	(2.86)	10.53	(6.91)	9.925	< .001*	1.330
* significant at Bonferroni corrected $p. < .005$							

[INSERT Table 6 HERE]

Comparison of older adults experiencing high levels of loneliness with those not lonely revealed a pattern of significantly lower familial and friendship social network quality, higher levels of hypervigilance, attentional bias, behavioural confirmation, negative interactions, anxiety and depression. Effect sizes for these differences were all in the very large range ($d. > .80$) with the exception of hypervigilance ($d. = .71$) and negative interactions ($d. = .48$) which displayed moderate effect sizes. There was no evidence that lonely older adults were significantly different in age to older adults who were not lonely.

Overall, the AVA results showed that the focal variables were significantly interrelated at the zero-order level, that adding social networks substantially increased explained variance in loneliness, and that social network family and friendship variables accounted for the largest unique portions of variance in the semi-partial regression. Alternative model testing indicated that the social network–loneliness association was robust, but that its directional placement could not be resolved using cross-sectional data.

Discussion

Previous research has predominantly examined loneliness in young adults, with a reliance on university students for most research (Bangee et al., 2014; Cacioppo et al., 2009; Cacioppo, Balogh, et al., 2015; Lau & Gruen, 1992; Lodder et al., 2015; Pfeifer et al., 2025; Rotenberg et al., 2002). The present study sought to redress this imbalance and explore factors contributing to loneliness in older adults, by examining associations among previously identified cognitive and behavioural mechanisms on loneliness. While research with young adults indicates hypervigilance, attentional bias (Bangee et al., 2014; Cacioppo et al., 2009; Cacioppo, Balogh, et al., 2015) and negative interactions, displays and affect (Lau & Gruen, 1992; Rotenberg et al., 2002) increase levels of loneliness, some studies of young adults report no effect of these factors on level of loneliness (Lodder et al., 2015; Pfeifer et al., 2025). The results of the present study provided partial support for an associational pattern consistent with the Cacioppo and Hawkley (2009) theoretical model for the development and maintenance of loneliness in older adults. The model demonstrated that hypervigilance, cognitive confirmation bias, behavioural bias, negative interactions and affect, and loneliness were connected through a theory-consistent associational pattern. Further, when social network quality and strength were included as an associational variable the model improved in explanatory capacity and accounted for approximately 93% of the variance in loneliness. Importantly, familial and friendship networks were negatively associated with loneliness, that is as social networks increased loneliness was decreased, accounting for substantial shared variance within the broader associational model incorporating hypervigilance, cognitive bias, behavioural bias, and negative interactions and affect. Therefore, for older adults, the proposed theoretical model by Cacioppo and Hawkley (2009) is partially supported when interpreted as an associational structure and was strengthened by the incorporation of social network strength and quality as a central associational variable.

For young adults, social life tends to be structured around study and work environments through which the younger adult has multiple and varied opportunities for social interactions. Additionally, ongoing parental and familial support may provide a buffer against social isolation and loneliness. In contrast, for the older adult, social connections may decrease after retirement from the workforce, as well as geographic relocation of family

members (e.g., children, grandchildren), and a reduction in networks due to illness or death (Schaie, 2000). Additional losses to important supportive networks for the older adult can occur through loss of spousal relationship either by late-life relationship breakdown or becoming widowed. The results of the present study indicate that for the older adult, quality of friendship and familial social networks (i.e., number of interactions, frequency of contact and quality of relationships) were strong protective correlates of lower loneliness. The model is consistent with the possibility that loneliness and social hypervigilance are closely linked, with cognitive confirmation bias increasing as hypervigilance increases. Cognitive confirmation bias towards experiences of social isolation and or exclusion was also associated with behavioural confirmation bias in response to the experience of loneliness, and is linked to socially negative behavioural displays, negative social interactions and an increase negative affect (anxiety and depression). This associational pattern is consistent with theoretical accounts in which maladaptive cognitive, behavioural, and affective patterns to loneliness may limit opportunities for meaningful social engagement and thus perpetuate feelings of loneliness (Watson & Nesdale, 2012). The cognitive response patterns to loneliness are similar to the maladaptive cognitions observed in depression, in which clinically depressed individuals report diminished interest in social activities, avoidance, withdrawal and ruminative cognitive patterns. Multiple longitudinal studies demonstrate a link between depression severity and loneliness in adults over 50 years of age (Domènech-Abella et al., 2019; Lee et al., 2021). A symptomatic consequence of clinical depression is social and emotional withdrawal; hence it is possible that a bidirectional relationship exists between depression and loneliness, such that either state can induce the other and result in a self-perpetuating cycle. The cross-sectional design of this study cannot test this directly and is recommended as an area for future research.

In comparing older adults identified as high loneliness with those considered not lonely, significant group differences were identified across all variables examined: familial social networks, friendship social networks, hypervigilance, cognitive bias, behavioural confirmation, negative interactions, anxiety and depression. The Cacioppo and Hawkley (2009) model of loneliness in which a maladaptive cycle of hypervigilance leading to cognitive confirmational biases, which in turn activates behavioural confirmation processes which increases negative social interactions and affect is reminiscent of the negative cognitive triad (Beck, 1991) and process of learned helplessness (Seligman, 1972) well-established in the development and maintenance of depression. The results of this study indicate that negative affect states (anxiety and depression) were closely embedded within the model of loneliness, suggesting that disentangling the cognitive processes associated with loneliness from those associated with depression may be difficult, particularly in cross-sectional data.

Meaningful connections in which the individual feels emotionally connected, valued, and supported may be more protective than having multiple superficial relationships. The results of the present study are consistent with previous research suggesting that reduced social networks are associated with increased risk of loneliness in older adults, with evidence suggesting that the quality rather than quantity of social interactions is most important (Hawkley et al., 2008; Pinquart & Sörensen, 2003; Routasalo et al., 2006; Susanty et al., 2025). Engaging in regular social connection and having a confidant has been shown to slow the process of cognitive decline (Samtani et al., 2022). Providing opportunities for social engagement both peer and intergenerational, may be important responses to the increasing aging population and social isolation emerging due to structural changes to local communities occurring in response to changes in workforce demands, housing supply, and technological transition.

Limitations

The cross-sectional design used in this study only enables exploration of loneliness at a single point in time. Accordingly, the path models and indirect associations should be interpreted as patterns of shared and unique variance, not as evidence of mediation, temporal sequencing, or causal pathways. Loneliness is a dynamic experience that can emerge, persist and diminish depending on life circumstances and social context. Longitudinal research examining the risk and protective factors into loneliness in older adults is required to identify the trajectory of loneliness across development, maintenance, and potential recovery phases.

Conclusion

In summary, the findings provide partial support for the Cacioppo and Hawkley (2009) model of loneliness in older adults when interpreted as a cross-sectional associational structure. Hypervigilance, cognitive bias, behavioural confirmation, negative interactions, negative affect, and loneliness were interrelated in theoretically consistent ways; however, social network quality and strength emerged as central associational variables. In particular, stronger family and friendship networks were associated with lower loneliness and accounted for substantial shared and unique variance in loneliness. These findings highlight the importance of meaningful social connection in later life, while underscoring the need for longitudinal research to clarify the temporal and potentially reciprocal relationships among cognitive, affective, behavioural, and social network factors.

Declarations

Declarations of conflicting interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding statement

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Ethical approval and informed consent statements

This study was approved by the University of the Sunshine Coast Human Research Ethics Committee (approval no. S242029) on November 7, 2024. All participants provided fully informed written consent to the collection and use of their deidentified data in any publications arising from this study.

Data availability

The data that support the findings of this study are available from the corresponding author (MJS), upon reasonable request.

Author Contribution

S.W.: conception and design of the project or output; acquisition of research data where the acquisition has required; significant intellectual judgement, planning, design, or input; contribution of knowledge; analysis or interpretation of research data; drafting significant parts of the research output. H.H.: analysis or interpretation of research data; critically revising significant parts of the research output so as to contribute to its interpretation. M.S.: conception and design of the project or output; acquisition of research data where the acquisition has required; significant intellectual judgement, planning, design, or input; contribution of knowledge; analysis or interpretation of research data; critically revising significant parts of the research output so as to contribute to its interpretation.

References

1. Andrew MK, Rockwood K (2010) Social vulnerability predicts cognitive decline in a prospective cohort of older Canadians. *Alzheimer's Dement* 6(4):319–325. <https://doi.org/https://doi.org/10.1016/j.jalz.2009.11.001>
2. Ausín B, Muñoz M, Martín T, Pérez-Santos E, Castellanos MÁ (2019) Confirmatory factor analysis of the Revised UCLA Loneliness Scale (UCLA LS-R) in individuals over 65. *Aging Ment Health* 23(3):345–351. <https://doi.org/10.1080/13607863.2017.1423036>
3. Aylaz R, Aktürk Ü, Erci B, Öztürk H, Aslan H (2012) Relationship between depression and loneliness in elderly and examination of influential factors. *Arch Gerontol Geriatr* 55(3):548–554. <https://doi.org/https://doi.org/10.1016/j.archger.2012.03.006>
4. Bangee M, Harris RA, Bridges N, Rotenberg KJ, Qualter P (2014) Loneliness and attention to social threat in young adults: Findings from an eye tracker study. *Pers Individ Differ* 63:16–23. <https://doi.org/https://doi.org/10.1016/j.paid.2014.01.039>
5. Baumeister RF, Leary MR (1995) The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychol Bull* 117(3):497–529. <https://doi.org/10.1037/0033-2909.117.3.497>
6. Beard C, Björgvinsson T (2014) Beyond generalized anxiety disorder: Psychometric properties of the GAD-7 in a heterogeneous psychiatric sample. *J Anxiety Disord* 28(6):547–552. <https://doi.org/https://doi.org/10.1016/j.janxdis.2014.06.002>
7. Beck AT (1991) Cognitive therapy: A 30-year retrospective. *Am Psychol* 46(4):368–375. <https://doi.org/10.1037/0003-066X.46.4.368>
8. Bernstein RE, Delker BC, Knight JA, Freyd JJ (2015) Hypervigilance in college students: Associations with betrayal and dissociation and psychometric properties in a Brief Hypervigilance Scale. *Psychol Trauma* 7(5):448–455. <https://doi.org/10.1037/tra0000070>
9. Byrne BM (2012) *Structural equation modeling with Mplus: Basic concepts, applications, and programming* (1st ed.). Routledge. <https://doi.org/10.4324/9780203807644>
10. Cacioppo JT, Hawkley LC (2009) Perceived social isolation and cognition. *Trends Cogn Sci* 13(10):447–454. <https://doi.org/https://doi.org/10.1016/j.tics.2009.06.005>
11. Cacioppo JT, Hawkley LC, Ernst JM, Burleson M, Berntson GG, Nouriani B, Spiegel D (2006) Loneliness within a nomological net: An evolutionary perspective. *J Res Pers* 40(6):1054–1085. <https://doi.org/https://doi.org/10.1016/j.jrp.2005.11.007>
12. Cacioppo JT, Norris CJ, Decety J, Monteleone G, Nusbaum H (2009) In the eye of the beholder: Individual differences in perceived social isolation predict regional brain activation to social stimuli. *J Cogn Neurosci* 21(1):83–92. <https://doi.org/10.1162/jocn.2009.21007>
13. Cacioppo S, Balogh S, Cacioppo JT (2015) Implicit attention to negative social, in contrast to nonsocial, words in the Stroop task differs between individuals high and low in loneliness: Evidence from event-related brain microstates. *Cortex* 70:213–233. <https://doi.org/https://doi.org/10.1016/j.cortex.2015.05.032>
14. Cacioppo S, Capitanio JP, Cacioppo JT (2014) Toward a neurology of loneliness. *Psychol Bull* 140(6):1464–1504. <https://doi.org/10.1037/a0037618>
15. Cacioppo S, Grippo AJ, London S, Goossens L, Cacioppo JT (2015) Loneliness: Clinical import and interventions. *Perspect Psychol Sci* 10(2):238–249. <https://doi.org/10.1177/1745691615570616>
16. Cohen J (1988) *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge. <https://doi.org/10.4324/9780203771587>

17. Domènech-Abella J, Mundó J, Haro JM, Rubio-Valera M (2019) Anxiety, depression, loneliness and social network in the elderly: Longitudinal associations from The Irish Longitudinal Study on Ageing (TILDA). *J Affect Disord* 246:82–88. <https://doi.org/https://doi.org/10.1016/j.jad.2018.12.043>
18. Duke D, Krishnan M, Faith M, Storch EA (2006) The psychometric properties of the Brief Fear of Negative Evaluation Scale. *J Anxiety Disord* 20(6):807–817. <https://doi.org/10.1016/j.janxdis.2005.11.002>
19. Hair JF, Black WC, Babin BJ, Anderson RE (2019) *Multivariate data analysis*, 8th edn. Cengage Learning
20. Hawkey LC, Hughes ME, Waite LJ, Masi CM, Thisted RA, Cacioppo JT (2008) From social structural factors to perceptions of relationship quality and loneliness: The Chicago Health, Aging, and Social Relations Study. *Journals Gerontology: Ser B Psychol Sci Social Sci* 63(6):S375–S384. <https://doi.org/10.1093/geronb/63.6.S375>
21. Holmes-Smith P, Coote L, Cunningham E (2006) *Structural Equation Modeling: From the Fundamentals to Advanced Topics*. School Research, Evaluation and Measurement Services. <https://books.google.com.au/books?id=zzc2twAACAAJ>
22. Holt-Lunstad J (2024) Social connection as a critical factor for mental and physical health: evidence, trends, challenges, and future implications. *World Psychiatry* 23(3):312–332. <https://doi.org/https://doi.org/10.1002/wps.21224>
23. Kline RB (2016) *Principles and practice of structural equation modelling*, 4th edn. Guilford Press
24. Krause N (1995) Negative interaction and satisfaction with social support among older adults. *Journals Gerontology: Ser B Psychol Sci Social Sci* 50(2):P59–73. <https://doi.org/10.1093/geronb/50b.2.p59>
25. Kroenke K, Spitzer RL, Williams JB (2001) The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med* 16(9):606–613. <https://doi.org/10.1046/j.1525-1497.2001.016009606.x>
26. Kuru Alici N, Kalanlar B (2021) Validity and reliability of the Lubben Social Network Scale-Revised (LSNS-R) on older adults in Turkey. *Curr Psychol* 40(1):21–28. <https://doi.org/10.1007/s12144-020-01125-0>
27. Lau S, Gruen GE (1992) The social stigma of loneliness: Effect of target person's and perceiver's sex. *Pers Soc Psychol Bull* 18(2):182–189. <https://doi.org/10.1177/0146167292182009>
28. Lee SL, Pearce E, Ajnakina O, Johnson S, Lewis G, Mann F, Lewis G (2021) The association between loneliness and depressive symptoms among adults aged 50 years and older: a 12-year population-based cohort study. *Lancet Psychiatry* 8(1):48–57. [https://doi.org/https://doi.org/10.1016/S2215-0366\(20\)30383-7](https://doi.org/https://doi.org/10.1016/S2215-0366(20)30383-7)
29. Lim MH (2018) One in four Australians are lonely, which affects their physical and mental health. *The Conversation*. <https://theconversation.com/one-in-four-australians-are-lonely-which-affects-their-physical-and-mental-health-106231>
30. Lodder GMA, Scholte RHJ, Clemens IAH, Engels RCME, Goossens L, Verhagen M (2015) Loneliness and hypervigilance to social cues in females: An eye-tracking study. *PLoS ONE* 10(4):e0125141. <https://doi.org/10.1371/journal.pone.0125141>
31. Lubben JE, Gironde MW (2003) Centrality of social ties to the health and well-being of older adults. In: Berkman B, Harootyan LK (eds) *Social Work and Health Care in an Ageing World*. Springer, pp 319–350
32. McDonald RP, Ho M-HR (2002) Principles and practice in reporting structural equation analyses. *Psychol Methods* 7(1):64–82. <https://doi.org/10.1037/1082-989X.7.1.64>
33. Ogrin R, Cyarto EV, Harrington KD, Haslam C, Lim MH, Golenko X, Lowthian JA (2021) Loneliness in older age: What is it, why is it happening and what should we do about it in Australia? *Australas J Ageing* 40(2):202–207. <https://doi.org/https://doi.org/10.1111/ajag.12929>
34. Patel T, Mansell W, Veale D (2015) The Cognitive Behavioural Processes Questionnaire: A preliminary analysis within student, mixed clinical and community samples and the identification of a core transdiagnostic process. *Cogn Therapy Res* 39(2):193–203. <https://doi.org/10.1007/s10608-014-9641-9>
35. Pfeifer J, de Winter J, Dodou D, Eisma YB (2025) Loneliness, personality, and attention to AI-generated images depicting social threat: An eye-tracking study. *Pers Individ Differ* 247:113415. <https://doi.org/https://doi.org/10.1016/j.paid.2025.113415>
36. Phelan E, Williams B, Meeker K, Bonn K, Frederick J, Legerfo J, Snowden M (2010) A study of the diagnostic accuracy of the PHQ-9 in primary care elderly. *BMC Fam Pract* 11:63. <https://doi.org/10.1186/1471-2296-11-63>
37. Pickett CL, Gardner WL, Knowles M (2004) Getting a cue: The need to belong and enhanced sensitivity to social cues. *Pers Soc Psychol Bull* 30(9):1095–1107. <https://doi.org/10.1177/0146167203262085>
38. Pinquart M, Sörensen S (2003) Risk factors for loneliness in adulthood and old age -a meta-analysis. *Advances in Psychology Research*, vol 19. Nova Science, pp 111–143
39. Rotenberg KJ, Gruman JA, Ariganello M (2002) Behavioral confirmation of the loneliness stereotype. *Basic Appl Soc Psychol* 24(2):81–89. https://doi.org/10.1207/S15324834BASP2402_1
40. Routasalo PE, Savikko N, Tilvis RS, Strandberg TE, Pitkälä KH (2006) Social contacts and their relationship to loneliness among aged people - a population-based study. *Gerontology* 52(3):181–187. <https://doi.org/10.1159/000091828>
41. Russell D, Peplau LA, Cutrona CE (1980) The revised UCLA Loneliness Scale: Concurrent and discriminant validity evidence. *J Personal Soc Psychol* 39(3):472–480. <https://doi.org/10.1037/0022-3514.39.3.472>

42. Samtani S, Mahalingam G, Lam BCP, Lipnicki DM, Lima-Costa MF, Blay SL, Brodaty H (2022) Associations between social connections and cognition: A global collaborative individual participant data meta-analysis. *Lancet Healthy Longev* 3(11):e740–e753. [https://doi.org/https://doi.org/10.1016/S2666-7568\(22\)00199-4](https://doi.org/https://doi.org/10.1016/S2666-7568(22)00199-4)
43. Schaie KW (2000) The impact of longitudinal studies on understanding development from young adulthood to old age. *Int J Behav Dev* 24(3):257–266. <https://doi.org/10.1080/01650250050118231>
44. Seemann A (2022) The psychological structure of loneliness. *Int J Environ Res Public Health* 19(3):1061. <https://doi.org/10.3390/ijerph19031061>
45. Seligman MEP (1972) Learned helplessness. *Annual Review of Medicine*, 23(Volume 23, 1972), 407–412. <https://doi.org/https://doi.org/10.1146/annurev.me.23.020172.002203>
46. Shankar A, Hamer M, McMunn A, Steptoe A (2013) Social isolation and loneliness: relationships with cognitive function during 4 years of follow-up in the English Longitudinal Study of Ageing. *Psychosom Med* 75(2):161–170. <https://doi.org/10.1097/PSY.0b013e31827f09cd>
47. Shiovitz-Ezra S, Ayalon L (2010) Situational versus chronic loneliness as risk factors for all-cause mortality. *Int Psychogeriatr* 22(3):455–462. <https://doi.org/https://doi.org/10.1017/S1041610209991426>
48. Spitzer RL, Kroenke K, Williams JBW, the Patient Health Questionnaire Primary Care Study Group (1999) Validation and utility of a self-report version of PRIME-MD: The PHQ primary care study. *JAMA* 282(18):1737–1744. <https://doi.org/10.1001/jama.282.18.1737>
49. Spitzer RL, Kroenke K, Williams JBW, Löwe B (2006) A brief measure for assessing Generalized Anxiety Disorder: The GAD-7. *Arch Intern Med* 166(10):1092–1097. <https://doi.org/10.1001/archinte.166.10.1092>
50. Susanty S, Nadirawati N, Setiawan A, Haroen H, Pebrianti S, Harun H, Banda KJ (2025) Overview of the prevalence of loneliness and associated risk factors among older adults across six continents: A meta-analysis. *Arch Gerontol Geriatr* 128:105627. <https://doi.org/https://doi.org/10.1016/j.archger.2024.105627>
51. Watson J, Nesdale D (2012) Rejection sensitivity, social withdrawal, and loneliness in young adults. *J Appl Soc Psychol* 42(8):1984–2005. <https://doi.org/10.1111/j.1559-1816.2012.00927.x> <https://doi.org/>
52. Weems CF (2025) An alternative framework for nonexperimental cross-sectional mediation studies: Associational variable analysis. *Psychological Methods*, advance online. <https://doi.org/10.1037/met0000774>

Figures

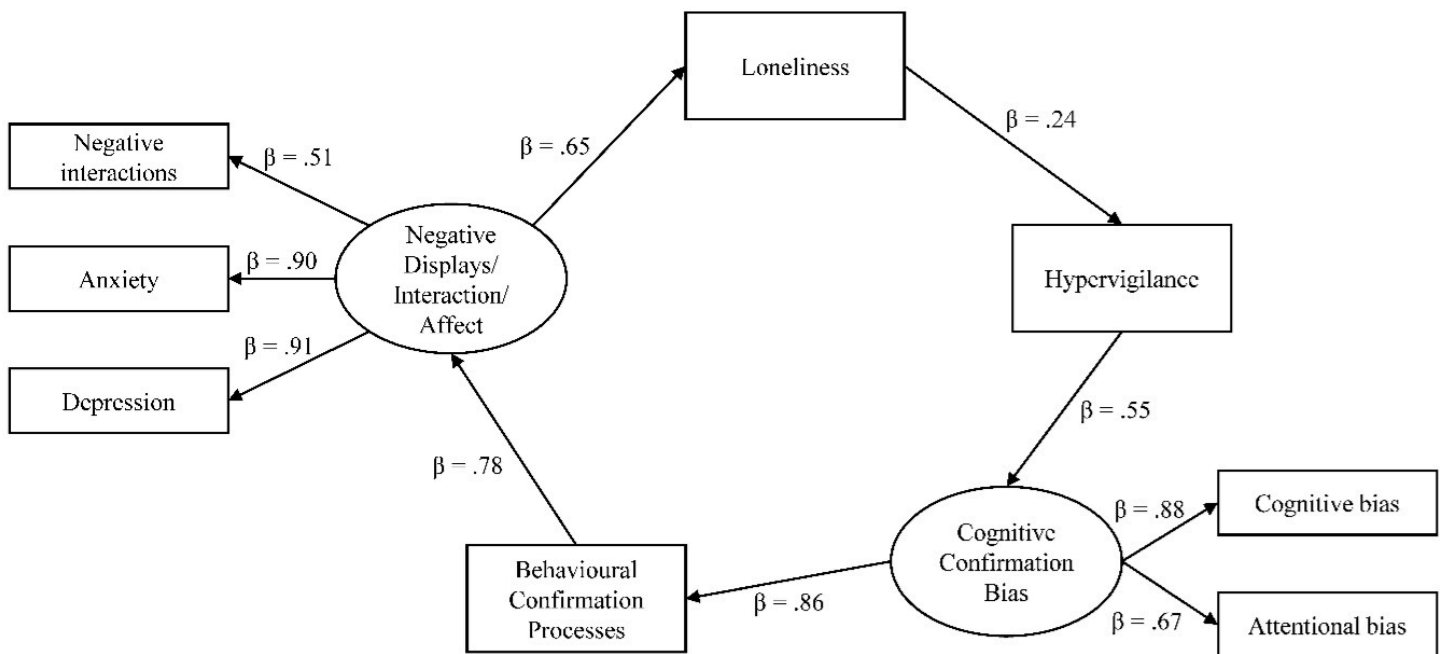


Figure 1

Baseline theory-derived associational model linking loneliness, hypervigilance, cognitive confirmation bias, behavioural confirmation bias, and negative displays/interactions/affect. Values are standardised path coefficients. Error terms and residual variances are omitted for clarity.

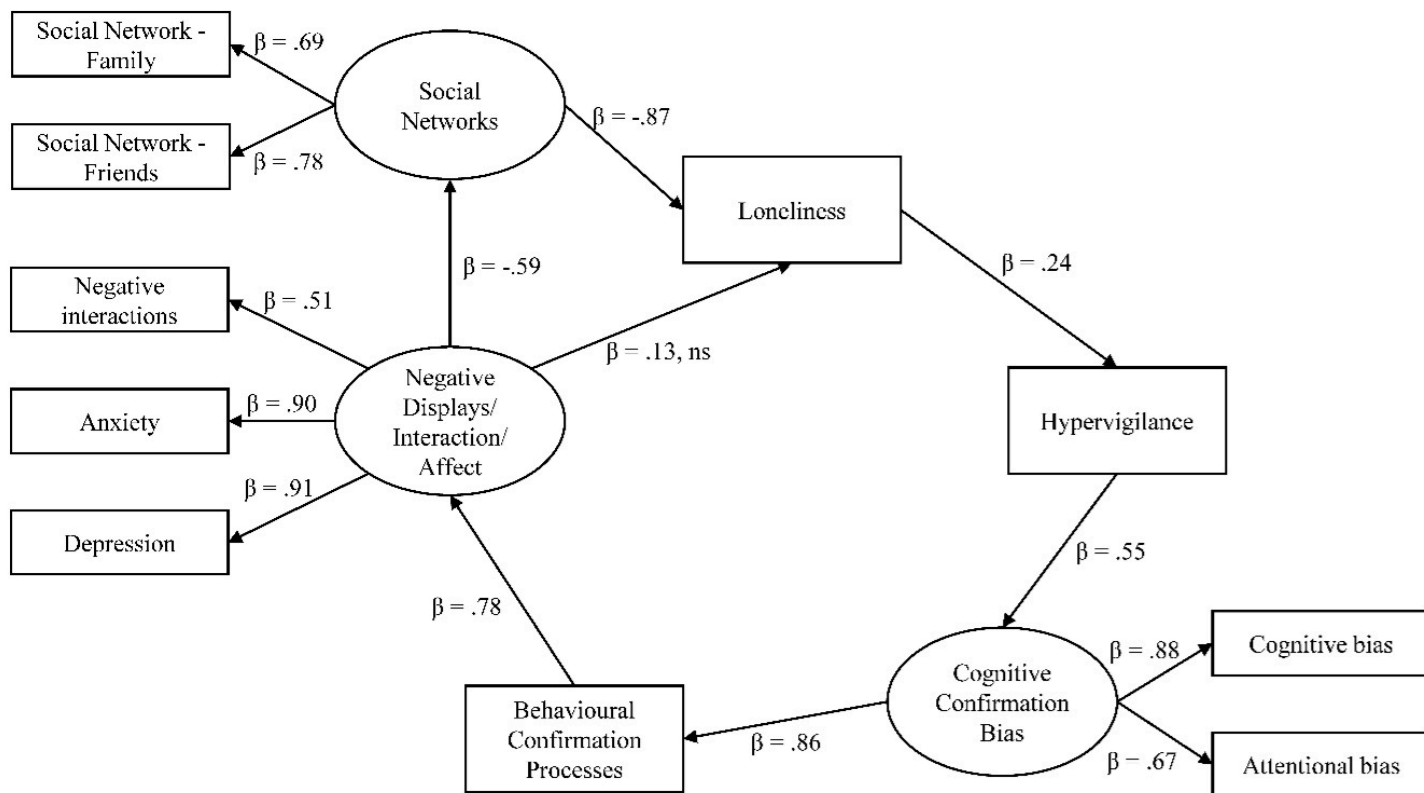


Figure 2

Theory-derived AVA model with social networks included as an associational variable linking negative displays/interactions/affect and loneliness. Values are standardised path coefficients. Error terms and residual variances are omitted for clarity. The negative displays/interactions/affect → loneliness path was non-significant

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryTable1.docx](#)