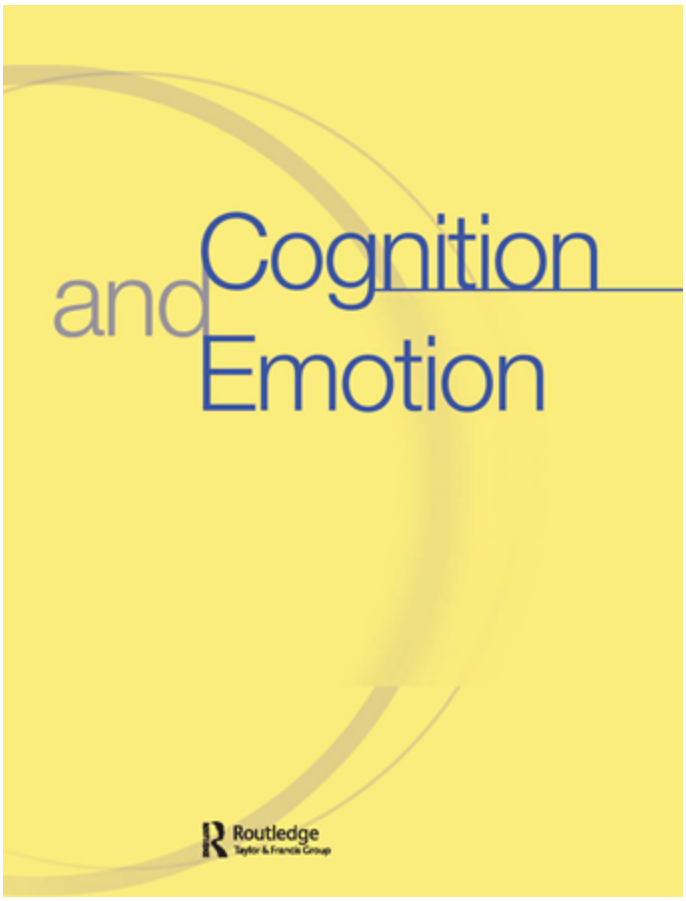


The Loneliness Paradox: A Scoping Review of Cognitive Biases in Loneliness

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The Loneliness Paradox: A Scoping Review of Cognitive Biases in Loneliness

Ceyda Kiyak[1,2*], S. Gareth Edwards[1], Sara L. Bengtsson[1]
[1]School of Psychology, University of East Anglia, Norwich, UK
[2]Department of Psychology, University of Southern Denmark, Esbjerg, Denmark

***Corresponding author:** Ceyda Kiyak, Department of Psychology, University of Southern Denmark, Esbjerg, Denmark. Email: ckiyak@health.sdu.dk
ORCID: Ceyda Kiyak 0000-0002-9218-2248

Abstract

Loneliness motivates reconnection, yet paradoxically fosters hypervigilance to negative social cues and cognitive biases that may serve self-protection. This scoping review mapped studies of three biases, attention, interpretation and approach–avoidance, through the lens of Social Information Processing theory, to identify patterns and methodological gaps. Searches of PsycINFO, MEDLINE, Scopus and Web of Science identified 50 studies using behavioural, eye-tracking, psychophysiological, self-report and neural measures. Findings depended on how each bias was measured. Behavioural evidence for attention bias towards negative social cues was mixed, whereas neural studies more consistently showed heightened responses to such cues. Interpretation bias was the most consistent finding: lonely individuals interpreted ambiguous social cues as hostile or rejecting. Evidence on approach–avoidance bias was limited but theoretically informative: situational loneliness was linked to approach and chronic loneliness to avoidance. Because almost all studies were cross-sectional, they reflect between-person differences rather than the within-person processes that evolutionary accounts describe. Future research needs within-person and experimental designs, reliable bias measures, more studies of children and adolescents, and a clearer distinction between situational and chronic loneliness.

Keywords: loneliness; cognitive bias; attention bias; interpretation bias; approach–avoidance

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1. Introduction

Loneliness emerges when there is a subjective discrepancy between desired and perceived interpersonal relationships in terms of both quality and quantity (Peplau & Perlman, 1982). It may be situational or chronic, varying in frequency and intensity (Shiovitz-Ezra & Ayalon, 2010). While transient situational loneliness can motivate people to reconnect, chronic loneliness can lead to adverse psychological and physical health outcomes, including increased morbidity and mortality (Jensen et al., 2025).

1.1. Evolutionary theory of loneliness

The Evolutionary Theory of Loneliness (Cacioppo et al., 2006; Cacioppo & Hawkley, 2009) proposes that loneliness is an aversive signal shaped by evolutionary pressure which, like hunger, thirst and pain, evolved for an organism to change its behaviour for survival. However, this adaptive mechanism simultaneously increases hypervigilance to negative emotional, social and environmental cues; although originally self-protective, this hypervigilance can paradoxically intensify fear of social interaction and, over time, become maladaptive (Cacioppo et al., 2014).

Specifically, loneliness promotes a confirmatory bias towards perceiving social threats through attention, interpretation and memory biases (Cacioppo et al., 2014). These biases lead to negative expectations, which shape behaviour through more negative displays such as withdrawing or avoiding social interaction; this in turn reinforces the behavioural confirmation process (Spithoven et al., 2017), creating a self-reinforcing loop that perpetuates loneliness.

1.2. Cognitive biases and social information processing in loneliness

In the broadest sense, cognitive biases are systematic, non-random deviations in information processing, in which some kinds of information are prioritised over others at the

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stages of attention, interpretation, memory or action (Haselton et al., 2005). In emotion and psychopathology research, the term more specifically refers a relative processing preference for emotionally or motivationally relevant information, typically threat, over neutral or positive information (Mathews & MacLeod, 2005). Applied to loneliness, cognitive biases are systematic differences in the processing of social and emotional information, that is, in what is attended to, how ambiguous information is interpreted, and whether social stimuli are approached or avoided, which may reinforce negative social expectations (Spithoven et al., 2017). This definition is process-based where it covers biases measured as responses to specific social stimuli or situations, but not global self-reported attitudes or beliefs about others (e.g., generalised trust questionnaires). Qualter et al. (2015) examined loneliness through the Reaffiliation Motive (RAM) process, and identified hypervigilance as a critical stage at which chronic loneliness reinforces negative biases and social withdrawal.

Loneliness is associated with structural and functional alterations in brain regions supporting emotion, social processing and reward (Lam et al., 2021). Task-based fMRI and EEG/ERP studies show altered responses to social and emotional stimuli, including earlier or heightened responses to negative social cues (Cacioppo et al., 2009, 2015, 2016), and a meta-analysis of task-based neuroimaging studies points to altered recruitment of cognitive-control regions during emotion processing in loneliness (Wong et al., 2022). Structural MRI and voxel-based morphometry studies link loneliness to grey-matter differences in regions supporting social perception, such as the posterior superior temporal sulcus (Kanai et al., 2012; Lam et al., 2021). Resting-state fMRI shows altered intrinsic connectivity within and between networks associated with tonic alertness, attention and executive control (Layden et al., 2017). Neurocomputational accounts suggest that these alterations bias how lonely individuals learn about and form expectations of others, with a heightened sensitivity to negative information (Arioli et al., 2026; Bellucci et al., 2026).

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Correspondingly, Spithoven et al. (2017) suggested that this maladaptive processing can be understood through the Social Information Processing model (SIP; Crick & Dodge, 1994). In this model, social cognition is shaped by a series of steps: (1) attention to and decoding of cues; (2) interpretation of the cues; (3) goal-driven response selection; and (4) behavioural enactment. Lonely individuals deploy biased processing across all these stages, particularly interpreting social cues negatively, expecting rejection, and engaging in self-defeating behaviours.

Because the SIP model was formulated to explain children's social adjustment (Crick & Dodge, 1994), and both loneliness and attentional control change with age (Field & Lester, 2010; Qualter et al., 2015), loneliness-related biases may be expressed differently in children, adolescents and adults; we therefore map the evidence separately for these groups.

Together, these accounts suggest that loneliness involves neurobiological and cognitive processes that perpetuate social cognitive biases and withdrawal. Yet the studies testing these predictions are scattered across paradigms, measurement modalities and age groups, and have not been systematically mapped through this unified lens.

We adapted the evolutionary model of Cacioppo and Hawkley (2009), which included attentional, confirmatory and memory biases, to focus on attention, interpretation and approach–avoidance biases in the light of SIP (Figure 1).

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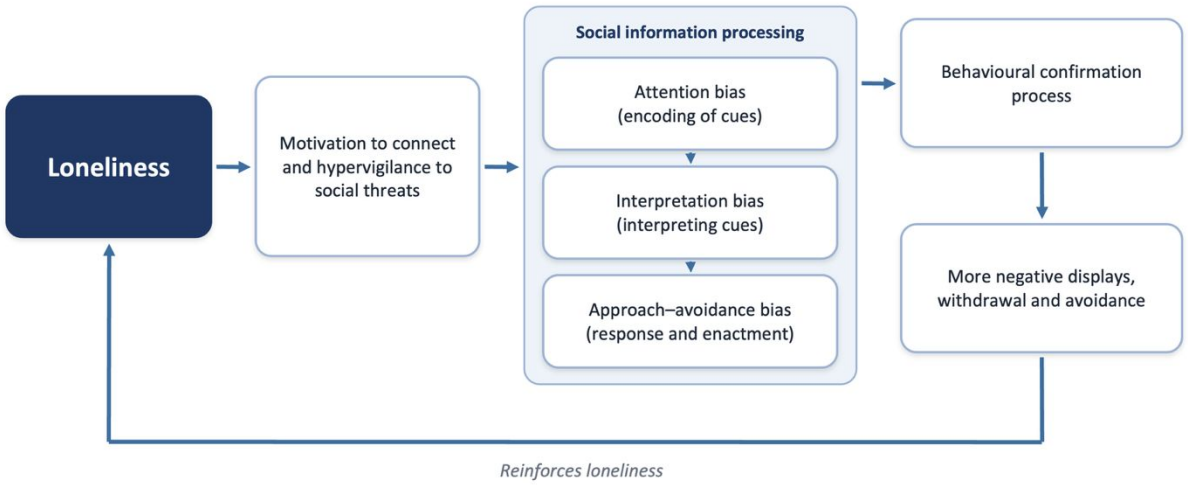


Figure 1. The self-reinforcing cycle of loneliness mapped onto the stages of social information processing (adapted and extended from Cacioppo & Hawkley, 2009, and Crick & Dodge, 1994).

Note. Loneliness increases both the motivation to reconnect and hypervigilance to social threat. Within social information processing, this is expressed as attention bias when social cues are encoded, interpretation bias when they are interpreted, and approach–avoidance bias at the stage of response selection and enactment. The resulting behaviour tends to elicit negative responses from others (behavioural confirmation), prompting more negative displays, withdrawal and avoidance, which in turn reinforce loneliness. The original model (Cacioppo & Hawkley, 2009) included attention, confirmatory and memory biases; here it is restricted to the three biases examined in this review.

1.2.1. Attention bias: It refers to the selective allocation of attention to certain stimuli (Cacioppo et al., 2015). In loneliness, it often manifests as a tendency to focus more quickly, or with longer fixations, on negative social information, and has been linked to amygdala hyperactivity and prefrontal dysfunction (Lam et al., 2021).

1.2.2. Interpretation bias: While attention bias determines what people focus on, interpretation bias concerns how social and emotional information is construed. In loneliness this often includes a tendency to interpret ambiguous or neutral cues negatively (Lau et al., 2021). Lonely individuals are prone to misinterpret ambiguous cues as rejection or social threat (Nombro et al., 2022; Kiyak et al., 2024).

1.2.3. Approach-avoidance bias (AAB): AAB is characterised by altered automatic behaviours towards social stimuli (Loijen et al., 2020). Gable and Gosnell (2013) proposed that sensitivity to social reward and threat shapes approach motives (e.g., “to make friends”) and avoidance motives (e.g., “to not be lonely”), which in turn shape relationship outcomes such

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as loneliness. AAB is therefore important for understanding the paradoxical behaviour of lonely individuals, who simultaneously desire connection yet withdraw due to hypervigilance to social threat (Cacioppo & Hawkley, 2009).

No review has yet mapped this evidence through the SIP lens. We map studies of cognitive biases in loneliness using behavioural, eye-tracking, psychophysiological, self-report and neuroimaging methods, with the following aims:

i. Map the landscape of studies investigating attention, interpretation, and approach–avoidance biases in loneliness through the lens of social information processing,
ii. Identify and characterise the key methodological approaches, including designs, experimental paradigms, measurement modalities, and study populations,
iii. Identify research gaps (e.g., theoretical, methodological, empirical, population, conceptual) to inform future studies.

RQ: What is currently known about *attention, interpretation* and *approach-avoidance* biases in loneliness through the lens of Social Information Processing across the empirical literature?

2. Methods

2.1. *Study design*

This scoping review followed the methodological framework of Arksey and O'Malley (2005), as advanced by Levac et al. (2010), and is reported in accordance with the PRISMA-ScR (Tricco et al., 2018). Consistent with scoping-review methodology, the aim was to map the evidence, and no formal quality appraisal was undertaken. The review protocol was preregistered on the Open Science Framework (OSF view only link; https://osf.io/2g6dh/overview?view_only=817344180ec348979e71ad9119fc364e).

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2.2. Eligibility criteria

Studies were included based on the following eligibility criteria:

i. Loneliness was measured with a validated scale and analysed as a primary or secondary variable, provided that a loneliness-specific effect on at least one cognitive bias outcome is isolable from the analysis (e.g., as a main effect, unique predictor, or simple effect within an interaction).

ii. Studies must examine at least one of the following aspects of social information processing in relation to loneliness: (a) attention bias: selective allocation of attention towards or away from social stimuli, indexed by behavioural measures (e.g., RT, fixation duration) and/or neural measures (e.g., activation or structural indices); (b) interpretation bias: systematic tendencies in how ambiguous, emotional or social information is decoded, evaluated, or attributed, such as decoding accuracy, hostile attribution, social judgments, and asymmetric weighting of positive versus negative social feedback; (c) approach–avoidance bias: behavioural tendencies to approach or withdraw from social stimuli or targets, including conditioned approach–avoidance responses and/or regulation of interpersonal distance.

iii. Studies (experimental, quasi-experimental, cross-sectional, or longitudinal) employing at least one of the following: computerised or paper-based performance tasks; eye-tracking; psychophysiological recording (e.g., ECG/HRV); neurocognitive measures (e.g., EEG/ERP, MRI, fMRI); or validated self-report measures of the target bias that present specific stimuli or situations.

iv. Paradigms or tasks using visual (e.g., static images, videos), auditory (e.g., voices), or linguistic stimuli (e.g., words, scenario vignettes) and/or social-interaction paradigms, presented in laboratory, online, or paper-based formats.

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v. Community, student and general-population samples were eligible, as were clinical samples, provided that the loneliness-specific effect on the bias outcome could be isolated, either because the loneliness effect was estimated within the clinical sample or because comorbid symptoms (e.g., depression, social anxiety) were statistically controlled. Sample type (non-clinical vs clinical) was charted for every study; four of the 50 included studies used clinical samples (Cheeta et al., 2021; Lee et al., 2022; McKenna et al., 2025; Yoo-Jeong et al., 2025).

vi. Published in peer-reviewed journals in English.

2.3. *Literature search strategy*

A comprehensive search was conducted across PsycINFO (via OVID), MEDLINE (via OVID), Scopus, and Web of Science using terms for loneliness, cognitive biases, and methods/paradigms (Table 1). In addition, we conducted citation tracking and hand-searched reference lists and online platforms (e.g., ResearchGate, Google). No date limits were applied; each database was searched from its inception to the date of the search. MEDLINE was searched via OVID rather than PubMed because it makes up most of PubMed's content and allowed the same syntax as PsycINFO; non-MEDLINE PubMed records were expected to be captured by Scopus and Web of Science.

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Table 1. Search Strategy: Key Concepts and Search Terms

Key Concepts	Related Keywords and Terms
Loneliness	loneliness OR "social loneliness" OR "emotional loneliness" OR "chronic loneliness" OR "situational loneliness" OR "transient loneliness" OR "state loneliness" OR "trait loneliness" OR "subjective social isolation" OR "perceived social isolation"
Cognitive biases	"cognitive bias" OR "attention bias" OR "attentional bias" OR "interpretation bias" OR "attribution bias" OR "hostile attribution" OR "approach avoidance" OR "social avoidance" OR "hypervigilance" OR "vigilance" OR "rejection sensitivity" OR "social threat" OR "social information processing" OR "social feedback" OR "emotion recognition" OR "facial emotion" OR "emotional processing" OR "face processing" OR "social cognition" OR "interpersonal distance"
Methods/paradigms	"eye tracking" OR "eye-tracking" OR "EEG" OR "fMRI" OR "ERP" OR "ECG" OR "electroencephalography" OR "neuroimaging" OR "psychophysiological" OR "drift diffusion" OR "reaction time" OR "response time" OR "dot probe" OR "Stroop" OR "gaze cue" OR "experimental task" OR "cognitive task" OR "computerised task" OR "computerized task" OR "behavioural experiment" OR "behavioral experiment"

Note. Search terms within each key concept were combined using the Boolean operator "OR"; concepts were combined using "AND." Quotation marks indicate exact-phrase searching.

2.4. Study selection

Initial duplicates were removed using Rayyan (Ouzzani et al., 2016). Titles and abstracts were screened against the eligibility criteria, followed by full-text assessment, with screening conducted independently by two reviewers (CK and SLB) at both stages. A pilot charting of 12 sources was carried out to trial the framework. The initial search was run in December 2024 and updated in August 2026. The study flow is shown in Figure 2.

2.5. Data extraction

Data were charted to capture authors, year, country, bias type, sample size, age group, measures, stimulus materials, measurement methods, design, and key findings (Supplementary Table S1). Charting was performed by the first author (CK) and independently checked by a second (SLB).

2.6. **Data synthesis**

Given substantial heterogeneity in loneliness measures, stimuli, outcome indices, designs and paradigms, findings were synthesised narratively, structured by bias type and,

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within each, by measurement modality. Each study–bias examination was coded for direction of effect (bias present, conditional, null, or reverse; see Table 2) based on the inferential tests reported by the original authors. Because this coding relies on statistical significance, it is sensitive to sample size and cannot distinguish a small, imprecisely estimated effect from a true absence of effect (Meehl, 1990). The resulting counts are therefore used descriptively, to map where evidence has been sought and how consistent it is, not as evidence for or against the existence of an effect.

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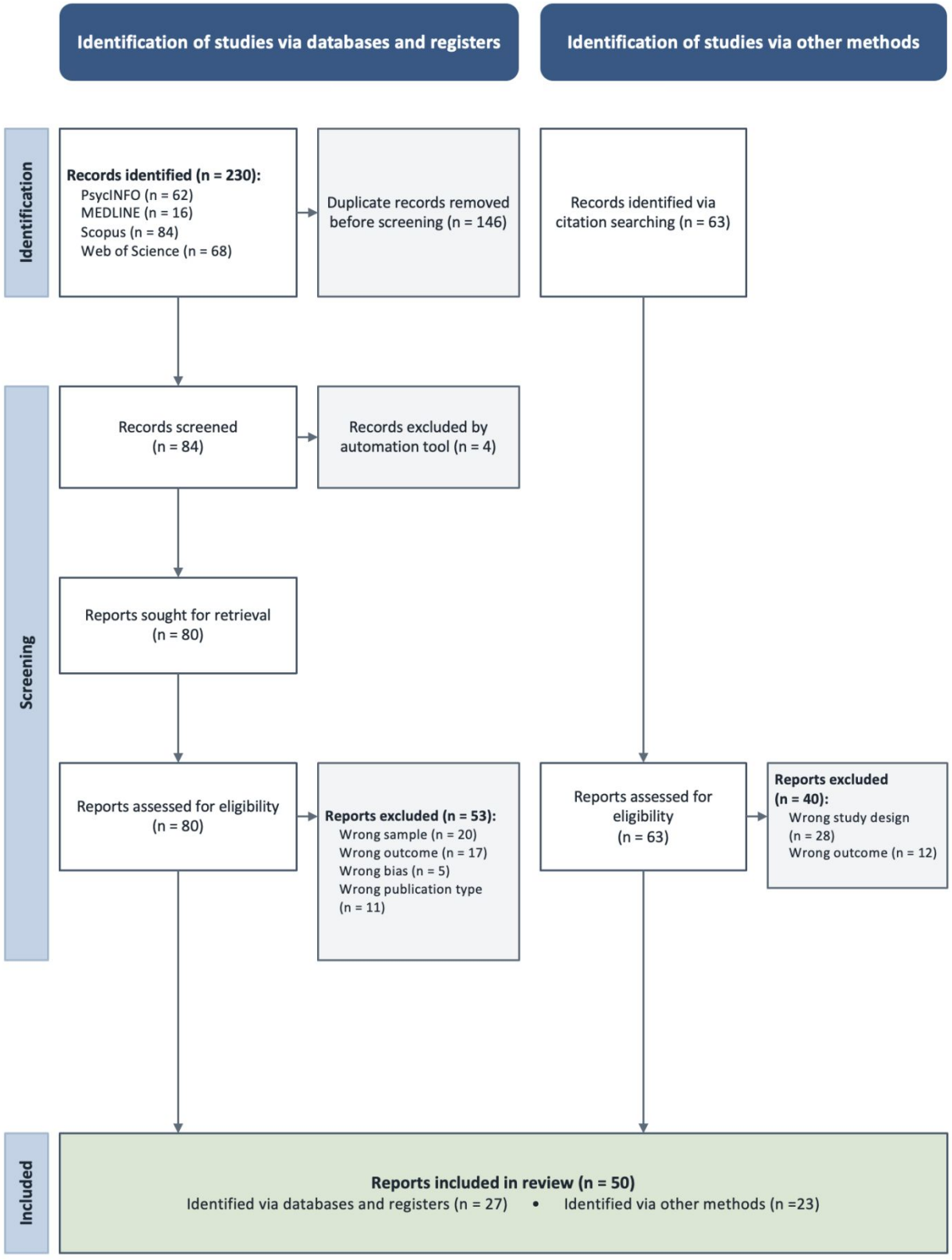


Figure 2. PRISMA flow diagram of study identification, screening, and selection of included reports

3. Results

3.1. Characteristics of the studies

Fifty studies met the inclusion criteria, published between 2001 and 2026. Among them, 27 examined attention bias, 31 interpretation bias and 7 approach–avoidance bias; 15 studies examined more than one bias (Table 2). Sample sizes ranged from 19 (Cacioppo et al., 2016) to 22,054 participants (Pearce et al., 2020), the emotion-recognition sample of the online BBC Loneliness Experiment (total N = 54,060), and spanned children (8–13 years; Qualter et al., 2013) to adults (16–99 years; Pearce et al., 2020) across 15 countries. Measurement methods are summarised in Figure 3. Most studies were cross-sectional and examined between-person associations; few used longitudinal designs (e.g., Lau et al., 2021; McKenna et al., 2025; Rudolph et al., 2025; Smith et al., 2022) and only one experimentally induced loneliness (Grocott et al., 2024). Loneliness was mostly assessed as a trait or chronic construct with multi-item scales, most often the UCLA Loneliness Scale; only three studies also assessed state or situational loneliness (Grocott et al., 2024; Pfeifer et al., 2025; Saporta et al., 2021). Most studies used social stimuli only, and a minority directly contrasted social with non-social material (e.g., Arioli et al., 2025; Cacioppo et al., 2009, 2015, 2016; Lodder et al., 2015; Shin & Kim, 2019). The loneliness measure and stimulus materials of every study are listed in Supplementary Table S1.

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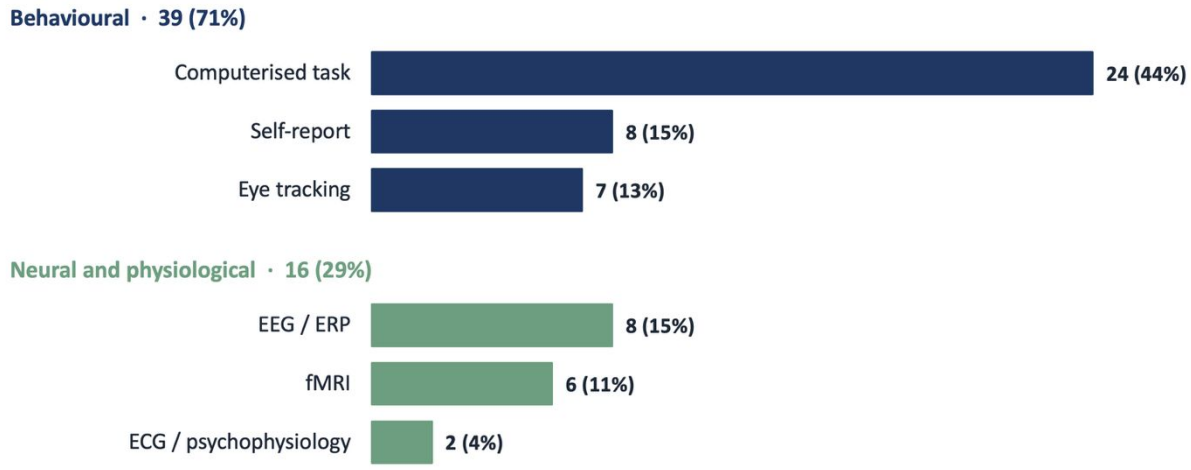


Figure 3. Measurement methods used across the included studies, grouped by type of measure.

Note. Number of studies using each method (N = 50 studies; 55 method applications; studies using more than one method are counted once per method). Percentages are of the 55 applications.

3.2. Narrative results

Because age categorisation was inconsistent across studies, we treated participants aged 18+ as a single adult group and those aged 8–17 years as children and adolescents (Sawyer et al., 2018). We retained this two-group distinction for the developmental reasons outlined in the Introduction. A finer subdivision of the adult group (e.g., a separate older-adult group aged 65+) was considered but not adopted, because few studies sampled older adults exclusively and most adult samples spanned wide age ranges, which would have made assignment to narrower age bands unreliable. Studies spanning the boundary were assigned to the group representing most of their participants (Bangee et al., 2014, and Morningstar et al., 2020, to children and adolescents; Du et al., 2022, and Lodder et al., 2016, to adults). Also, since several paradigms captured overlapping processes, studies were classified by the primary cognitive process rather than technique.

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Table 2. Synthesis of included studies (N = 50) by cognitive bias and direction of effect

Cognitive bias (n)	Bias present	Bias conditional	Null	Reverse bias
Attention (n = 27)	**(14)** Arioli et al. (2025) Bangee et al. (2014) Bangee & Qualter (2018) Cacioppo et al. (2009) † Cacioppo et al. (2015) † Cacioppo et al. (2016) † Du et al. (2022) Grennan et al. (2021) Mąka et al. (2025) † McKenna et al. (2025) † Qualter et al. (2013) † Shin & Kim (2019) Smith et al. (2022) † Vanhalst et al. (2017) †	**(4)** Huc et al. (2026) † Lodder et al. (2016) † Rudolph et al. (2025) Saito et al. (2020)	**(8)** Cheeta et al. (2021) † Lodder et al. (2015) Mąka et al. (2023) Mąka et al. (2026) † Pecchinenda et al. (2026) Pfeifer et al. (2025) Restrepo et al. (2025b) Wei et al. (2020)	**(1)** Kanai et al. (2012) †
Interpretation (n = 31)	**(15)** Edwards et al. (2001) Qualter et al. (2013) † Floyd & Woo (2020) Lau et al. (2021) Lieberz et al. (2021) † Okruszek et al. (2021) Nombro et al. (2022) Bellucci & Park (2023) Skoko et al. (2024) † Mąka et al. (2025) † Restrepo et al. (2025a) Skoko et al. (2025) Vos et al. (2025) Wolters et al. (2025) Yoo-Jeong et al. (2025)	**(6)** Knowles et al. (2015) Lodder et al. (2016) † Morningstar et al. (2020) Cheeta et al. (2021) † Smith et al. (2022) † Huc et al. (2026) †	**(7)** Cacioppo et al. (2015) † Cacioppo et al. (2016) † Grocott et al. (2024) Kanai et al. (2012) † Lee et al. (2022) Pearce et al. (2020) Vanhalst et al. (2017) †	**(3)** Cacioppo et al. (2009) † Lieberz et al. (2022) Mąka et al. (2026) †
Approach–Avoidance (n = 7)	**(5)** Lieberz et al. (2021) † Saporta et al. (2021) Skoko et al. (2024) † McKenna et al. (2025) † Wu et al. (2025)	**(2)** Layden et al. (2018) Smith & Pollak (2022)	—	—
Total	**34**	**12**	**15**	**4**

Note. Studies examining more than one bias (marked †) appear under each relevant bias, with direction coded separately for each. Row ns *count study–bias examinations (65 placements across 50 studies; 15 dual-coded). Bias present = significant bias in the hypothesised direction; Bias conditional = significant but qualified (specific stimuli, timeframes, subgroups, or moderated); Null = no significant association; Reverse bias = significant effect opposite to the hypervigilance/negativity account.* Within each cell, studies are listed alphabetically by first author.

3.2.1. Attention Bias

We categorised attention bias findings by measure, reaction time, eye tracking, and neural activity.

Children and adolescents: 4 studies examined attention bias spanning childhood to late adolescence. Findings point to heightened attentional sensitivity to socially threatening, particularly rejection-related, cues. Lonely children were slower to disengage from rejection-

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themed video scenes, fixating longer than non-lonely peers (Qualter et al., 2013). Bangee et al. (2014) reported the same early vigilance in lonely adolescents, with only the upper quartile fixating more on socially threatening images in the first two seconds. Vanhalst et al. (2017) found lonely adolescents more sensitive to negative facial emotions, detecting sadness and fear at lower morph intensities. At the neural level, Rudolph et al. (2025) found that adolescent girls' neural sensitivity to social threat cues was associated with loneliness and moderated the link between interpersonal stress and later loneliness.

Adults: 23 studies sampled adult populations (17–84 years), showing a complex pattern outlined below by dependent measure; studies reporting more than one class of outcome are discussed in each relevant subsection.

i. Reaction time: 13 adult studies reported RT indices, with mixed findings that hinged on the stimuli. Loneliness was associated with an RT bias in four of the thirteen, and null findings predominated in every stimulus class except the single auditory study.

Static facial emotions: Findings were evenly split. Du et al. (2022) found attention bias to negative faces, with faster reaction times than to neutral and positive faces, whereas Grennan et al. (2021) found the opposite sign, with loneliness associated with reduced processing speed for angry stimuli. Mąka et al. (2025), applying drift diffusion modelling to a dot-probe task, found higher loneliness associated with shorter non-decision times. Cheeta et al. (2021), Mąka et al. (2023) and Pecchinenda et al. (2026) found no reaction-time effects.

Dynamic facial emotions: Neither study found a reaction-time effect of loneliness. Lodder et al. (2016) found no association across morph-based and micro-expression recognition tasks, while Smith et al. (2022) reported that lonely adults identified sadness faster than other emotions.

Social scenes: Neither study yielded bias. Cacioppo et al. (2016), using complex social-threat scenes, found no behavioural evidence of attention bias, although the neural data

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diverged (see section iii). In Wei et al. (2020), loneliness acted as a proxy for anxiety rather than a moderator, and the attentional bias effect dropped out once loneliness was entered.

Verbal and auditory stimuli: Neither verbal study found an effect on reaction times. Restrepo et al. (2025b) found no Stroop interference for negative social words across four pooled datasets, and Arioli et al. (2025) found faster responses to socially negative than individually negative words, but this vanished once loneliness was controlled. In the only auditory study, Shin and Kim (2019) found lonely adults showed greater Stroop interference from negative vocal tone, more so for social than non-social words.

ii. Eye tracking: Eight adult studies used eye-tracking paradigms, spanning static faces (n = 3), static complex social scenes (n = 3), and naturalistic interaction video (n = 2). Findings were stimulus-dependent in a systematic way: bias was absent for isolated faces and emerged only with socially contextualised material.

Static facial emotions: No study found a general orienting bias to facial emotion. Lodder et al. (2015) found no evidence of attention bias, and Bangee and Qualter (2018) found no general bias when four expressions were presented simultaneously. In contrast, Saito et al. (2020) found higher loneliness associated with preferential attention toward warm relative to competent faces.

Static social scenes: Results diverged. Bangee and Qualter (2018) found lonely adults oriented more readily to angry faces embedded in a crowd and dwelled longer on social-rejection scenes, with no comparable pull toward physical-threat or positive images. Against this, Lodder et al. (2015) found no effect for IAPS social versus non-social images, and Pfeifer et al. (2025), using AI-generated threat-related images, found no association with state or trait loneliness.

Naturalistic interaction video: Lodder et al. (2015) found no association between loneliness and gaze allocation during real-life interaction clips. Lodder et al. (2016, Study 2), which

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video-coded gaze during a real conversation with an unfamiliar peer, found loneliness associated with increased gaze towards the partner's face, the only positive gaze finding obtained in an interactive setting.

iii. Neural activity: Eleven studies examined attention bias in lonely adults using fMRI, MRI or EEG. Neural evidence was more consistent than behavioural evidence: eight of the eleven reported a neural effect of loneliness. In three of these, Cacioppo et al. (2015, 2016) and Arioli et al. (2025), the neural effect appeared alongside a null behavioural result in the same sample.

Static facial emotions: Findings were mixed. Grennan et al. (2021) and Du et al. (2022) each paired positive behavioural findings with neural evidence, increased theta over attentional-control regions to angry faces, and enhanced early visual responses to negative faces, respectively. Kanai et al. (2012) found reduced grey matter volume in the left posterior superior temporal sulcus (pSTS) in lonely adults. Two studies were null or qualified: Mąka et al. (2023) found no attentional bias to facial emotion in the EEG signal and Huc et al. (2026) found no main effect of loneliness.

Dynamic facial emotions: McKenna et al. (2025) sits at the boundary with approach–avoidance bias: lonely adults showed greater hippocampal activation to faces that withdrew than to those that approached, a response that predicted higher loneliness one year later.

Social scenes: Two of three studies found evidence of neural bias. Cacioppo et al. (2009) found reduced activation in the ventral striatum when viewing pleasant social stimuli compared to pleasant non-social stimuli and greater activation in the bilateral visual cortex in response to unpleasant social stimuli compared to unpleasant non-social stimuli in lonely when compared to less lonely participants. Supporting these findings, Cacioppo et al. (2016) found quicker processing (earlier neural differentiation) for social threat stimuli in lonely adults compared to non-social ones despite no corresponding behavioural reaction-time differences. In contrast,

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Mąka et al. (2026), in a preregistered and comparatively well-powered study, found no heightened early ERPs to negative social stimuli; the only reliable effect was a larger P300 alongside lower self-reported arousal.

Verbal stimuli: Both studies were positive. Cacioppo et al. (2015) found earlier neural differentiation of negative social words in attention-related regions, mirroring their scene-based findings, and Arioli et al. (2025) found that at higher loneliness the differential N450 between socially negative and neutral words was larger, interpreted as heightened hypervigilance.

Summary: Across 27 studies, evidence for attention bias in loneliness was mixed and depended on how attention was measured and which stimuli were used. Reaction-time measures rarely detected a bias (4 of 13 adult studies); eye-tracking detected one only for socially contextualised material; and neural measures detected an effect most often (8 of 11 adult studies), although the largest preregistered study found no heightened early neural responses (Mąka et al., 2026). In children and adolescents, the four available studies point to difficulty disengaging from rejection-related cues. Because reaction-time, eye-tracking and task-based neural bias indices often have modest reliability (see Discussion), null findings in particular should be interpreted with caution.

3.2.2. Interpretation Bias

Children and adolescents: Three studies investigated interpretation bias in this group, with mixed results tracking the material used. Using ambiguous peer-provocation scenarios, Qualter et al. (2013) found lonely children attributed more hostile intent and endorsed more retaliation. Vanhalst et al. (2017) found no bias when the task required accurate recognition of facial emotion, and Morningstar et al. (2020), using vocal emotion, found an emotion-specific pattern rather than blanket negativity. All three used behavioural or self-report measures; no study has examined interpretation bias in this age group with neural or physiological measures.

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Adults: Twenty-eight studies examined how lonely adults interpret emotional and social information. Materials fell into six classes: static facial emotions (n = 10), dynamic facial stimuli (n = 2), ambiguous scenario vignettes (n = 8), complex social scenes (n = 3), verbal stimuli (n = 1), and live interactive paradigms (n = 4). Findings are organised first by behavioural and self-report measures, grouped by material (i), and then by neural and physiological measures (ii).

i. Behavioural and self-report measures

Static facial emotions: Findings were divided. Knowles et al. (2015) reported that lonely adults "choke under social pressure". Across four studies they decoded emotion less accurately than non-lonely adults only when the task was framed as a test of social skills. Floyd and Woo (2020) sought to replicate this framing effect but found loneliness predicted lower Reading-the-Mind-in-the-Eyes accuracy across all framings; the "choking" interaction did not replicate. Mąka et al. (2025), using a vignette-based questionnaire, reported a stronger tendency to interpret others' ambiguous intentions as self-threatening. Pearce et al. (2020) found no overall association between loneliness and emotion recognition; a small choking effect emerged only in the 25–34-year band. Cheeta et al. (2021) found an altered rather than uniformly negative profile: better accuracy for sad, worse for fear faces, and a tendency to mislabel neutral faces as sad, while Yoo-Jeong et al. (2025), in adults living with HIV, found emotional and social loneliness relating to distinct facial-emotion-perception profiles. Four studies were null: Huc et al. (2026) found no significant loneliness effect; Lee et al. (2022), in euthymic bipolar patients, found loneliness unrelated to recognition accuracy within the sample; Kanai et al. (2012) found poorer gaze perception but no broader recognition deficit; and Grocott et al. (2024) found no association between chronic loneliness and negative interpretation.

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Dynamic facial emotions: Both studies were qualified rather than clearly positive. Lodder et al. (2016) found no overall emotion-recognition difference, only a small advantage for anger, while Smith et al. (2022), using dynamic video, found reduced accuracy for anger and sadness alongside more frequent mislabelling as pain.

Ambiguous scenario vignettes: All eight studies found that lonely adults read ambiguous social situations more negatively, as rejecting, hostile, or threatening. Edwards et al. (2001) and Okruszek et al. (2021) reported more rejecting or hostile attributions, and Lau et al. (2021) found more threatening interpretations of ambiguous scenarios, although the effect weakened once depression and anxiety were accounted for. Nombro et al. (2022) linked more negative interpretations specifically to social, rather than romantic or family, loneliness, and Wolters et al. (2025) found a loneliness-specific bias that was most pronounced for scenarios concerning social disconnection. Vos et al. (2025) showed that lonely adults not only formed more negative interpretations of ambiguous social scenarios but were also less willing to revise them in light of disconfirming evidence. Skoko et al. (2025) showed the effect to be robust to how loneliness was operationalised, with frequency, distress, and chronicity each predicting stronger interpretation bias after controlling for depression and social anxiety. Skoko et al. (2024) found the same bias, buffered by self-esteem.

Complex social scenes: No study found interpretation bias in the hypothesised direction, and two showed the opposite pattern. Cacioppo et al. (2009) found lonely adults rated social and non-social emotional stimuli more alike than non-lonely adults, indicating reduced differentiation rather than heightened negativity, and Mąka et al. (2026) similarly found blunted self-reported arousal and reduced perceived reappraisal of negative social content. Cacioppo et al. (2016) found no group difference in explicit unpleasantness ratings despite clear neural differences.

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Live interactive paradigms: Three of four studies found bias. Restrepo et al. (2025a) showed that lonely adults felt more rejected during the ambiguous early rounds of a progressive social-exclusion game. Lieberz et al. (2021) found that lonely adults trusted less in a monetary trust game, and Bellucci and Park (2023) found that higher loneliness predicted more negative trustworthiness expectations and a stronger negativity bias toward dishonest advisers. Lieberz et al. (2022), using the same sample as their 2021 study, ran counter to this pattern: rather than heightened negative appraisal, lonely adults showed blunted nucleus-accumbens responses to negative social feedback.

Verbal stimuli. The single study using verbal material found no interpretation bias: Cacioppo et al. (2015) reported altered neural processing of socially negative words without a corresponding difference in explicit evaluation.

ii. Neural and physiological measures. Six adult studies combined interpretation measures with neural or endocrine indices. Lonely adults showed reduced reward- and insula-related activation and attenuated oxytocin release during trust decisions (Lieberz et al., 2021), blunted nucleus-accumbens responses to negative social feedback (Lieberz et al., 2022), and reduced orbitofrontal activity that statistically mediated more negative trustworthiness expectations (Bellucci & Park, 2023). In the remaining three, neural differences emerged without a corresponding difference in explicit evaluations (Cacioppo et al., 2015, 2016) or alongside blunted self-reported arousal (Mąka et al., 2026).

Summary: Taken together, interpretation bias in loneliness depends on whether a task requires participants to construct meaning from ambiguous social content. Where the material was narrative and genuinely ambiguous, vignettes, live exclusion, trust decisions, bias was near-universal (11 of 12 studies). Where participants instead rated or categorised presented stimuli, findings were mixed at best and reversed at worst. Interpretation bias in loneliness

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therefore looks like a difference in how people reason about social information, not in how they perceive it.

3.2.3. Approach-Avoidance Bias

Seven studies examined approach–avoidance bias. Findings are organised by chronicity of loneliness. No study examined approach–avoidance bias in children or adolescents; all seven sampled adults. Interpersonal-distance preferences were measured behaviourally (Lieberz et al., 2021; Saporta et al., 2021) or by questionnaire (Layden et al., 2018); approach and avoidance tendencies were also indexed by temporal-bisection tasks (Wu et al., 2025), self-report (Skoko et al., 2024), hippocampal activation (McKenna et al., 2025) and an approach task combined with cardiac vagal measures (Smith & Pollak, 2022).

Avoidance under chronic or trait loneliness: Five studies converged on a withdrawal-dominant profile. Saporta et al. (2021) found chronic loneliness predicted a preference for larger interpersonal distance, with lonely adults more avoidant when approached than when approaching. Layden et al. (2018) reported a closely matching effect across two surveys, concentrated within intimate (proximal) space. Lieberz et al. (2021) found lonely adults kept greater physical distance from a real interaction partner. Skoko et al. (2024) added self-reported behavioural avoidance, with self-esteem buffering. McKenna et al. (2025) found greater hippocampal activation to withdrawing than approaching faces, a response that forecast greater loneliness one year later.

Approach under situational or distal conditions: Two studies found the opposite tendency when loneliness was acute, or the response window extended. In the same paradigm that produced avoidance under chronic loneliness, Saporta et al. (2021) found situational, COVID-related loneliness predicted a smaller preferred distance and thus greater approach. Wu et al.

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(2025), across three temporal bisection experiments, found both tendencies simultaneously: proximal social avoidance in the sub-second range but distal approach motivation over longer intervals.

Physiological moderation: Smith and Pollak (2022) found that loneliness alone predicted neither approach nor avoidance; only lonely adults with higher parasympathetic activity (HF-HRV) showed heightened approach toward both rewarding and aversive social cues.

Summary: Approach–avoidance bias has been examined in only seven adult studies, and in none with children or adolescents. Chronic or trait loneliness was consistently linked with avoidance, whereas situational loneliness and longer response windows were linked with approach, and physiological regulation moderated whether loneliness translated into approach. Because the studies used different paradigms and only one compared situational and chronic loneliness within the same sample (Saporta et al., 2021), these conclusions remain provisional.

4. Discussion

This scoping review mapped 50 studies of attention, interpretation and approach–avoidance biases in loneliness. First, the most reliable evidence concerns interpretation bias in which lonely individuals interpret ambiguous social information more negatively, but this bias is specific to tasks that demand inference rather than perception. Second, attention bias is not stable, revealing more consistently in neurophysiological paradigms and depending heavily on the stimulus. Third, approach-avoidance bias is theoretically the most generative despite little evidence, because it reveals meaningful distinctions of the dual nature of loneliness based on its chronicity.

Interpretation bias emerged as the most consistent finding, with lonely adults interpreting ambiguous cues more negatively. This bias was near-universal with 11 of 12 studies involving

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tasks required participants to interpret ambiguous social material such as written vignettes and live social-exclusion or trust paradigms (e.g., Lau et al., 2021; Wolters et al., 2025). In contrast, the same bias did not appear when tasks required participants to recognise and categorise the stimuli (e.g., Floyd & Woo, 2020; Pearce et al., 2020). Studies using complex social scenes reversed the expected bias direction, with lonely adults showing reduced differentiation to negative social stimuli rather than heightened sensitivity (Cacioppo et al., 2009, 2016; Mąka et al., 2026). The bias appeared when a situation left room for interpretation and weakened or reversed when the stimulus already carried a clear meaning. Converging evidence comes from economic trust paradigms. Lonelier individuals hold more negative expectations about others' fairness and trustworthiness (Bellucci, 2020; Bellucci & Park, 2024) and are less willing to rely on expectations of reciprocity (Bellucci et al., 2025), even though they may still choose to trust (Bellucci & Park, 2024), a dissociation between expectation and behaviour that mirrors the loneliness paradox.

Attention bias findings in adults depended on how attention was measured. Behavioural reaction-time studies more often found no effect, with only four of thirteen showing a bias. In eye-tracking, by contrast, the effect was clearly stimulus-dependent: bias was absent for isolated faces but emerged when social cues were embedded in context, such as angry faces in a crowd or social-rejection scenes (Bangee & Qualter, 2018). Two further findings caution against over-interpretation: Wei et al. (2020) showed that an apparent attention-bias effect was better explained as shared variance with anxiety than as a loneliness-specific mechanism, and the preregistered, better-powered null of Mąka et al. (2026) indicates that several earlier positive effects rest on small samples**.** Neural measures were more sensitive. 8 of 11 neural studies detected an effect, sometimes without a behavioural counterpart (e.g., Cacioppo et al., 2016). Consistent with evidence that loneliness-related biases are stronger for social than for non-social emotional cues (Cacioppo et al., 2015), the clearest attentional effects emerged

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when social stimuli were contrasted with non-social material or embedded in a social context (Bangee & Qualter, 2018; Cacioppo et al., 2009, 2016; Shin & Kim, 2019).

Approach–avoidance bias rested on the smallest evidence base (seven studies) yet yielded this review's most theoretically interesting pattern. Chronic or trait loneliness was consistently associated with avoidance (Layden et al., 2018; Lieberz et al., 2021; McKenna et al., 2025; Saporta et al., 2021; Skoko et al., 2024). In contrast, situational loneliness was linked to approach which was particularly informative as it emerged within the same paradigm and sample (Saporta et al., 2021) and over longer response windows (Wu et al., 2025), isolating chronicity, rather than loneliness itself that shapes the direction of the response. Smith and Pollak (2022) provides a possible mechanism for when this shift occurs: only lonely adults with higher parasympathetic (vagal) regulation translated the loneliness signal into approach. This fits the loneliness paradox: a pull towards reconnection alongside a push towards self-protective withdrawal. Because paradigms differed, however, convergence is conceptual rather than psychometric.

Developmentally, the evidence is weak but coherent. Lonely children showed prolonged fixation on, and difficulty disengaging from, negative social cues (Qualter et al., 2013), whereas lonely adolescents oriented to threat equally quickly but disengaged more quickly (Bangee et al., 2014), a contrast consistent with maturing attentional control across adolescence (Field & Lester, 2010). With only a few studies spanning childhood to late adolescence, it remains unclear whether these represent a stable developmental trajectory or paradigm-specific effects. The broad adult category is a further limitation. Adult samples ranged from late adolescence to very old age, and few studies sampled older adults exclusively, so differences within adulthood could not be examined. The one study that compared age bands directly found the effect of social framing on emotion recognition only in adults aged 25–34 (Pearce et al., 2020), suggesting that age moderation within adulthood merits systematic testing.

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Taken together, the three domains cohere around Social Information Processing theory: loneliness appears to bias the interpretive stage most strongly, the attentional stage more weakly and conditionally, and behavioural approach–avoidance in a manner gated by chronicity and physiology. An important qualifier concerns co-occurring symptoms: Lau et al. (2021) found that in chronic loneliness the interpretation bias was better explained by depression and anxiety. Distinguishing loneliness-specific from comorbidity-driven variance is thus a priority.

A more fundamental limitation concerns the level of analysis. The evolutionary theory of loneliness, and its integration with the SIP model, posits within-person processes: elevations in an individual's loneliness relative to their own baseline are expected to heighten reaffiliation motivation and vigilance for social threat. The included studies, however, were predominantly cross-sectional and compared individuals differing in loneliness, thereby estimating between-person rather than within-person associations. Between-person associations are not informative about within-person processes unless strong ergodicity assumptions hold, which are rarely met in psychological data (Fisher et al., 2018; Gomes et al., 2025; Molenaar, 2004; Speelman et al., 2024). The present findings should therefore be read as describing how people who are lonelier than others differ in social information processing, which bears mainly on accounts of chronic or trait loneliness, not as tests of how an increase in loneliness changes processing within a person. The opposite associations of chronic and situational loneliness with interpersonal distance (Saporta et al., 2021) show how conclusions can depend on the level considered. We retained between-person studies because the aim of a scoping review is to map the existing evidence and because they make up almost all of it. We recommend that future research (1) measure loneliness and cognitive biases repeatedly within the same individuals, for example by combining ecological momentary assessment with brief, repeated smartphone-based bias tasks; (2) separate within-person from between-person variance statistically, for example by

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person-mean centring in multilevel models or random-intercept cross-lagged panel models (Hamaker et al., 2015); (3) manipulate loneliness experimentally in within-subject designs (e.g., loneliness inductions; Grocott et al., 2024); and (4) state explicitly whether hypotheses concern between-person or within-person effects.

A second limitation concerns the reliability of the bias measures. Reaction-time bias scores often have poor internal consistency and test–retest reliability (Schmukle, 2005), as do free-viewing eye-tracking indices of attentional bias (Sears et al., 2019) and many task-based fMRI measures (Elliott et al., 2020). Low reliability attenuates observed correlations with loneliness, which may contribute to the many null reaction-time findings and to inconsistencies between studies, and it limits the extent to which such measures can serve as stable trait or state markers. Future studies should report the reliability of every bias index, preferably with permutation-based split-half estimates (Kahveci et al., 2025).

Further, studies varied widely in how loneliness was measured (trait vs state; single-item vs multi-item scales) and bias was operationalised. A small number of reports were non-independent: the two Restrepo et al. (2025a, 2025b) papers share 142 participants and the two Lieberz et al. (2021, 2022) papers analyse the same 82-participant cohort, so these should be weighted as overlapping rather than separate samples. In addition, the direction-of-effect coding relied on the statistical significance of the reported tests. Because significance depends on sample size, an effect of the same magnitude may be coded as present in a large study and as null in a small one, and null results cannot be read as evidence of absence (Meehl, 1990). The counts in Table 2 should therefore be read as a map of the evidence, not as estimates of effect size; future meta-analyses should pool effect sizes with their confidence intervals and, where the aim is to establish the absence of an effect, use equivalence tests against a smallest effect size of interest (Lakens et al., 2018). Finally, only peer-reviewed published studies were eligible, so the evidence base may over-represent positive results and the proportion of null

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findings, particularly for attention bias, may be underestimated; including preprints and unpublished data in future syntheses would reduce this risk.

Clinically, the pattern argues for bias-specific approaches involving interpretation-focused training where ambiguity is central, and interventions that simultaneously raise social motivation and lower avoidance to address the dual approach–avoidance signal, ideally tailored to whether a given person's loneliness is situational or chronic.

5. Conclusion

This scoping review supports a narrower claim than the evolutionary theory of loneliness. Loneliness is most reliably associated with a negative, inflexible interpretation of ambiguous social information, whereas attentional and approach–avoidance effects emerge only conditionally, depending on the level of measurement, on stimulus context, and, most importantly, on the chronicity of loneliness. Future research should prioritise designs that separate within-person from between-person effects (e.g., ecological momentary assessment, experimental loneliness inductions); reliable bias measures, with reliability and effect sizes routinely reported; more studies of approach–avoidance bias and of children and adolescents; ecologically valid, multi-method paradigms such as virtual reality; and a validated measure of situational loneliness so that the chronic–situational distinction can be tested directly. These findings support developing cognitive bias modification (CBM) interventions that target all three biases to disrupt the self-reinforcing cycle of loneliness.

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Author contributions (CRediT)

CK: Conceptualisation, Methodology, Investigation, Validation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing.
SGE: Conceptualisation, Methodology, Supervision, Writing – review & editing.
SLB: Conceptualisation, Methodology, Investigation, Validation, Supervision, Writing – review & editing.

Ethical Approval: This study is a scoping review of previously published literature and did not involve the collection of primary data or human participants. Therefore, ethical approval was not required.

Data Availability: The data that support the findings of this study are available from the corresponding author, CK, upon reasonable request.

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#	Study (authors, year)	Country	Study / sub-study	Bias type	N	Age (range / Mage)	Population	Loneliness measure
1	**Edwards et al. (2001)**	USA	—	Interpretation	173	18+	Non-clinical	R-UCLA (20-item)
2	**Cacioppo et al. (2009)**	USA	—	Attention	23	Young adults	Non-clinical	UCLA-3 (20-item)
3	**Kanai et al. (2012)**	UK	Experiment 2	Interpretation	22	19–30	Non-clinical	R-UCLA (20-item)
4	**Qualter et al. (2013)**	UK	Study 1	Interpretation	185	11y7m–12y6m	Non-clinical	ILSS + LACA
			Study 2	Interpretation	248	9y4m–11y8m		
			Study 3	Attention	140	8y10m–12y10m		
5	**Bangee et al. (2014)**	UK	—	Attention	85	17–19 (Mage=18.2)	Non-clinical	UCLA-3 (20-item)
6	**Cacioppo et al. (2015)**	USA	—	Attention	70	Mage=23	Non-clinical	R-UCLA (20-item)
7	**Knowles et al. (2015)**	USA	Studies 1–4	Interpretation	78–203	Undergraduates	Non-clinical	R-UCLA (20-item)
8	**Lodder et al. (2015)**	Netherlands	4 gaze tasks (1 sample)	Attention	50	18–24	Non-clinical	UCLA-3 (20-item)

#	Study (authors, year)	Country	Study / sub-study	Bias type	N	Age (range / Mage)	Population	Loneliness measure
9	**Cacioppo et al. (2016)**	USA–UK	—	Attention	19	18–44	Non-clinical	R-UCLA (20-item)
10	**Lodder et al. (2016)**	Netherlands	Study 1	Interpretation	170	Mage=19.26	Non-clinical	UCLA-3 (20-item)
			Study 2	Attention + Interpretation	130	Mage=19.33		
11	**Vanhalst et al. (2017)**	Belgium–USA	—	Interpretation	170	Mage=13.65	Non-clinical	LACA (peer-related, 12-item)
12	**Bangee & Qualter (2018)**	UK	3 tasks (1 sample)	Attention	43	Mage=20	Non-clinical	UCLA-3 (20-item)
13	**Layden et al. (2018)**	USA	Study 1	Approach-avoidance	175	Mage=44.0	Non-clinical	R-UCLA (20-item)
			Study 2	Approach-avoidance	405	Mage=44.4		
14	**Shin & Kim (2019)**	South Korea	—	Attention	95	Mage=21.9	Non-clinical	UCLA-3 (20-item)
15	**Floyd & Woo (2020)**	USA	—	Interpretation	1,035	Adults	Non-clinical	UCLA-3 (20-item)
16	**Morningstar et al. (2020)**	Canada	—	Interpretation	122	11–18	Non-clinical	LACA

#	Study (authors, year)	Country	Study / sub-study	Bias type	N	Age (range / Mage)	Population	Loneliness measure
17	**Pearce et al. (2020)**	UK	Emotion-recognition task	Interpretation	22,054	16–99 (Mage=49.6)	Non-clinical	UCLA (4-item)
18	**Saito et al. (2020)**	Japan	—	Attention	43	Mage=21	Non-clinical	UCLA-3 (20-item)
19	**Wei et al. (2020)**	Australia	—	Attention	260	Mage=22.4	Non-clinical	UCLA-3 (20-item)
20	**Cheeta et al. (2021)**	UK	—	Interpretation	77	18–70 (Mage=29.6)	Clinical/comorbid (depression)	UCLA-3 (20-item)
21	**Grennan et al. (2021)**	USA	—	Attention + Interpretation	147	18–84	Non-clinical	UCLA-3 (20-item)
22	**Lau et al. (2021)**	UK	Longitudinal (3 waves)	Interpretation	104	18–24	Non-clinical	UCLA-3 (20-item)
23	**Lieberz et al. (2021)**	Germany–Israel	—	Interpretation	82	Adults	Non-clinical	R-UCLA (20-item)
24	**Okruszek et al. (2021)**	Poland	—	Interpretation	252	18–50	Non-clinical	R-UCLA (20-item)
25	**Saporta et al. (2021)**	Israel–Germany	—	Approach-avoidance	479	24–78 (Mage=43.1)	Non-clinical	UCLA-3 (20-item)
26	**Du et al. (2022)**	China	—	Attention	30	17–29	Non-clinical	UCLA (20-item)

#	Study (authors, year)	Country	Study / sub-study	Bias type	N	Age (range / Mage)	Population	Loneliness measure
27	**Lee et al. (2022)**	Taiwan	—	Interpretation	85	18–65	Clinical/comorbid (euthymic bipolar)	UCLA-3 (20-item)
28	**Lieberz et al. (2022)**	Germany–Israel	—	Interpretation	82	Adults	Non-clinical	UCLA-3 (20-item)
29	**Nombro et al. (2022)**	Canada	Study 1	Interpretation	113	Mage=21.8	Non-clinical	SELSA-S
			Study 2	Interpretation	224	Mage=43.63		
30	**Smith et al. (2022)**	USA	Longitudinal	Interpretation	122	21–33	Non-clinical	UCLA-3 (20-item)
31	**Smith & Pollak (2022)**	USA	—	Approach-avoidance	74	18–46	Non-clinical	UCLA (3-item)
32	**Bellucci & Park (2023)**	Germany–UK	—	Interpretation	35	Mage=22.37	Non-clinical	R-UCLA (20-item)
33	**Mąka et al. (2023)**	Poland	—	Attention	51	18–35	Non-clinical	R-UCLA (20-item)
34	**Grocott et al. (2024)**	Canada	Pre/post induction	Interpretation	591	Mage=20.5	Non-clinical	UCLA-3 (20-item)
35	**Skoko et al. (2024)**	Switzerland	—	Interpretation + Approach-avoidance	436	Mage=32.2 (18+)	Non-clinical	UCLA (9-item, German)

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#	Study (authors, year)	Country	Study / sub-study	Bias type	N	Age (range / Mage)	Population	Loneliness measure
36	**Arioli et al. (2025)**	Italy	—	Attention	34	Mage=23	Non-clinical	UCLA-3 (20-item)
37	**Mąka et al. (2025)**	Poland	—	Attention + Interpretation	271	18–35 (Mage=24)	Non-clinical	R-UCLA (20-item)
38	**McKenna et al. (2025)**	USA	—	Attention	100	Mage=26.2	Clinical/comorbid (psychosis)	UCLA-3 (20-item)
39	**Pfeifer et al. (2025)**	Netherlands	—	Attention	241	Mage=23.5	Non-clinical	UCLA (3-item) + state loneliness
40	**Restrepo et al. (2025a)**	USA	—	Interpretation	142	23–74 (Mage=42.35)	Non-clinical	UCLA-3 (20-item)
41	**Restrepo et al. (2025b)**	USA	4 datasets (IPD meta)	Attention	414	Adults	Non-clinical	UCLA-3 (20-item)
42	**Rudolph et al. (2025)**	USA	—	Attention	86	Mage=16.3	Non-clinical	R-UCLA (20-item)
43	**Skoko et al. (2025)**	Switzerland	—	Interpretation	790	Mage=31.9	Non-clinical	UCLA-LS + RTLS
44	**Vos et al. (2025)**	Netherlands–USA	—	Interpretation	295	Mage=37	Non-clinical	NIH Toolbox Loneliness (5-item)
45	**Wolters et al. (2025)**	Netherlands	Sample 1	Interpretation	138	Mage=20.8	Non-clinical	DJGLS

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#	Study (authors, year)	Country	Study / sub-study	Bias type	N	Age (range / Mage)	Population	Loneliness measure
45	**Wolters et al. (2025)**	Netherlands	Sample 2	Interpretation	315	Mage=23.8	Non-clinical	DJGLS
46	**Wu et al. (2025)**	China	Experiment 1	Approach-avoidance	76	17–26 (Mage=20)	Non-clinical	UCLA-3 (20-item)
			Experiment 2	Approach-avoidance	77	17–26 (Mage=20)		
47	**Yoo-Jeong et al. (2025)**	USA	—	Interpretation	75	Mage=59.4	Clinical/comorbid (HIV)	DJGLS (6-item)
48	**Huc et al. (2026)**	Canada	—	Interpretation	78	18–41 (Mage=25.54)	Non-clinical	UCLA-3 (20-item)
49	**Mąka et al. (2026)**	Poland	—	Attention	150	18–35	Non-clinical	R-UCLA (20-item)
50	**Pecchinenda et al. (2026)**	Italy	—	Attention	134	Mage=22.03	Non-clinical	UCLA-3 (20-item)

Note: Studies are listed chronologically by year of publication (alphabetically by first author within the same year), so that the development of the evidence base over time can be follo

Note: Comorbid samples: for studies with clinical/comorbid samples (Cheeta 2021 depression; Lee 2022 bipolar; McKenna 2025 psychosis; Yoo-Jeong 2025 HIV), ONLY the loneline

Note: The age range is reported where the authors provided one; where no range was given but a mean age was, the mean age is reported as 'Mage=x'. Where neither a range nor a These are population labels used in the source, not age values.

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#	Study (authors, year)	Materials (stimuli)	Modality	Experimental paradigm	Key finding (loneliness-specific)
1	**Edwards et al. (2001)**	Two ambiguous message vignettes	Self-report	Vignette message-interpretation task (rejection ratings)	Loneliness (with verbal aggressiveness) predicted more negative/rejecting interpretations of ambiguous messages and greater perceived communication difficulty
2	**Cacioppo et al. (2009)**	Pleasant/unpleasant social vs object pictures	fMRI	Passive-viewing fMRI (BOLD to social vs non-social)	For unpleasant images, lonelier individuals showed greater visual-cortex activation to social vs object pictures (attention drawn to others' distress)
3	**Kanai et al. (2012)**	Emotional-expression & films emotion stimuli	Behavioural	Emotion-expression & films emotion-recognition tasks (accuracy)	Loneliness was NOT significantly associated with emotion recognition (null); its significant links were to eye-gaze perception and pSTS grey-matter volume, which fall outside the three-bias scope
4	**Qualter et al. (2013)**	Ambiguous social-exclusion scenarios	Behavioural	Hostile-attribution paradigm (ambiguous exclusion)	Only children in the upper loneliness range showed elevated hostile attributions to ambiguously motivated exclusion (quadratic)
		Rejection scenarios (questionnaire)	Self-report	Children's Rejection-Sensitivity Questionnaire	Upper-range lonely children reported higher rejection sensitivity (quadratic)
		Socially rejecting images	Eye-tracking	Eye-tracking of rejecting images (dwell / disengagement)	Upper-range lonely children showed difficulty disengaging attention from socially rejecting stimuli
5	**Bangee et al. (2014)**	Social-rejecting / threat images	Eye-tracking	Free-viewing eye-tracking (early dwell to social threat)	Upper-quartile lonely showed visual vigilance (greater early attention) to socially threatening stimuli at 2 s, but not over longer periods
6	**Cacioppo et al. (2015)**	Negative social vs nonsocial words	EEG / ERP	Social/emotional Stroop with high-density EEG (ERP microstates)	Negative social vs non-social words were differentiated more quickly in high- than low-lonely brains (implicit vigilance)
7	**Knowles et al. (2015)**	Facial (S1,3,4) & vocal (S2) emotion stimuli	Behavioural	Emotion-decoding tasks under social vs academic framing	Lonely decoded emotion worse than non-lonely when the task was framed as a social-skills test, but equally well/better under academic framing (choking under social pressure)
8	**Lodder et al. (2015)**	Emotional faces & social/nonsocial images	Eye-tracking	Eye-tracking, 4 tasks (dwell / first fixation)	No differences between lonely and non-lonely in overt gaze to social cues (null)

#	Study (authors, year)	Materials (stimuli)	Modality	Experimental paradigm	Key finding (loneliness-specific)
9	**Cacioppo et al. (2016)**	Social vs nonsocial threat pictures	EEG / ERP	Threat-picture viewing with high-density EEG (ERP timing)	Social threat images were differentiated from non-social threat faster in lonely (~116 ms) than non-lonely (~252 ms) brains
10	**Lodder et al. (2016)**	Morphed faces + micro-expressions	Behavioural	Emotion-recognition (morph) + micro-expression tasks (accuracy)	Loneliness was NOT related to emotion-recognition accuracy on any task (null)
		RMET + live conversation partner	Behavioural + eye-tracking	Reading-the-Mind-in-the-Eyes + real-life conversation gaze	Loneliness was unrelated to RMET but was associated with increased gazing at the conversation partner's face
11	**Vanhalst et al. (2017)**	Morphing emotional faces (video)	Behavioural	Morph emotion-recognition task (sensitivity thresholds)	Loneliness was associated with heightened sensitivity to sad and fear faces (controlling for depression and social anxiety)
12	**Bangee & Qualter (2018)**	Emotional faces, face-ratios & social scenes	Eye-tracking	Eye-tracking, 3 tasks (dwell to faces/scenes)	Loneliness related to hypervigilant viewing of socially rejecting scenes but not facial expressions (specific, not general, attentional bias)
13	**Layden et al. (2018)**	Imagined interpersonal-distance zones (Hall)	Self-report	Interpersonal-distance preference (proxemic zones)	Loneliness predicted a preference for larger interpersonal distance within intimate space
		Imagined interpersonal-distance zones (Hall)	Self-report	Interpersonal-distance preference (proxemic zones)	Replicated in a larger sample; social-closeness measures did not account for the association
14	**Shin & Kim (2019)**	Words spoken in emotional vocal tone	Behavioural	Auditory (vocal) emotional Stroop (RT interference)	Lonelier participants were more distracted (slower) by negative vocal tone, especially for social words (controlling for neuroticism)
15	**Floyd & Woo (2020)**	DANVA faces/voices under framing	Behavioural	Emotion-decoding (DANVA) under social/academic/no-frame	A loneliness main effect on decoding emerged, but the 'choking under pressure' framing effect was not replicated
16	**Morningstar et al. (2020)**	Vocal socioemotional expressions (audio)	Behavioural	Vocal socioemotional-expression recognition (accuracy)	Loneliness was associated with poorer recognition of fear but better recognition of friendliness in voices (controlling for social anxiety)

#	Study (authors, year)	Materials (stimuli)	Modality	Experimental paradigm	Key finding (loneliness-specific)
17	**Pearce et al. (2020)**	DANVA-2 faces/voices	Behavioural	Emotion-decoding (DANVA-2) under social/academic framing	No loneliness main effect on emotion recognition (null); the small choking-under-framing effect (excluded here) did not meet the study's conservative threshold
18	**Saito et al. (2020)**	Warm/competent face distractors + houses	Eye-tracking	Target–distractor eye-tracking (automatic attention)	Loneliness modulated automatic attention to warmth/competence facial information (interaction with facial cues)
19	**Wei et al. (2020)**	Threat/neutral emotional scenes	Behavioural	Visual dot-probe (RT attentional-bias index)	Attentional bias no longer predicted anxiety after accounting for loneliness — loneliness better explained the attentional-bias–anxiety link
20	**Cheeta et al. (2021)**	Morphed emotional faces	Behavioural	Computerised morphed facial-emotion processing (accuracy)	Loneliness was associated with increased accuracy for sad faces and decreased accuracy for fearful faces (loneliness main effect)
21	**Grennan et al. (2021)**	Happy/angry emotional face stimuli	EEG / ERP	Emotion-bias task with EEG (RT + source-localised theta)	Loneliness was associated with slower processing when angry stimuli biased cognition and with enhanced angry-stimulus theta in the temporoparietal junction
22	**Lau et al. (2021)**	Ambiguous social/non-social situations (vignettes)	Self-report	Interpretation-of-ambiguous-situations questionnaire (cross-lagged panel)	Earlier interpretation bias did not predict later loneliness; earlier loneliness predicted later threatening interpretations (maintenance, not cause)
23	**Lieberz et al. (2021)**	Trust-game partners / interaction	fMRI / psychophys	Trust game with fMRI, salivary oxytocin & psychophysiology	High-lonely individuals showed reduced interpersonal trust and attenuated oxytocinergic/behavioural responses to positive social interaction
24	**Okruszek et al. (2021)**	Ambiguous-intention scenarios	Behavioural	Ambiguous-Intentions Hostility Questionnaire + social-cognition battery	More pronounced hostile-attribution bias predicted higher objective and perceived social isolation
25	**Saporta et al. (2021)**	Approaching friend/stranger avatars	Behavioural	Online interpersonal-distance task (approach × friend/stranger)	High chronic loneliness related to larger preferred interpersonal distance; high situational (COVID) loneliness related to smaller distance
26	**Du et al. (2022)**	Emotional faces vs buildings	EEG / ERP	Emotion vs building category-judgement task with ERP	Lonely individuals responded faster to negative emotion with larger early ERP (P100/N170): early attentional enhancement to negative social stimuli

#	Study (authors, year)	Materials (stimuli)	Modality	Experimental paradigm	Key finding (loneliness-specific)
27	**Lee et al. (2022)**	Emotional face expressions	Behavioural	Facial emotion-recognition task (accuracy)	Loneliness related to poorer social functioning (both groups); no direct loneliness–emotion-recognition association; only a group-level deficit in euthymic bipolar disorder vs. controls
28	**Lieberz et al. (2022)**	Social gamble / feedback	fMRI	Social gambling task with fMRI (subjective value; feedback)	Loneliness was behaviourally and neurally dissociable from social anxiety (comparable subjective value and amygdala/striatal responses)
29	**Nombro et al. (2022)**	Ambiguous situations (vignettes)	Self-report	Interpretation-of-ambiguous-situations measure (pleasantness ratings)	Social (but not other) loneliness related to less pleasant interpretations, over and above depression/anxiety
		Ambiguous situations (vignettes)	Self-report	Interpretation-of-ambiguous-situations measure (pleasantness ratings)	Replicated: social loneliness related to less pleasant interpretations in a general-population sample
30	**Smith et al. (2022)**	Emotional face expressions	Behavioural	Facial emotion-recognition task, repeated across 3 years	Increases in loneliness across medical school were associated with an increased tendency to mislabel emotional expressions as negative
31	**Smith & Pollak (2022)**	Reward/threat conditioned cues (shapes)	Behavioural / psychophys	Approach/avoid conditioning task with resting HRV	Higher loneliness combined with high resting parasympathetic activity predicted more approach-oriented behaviour
32	**Bellucci & Park (2023)**	Social partners' behaviour / feedback	fMRI	Iterative impression-formation (trust) task with fMRI & computational modelling	Lonelier individuals over-weighted negative first impressions (stronger weighting bias), mediated by reduced orbitofrontal-cortex activity
33	**Mąka et al. (2023)**	Threat / neutral faces	EEG / ERP	Visual dot-probe with EEG (N2pc) analysed via Drift-Diffusion Modelling	No social-threat hypervigilance in DDM parameters or N2pc; lonely showed reduced drift rate/efficiency (no attentional-bias effect)
34	**Grocott et al. (2024)**	Ambiguous (surprised) faces	Behavioural	Valence-judgment interpretation-bias task before/after a state-loneliness induction	State (not chronic) loneliness was associated with more positive interpretations of non-social stimuli; anxiety/depression predicted more negative interpretations
35	**Skoko et al. (2024)**	Ambiguous social situations (vignettes)	Self-report	Interpretation-of-ambiguous-situations + social-avoidance (SIAS-6)	Loneliness associated with more negative interpretation bias and greater social avoidance; self-esteem buffered the loneliness→interpretation-bias effect (controlling for depression and social anxiety)

#	Study (authors, year)	Materials (stimuli)	Modality	Experimental paradigm	Key finding (loneliness-specific)
36	**Arioli et al. (2025)**	Socio-emotional words	EEG / ERP	Socio-emotional Stroop with EEG (interference + ERP)	Loneliness was correlated with Stroop interference for socio-emotional stimuli (preliminary ERP evidence)
37	**Mąka et al. (2025)**	Threat / neutral social cues	Behavioural	Dot-probe + neuropsychological battery analysed via Drift-Diffusion Modelling	Loneliness was associated with longer perceptual-processing time and social-cognitive bias, directly and indirectly
38	**McKenna et al. (2025)**	Approaching/withdrawing faces (video)	fMRI	Dynamic approach/withdraw face fMRI (trust-weighted BOLD)	Higher loneliness was associated with greater hippocampal (and basal-ganglia) response to approaching versus withdrawing faces
39	**Pfeifer et al. (2025)**	AI-generated social-threat images	Eye-tracking	Free-viewing eye-tracking (dwell / fixation / first-orientation)	No significant association between state or trait loneliness and attention to social-threat images (null)
40	**Restrepo et al. (2025a)**	Inclusion/exclusion (Cyberball-type) cues	Behavioural	Progressive social-exclusion paradigm (random inclusion/exclusion/over-inclusion)	Cue ambiguity potentiated the effect of loneliness on feelings of rejection during social exclusion
41	**Restrepo et al. (2025b)**	Negative social vs nonsocial words	Behavioural	Emotional Stroop across four datasets (individual-participant-data meta-analysis)	No association between loneliness and attentional interference for negative social information (null across four samples)
42	**Rudolph et al. (2025)**	Social acceptance/rejection feedback	fMRI	Social Feedback Task with fMRI (neural sensitivity to feedback)	Neural sensitivity/vigilance to social-threat vs reward cues related to loneliness and moderated the stress→loneliness link
43	**Skoko et al. (2025)**	Ambiguous social situations (vignettes)	Self-report	Interpretation-of-ambiguous-situations & social-avoidance subscales	Across three loneliness classifications, lonely individuals showed more negative interpretation bias and greater social avoidance
44	**Vos et al. (2025)**	Ambiguous social scenarios	Behavioural	Emotional Bias-Against-Disconfirmatory-Evidence (BADE) task	Negatively biased and inflexible interpretations related to loneliness via socio-affective pathways (confirm loneliness edge is isolable)
45	**Wolters et al. (2025)**	Written ambiguous scenarios (vignettes)	Self-report	Ambiguous-scenarios interpretation task (content-specific)	Emotional and social loneliness related to content-specific negative interpretation bias

#	Study (authors, year)	Materials (stimuli)	Modality	Experimental paradigm	Key finding (loneliness-specific)
		Written ambiguous scenarios (vignettes)	Self-report	Ambiguous-scenarios interpretation task (content-specific)	Content-specific negative interpretation bias replicated
46	**Wu et al. (2025)**	Sub-second (300–700 ms) social/non-social intervals	Behavioural	Temporal-bisection task, social vs non-social context	Lonely showed proximal social avoidance (lengthened sub-second social intervals)
		Supra-second (1400–2600 ms) intervals	Behavioural	Temporal-bisection task, social vs non-social context	Lonely showed distal general approach (shortened supra-second intervals)
47	**Yoo-Jeong et al. (2025)**	Emotional face expressions	Behavioural	Facial emotion-perception task (recognition of 5 emotions)	Emotional loneliness related to reduced neutral bias; emotional and social loneliness related to distinct facial-emotion-perception patterns
48	**Huc et al. (2026)**	Emotional face expressions	EEG / ERP	Facial-expression emotion-recognition task with EEG (ERP components)	Higher loneliness was linked to increased cortisol and altered face-processing ERP components
49	**Mąka et al. (2026)**	Social / nonsocial affective pictures	EEG / ERP	Emotion processing/regulation (reappraisal) task with EEG	Only a weak loneliness–P300 link to negative social stimuli; loneliness linked to disrupted emotional self-awareness rather than early/late processing
50	**Pecchinenda et al. (2026)**	Gaze-cue faces (neutral/emotional)	Behavioural	Gaze-cueing (joint-attention) task + incidental face-recognition	Loneliness did not affect gaze-cueing (joint attention) or face-recognition memory (null)

Note: Studies are listed chronologically.

Note: Comorbid samples: for studies, only loneliness-specific effect was isolated and reported; effects attributable to the comorbid condition are not reported here.

Note: The age range is reported as mean age was reported, the authors' own sample descriptor is given (e.g., 'undergraduates', 'college students', 'students', 'adults', 'young adults'). These are population labels used.

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Abbreviation	Meaning
Loneliness measures	
R-UCLA	Revised UCLA Loneliness Scale (Russell, 1980; 20-item)
UCLA-3	UCLA Loneliness Scale Version 3 (Russell, 1996; 20-item)
UCLA (3-item)	3-item UCLA Loneliness Scale (Hughes et al., 2004)
UCLA (4-item)	4-item UCLA Loneliness Scale (short form)
UCLA-LS	UCLA Loneliness Scale (version as reported)
DJGLS	De Jong Gierveld Loneliness Scale (emotional & social subscales; 6- or 11-item)
SELSA-S	Social and Emotional Loneliness Scale for Adults – Short form
LACA	Loneliness and Aloneness Scale for Children and Adolescents
ILSS	Illinois Loneliness and Social Satisfaction Scale (children)
RTLS	Rasch-Type Loneliness Scale (De Jong Gierveld)
NIH Toolbox Loneliness	NIH Toolbox Loneliness fixed-form (5-item; validated)
Tasks / measures	
DANVA / DANVA-2	Diagnostic Analysis of Nonverbal Accuracy (emotion-decoding test)
RMET	Reading the Mind in the Eyes Test
AIHQ	Ambiguous Intentions Hostility Questionnaire
BADE	Bias Against Disconfirmatory Evidence task
SIAS-6	Social Interaction Anxiety Scale – 6-item (social-avoidance measure)
IB	Interpretation bias
RS	Rejection sensitivity
FEP	Facial emotion perception
Methods / indices	
fMRI	Functional magnetic resonance imaging
VBM	Voxel-based morphometry (grey-matter volume)
EEG	Electroencephalography
ERP	Event-related potential
P100 / N170 / P300 / LPP	ERP components (attention / face / late processing)
N2pc	ERP index of spatial attention
DDM	Drift-Diffusion Model
HRV	Heart-rate variability (parasympathetic activity)
ECG	Electrocardiography
TPJ	Temporoparietal junction
OFC	Orbitofrontal cortex
pSTS	Posterior superior temporal sulcus
BOLD	Blood-oxygen-level-dependent (fMRI) signal
RT	Reaction time
IPD	Individual-participant data (meta-analysis)
Sample terms	
HL / LL	High-lonely / low-lonely group
Mage	Mean age
PWH	People with HIV

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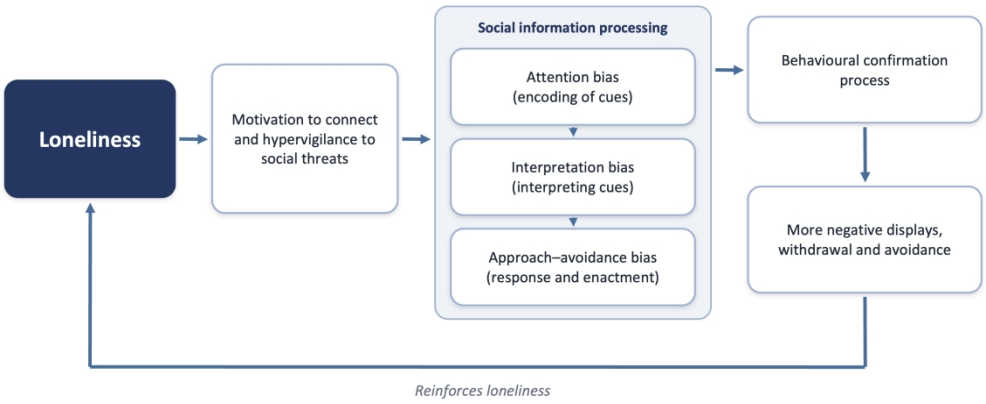


Figure 1. The self-reinforcing cycle of loneliness mapped onto the stages of social information processing (adapted and extended from Cacioppo & Hawkley, 2009, and Crick & Dodge, 1994).
Note. Loneliness increases both the motivation to reconnect and hypervigilance to social threat. Within social information processing, this is expressed as attention bias when social cues are encoded, interpretation bias when they are interpreted, and approach–avoidance bias at the stage of response selection and enactment. The resulting behaviour tends to elicit negative responses from others (behavioural confirmation), prompting more negative displays, withdrawal and avoidance, which in turn reinforce loneliness. The original model (Cacioppo & Hawkley, 2009) included attention, confirmatory and memory biases; here it is restricted to the three biases examined in this review.

1435x602mm (57 x 57 DPI)

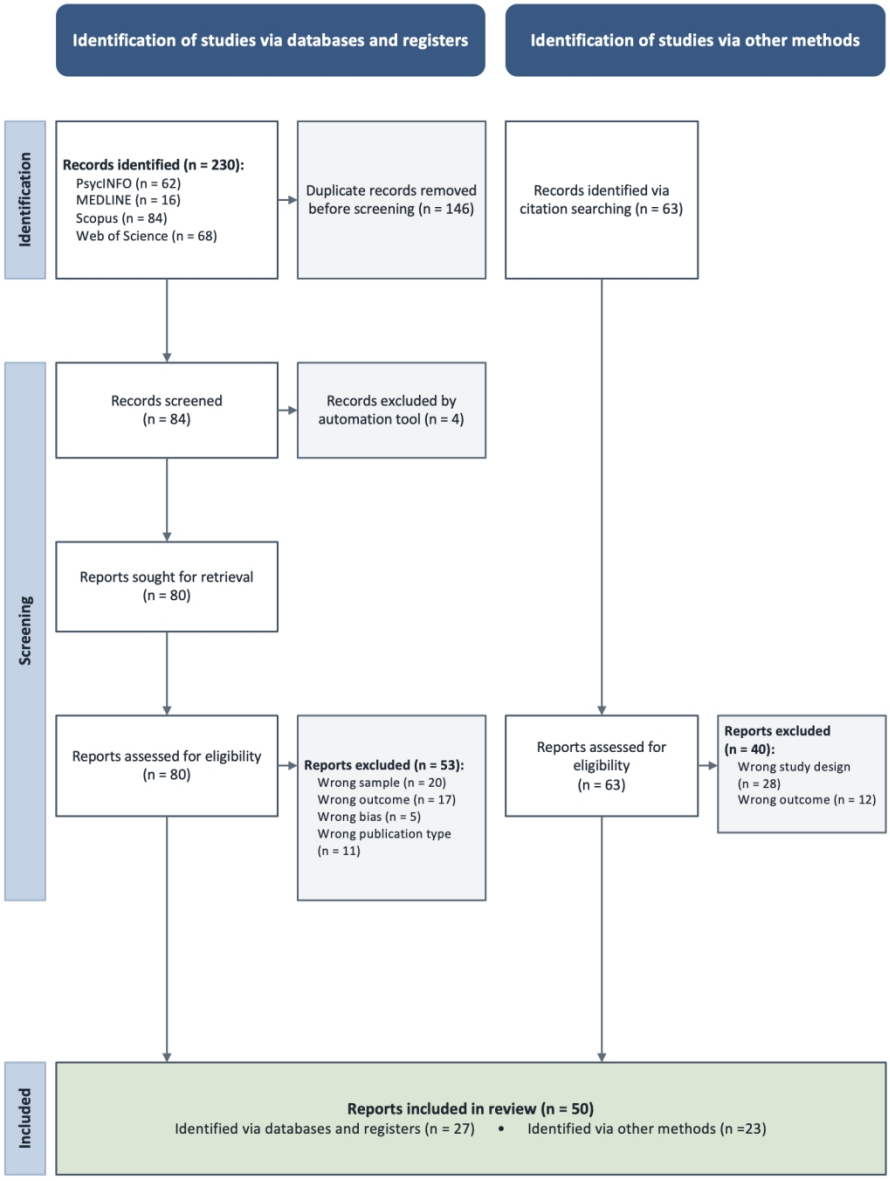


Figure 2. PRISMA flow diagram of study identification, screening, and selection of included reports

671x877mm (57 x 57 DPI)

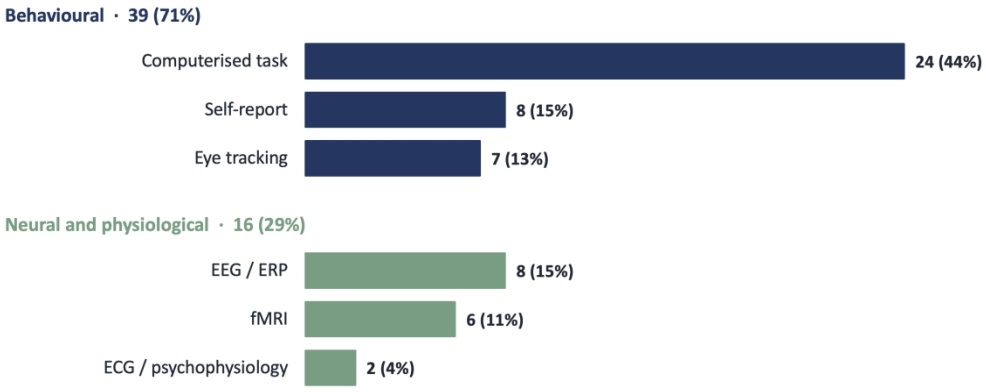


Figure 3. Measurement methods used across the included studies, grouped by type of measure.

Note. Number of studies using each method (N = 50 studies; 55 method applications; studies using more than one method are counted once per method). Percentages are of the 55 applications.

1319x523mm (57 x 57 DPI)