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Review article

# Furthering the language hypothesis of alexithymia: An integrated review and meta-analysis

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ABSTRACT

Alexithymia, including the inability to identify and express one's own feelings, is a subclinical condition responsible for some of the socioemotional symptoms seen across a range of psychiatric conditions. The language hypothesis of alexithymia posits a language-mediated disruption in the development of discrete emotion concepts from ambiguous affective states, exacerbating the risk of developing alexithymia in language-impaired individuals. To provide a critical evaluation, a systematic review and meta-analysis of 29 empirical studies of language functioning in alexithymia was performed. A modest association was found between alexithymia and multi-domain language deficits ($r = -0.14$), including structural language, pragmatics, and propensity to use emotional language. A more theoretically-relevant subsample analysis comparing alexithymia levels in language-impaired and typical individuals revealed larger effects, but a limited number of studies adopted this approach. A synthesis of 11 emotional granularity studies also found an association between alexithymia and reduced emotional granularity ($r = -0.10$). Language impairments seem to increase the risk of alexithymia. Heterogeneous samples and methods suggest the need for studies with improved alexithymia assessments.

## 1. Introduction

Alexithymia is a subclinical condition characterized by a low degree of emotional self-awareness (Taylor et al., 1991). Specifically, it is a multifaceted construct comprising (i) difficulties identifying and describing one's own feelings, (ii) difficulty recognising emotional experiences from internal bodily signals, and (iii) a thinking style that focuses more on the external and operational aspects of reality, and less on internal self-experiences, notably emotions (Bagby et al., 2020; Nemiah et al., 1976; Taylor et al., 1991). Although first originating from clinical observations of psychosomatic patients (Nemiah et al., 1976), contemporary research suggests that alexithymia in fact commonly co-occurs with a variety of psychiatric conditions, such as anxiety, depression, and post-traumatic stress disorder (PTSD) (Albantakis et al., 2020; Preece et al., 2022; Spitzer et al., 2007). The prevalence of alexithymia has been shown to be significantly elevated in individuals with Autism Spectrum Disorder (ASD) (e.g., 49.9% of autistic adults met clinical cut-offs in a study by Kinnaird et al., 2019, 55% of adolescents with ASD in a study by Milosavljevic et al., 2016), and alexithymia correlates more strongly with socioemotional difficulties in ASD than autism diagnosis or the severity of ASD symptoms (Brewer et al., 2016; Milosavljevic et al., 2016; Morie et al., 2019). It has therefore been suggested that alexithymia is a transdiagnostic condition that contributes to the emotional difficulties and affective psychopathology observed in several psychiatric conditions (Albantakis et al., 2020; Brewer et al., 2021; Grabe et al., 2004; Preece et al., 2022; see Weissman et al., 2020 for a developmental perspective).

In adult research, alexithymia is commonly assessed using the 20-item Toronto Alexithymia Scale (TAS; Bagby et al., 1994a, 1994b; Parker et al., 2003), a self-report questionnaire that measures the three core facets of alexithymia, namely *difficulties identifying feelings*, *difficulties describing feelings*, and *externally-oriented thinking*. Importantly, a 25-year review has concluded that the TAS-20 demonstrates good reliability and factor validity in a wide range of sociocultural and language

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settings (Bagby et al., 2020).

Despite its clinical significance, the psychological mechanisms that underlie reduced emotional awareness in alexithymia are largely unknown. One line of research posits that alexithymia stems from the inaccurate, or otherwise atypical, perception of internal bodily signals ('interoception'), which are informative as to one's affective state (e.g., Brewer et al., 2016; Ernst et al., 2014; Scarpazza et al., 2015). However, the association between alexithymia and interoceptive abilities is hard to assess as most studies have used measures of interoception which have limited validity (Murphy et al., 2018; Trevisan et al., 2019). Furthermore, interoceptive signals alone are not thought to be sufficient to explain the full range of human emotional experiences (Khalsa et al., 2018; Quigley et al., 2021), suggesting that alexithymia may arise as a product of atypicalities in systems beyond interoception.

From a constructionist perspective, emotions are concepts derived from "noisy" and ambiguous affective states. This conceptualization (or 'construction') process is supported by multiple psychological functions (Russell and Barrett, 1999; Lindquist and Barrett, 2008; also see Hoemann et al., 2019, 2020 for a developmental account). Language, in particular, is a necessary (but not sufficient) psychological function that allows one to make sense of current affective experiences, providing convenient access to emotion labels and linguistic devices (e.g., "*feel*") to identify and communicate one's own feelings with others (Hoemann et al., 2019; Lindquist, 2017). Developmentally, language also helps channel ambiguous affective states (e.g., unpleasant sensations) into discrete and specific emotion labels (e.g., anger) (Lindquist et al., 2015a, 2015b; Lindquist, 2017), allowing one to develop discrete emotion concepts (Brooks et al., 2016; Oosterwijk et al., 2012). It has been demonstrated empirically that the presentation of linguistic emotion labels influences subsequent perceptual judgment of (Gendron et al., 2012; Nook et al., 2015), and memory for emotional stimuli (Doyle et al., 2018), whilst verbal development mediates the development of multidimensional emotion concepts in 6- to 25-year-olds (Nook et al., 2017a), all of which suggest an interplay between language and the psychological representation and conceptualization of emotions.

Although there are only a few direct empirical tests of the language hypothesis of alexithymia, the theoretical claims are clear. First, if language plays a role in the development of emotion concepts, then language impairment would be expected to result in absent or impoverished emotion concepts. Impaired emotion concepts would be expected to lead to difficulties *identifying* one's own emotions, and thus alexithymia. Second, even if language does not play a role in the development of emotion concepts, language impairment would result in difficulties *describing* one's own emotions, again resulting in alexithymia. It should be noted, however, that the language hypothesis of alexithymia posits that language disorder plays a role in exacerbating and/or contributing to high alexithymia in a *subgroup* of individuals, i.e., just for those with language impairments (Hobson et al., 2019). Thus, while one would not expect every alexithymic individual to have language problems, one would expect language difficulties to lead to alexithymia (dependent upon the nature of those language deficits - see below). For example, patients with acquired language impairments following penetrating brain injury showed significantly higher degrees of alexithymia than healthy controls; while the extent of brain damage in the inferior frontal gyrus (IFG), a key part of the language network (Poeppel et al., 2012), was associated with higher alexithymia scores (Hobson et al., 2018; but see Hobson et al., 2020). Although the patients with brain injury show that language impairment can lead to alexithymia, individuals with alexithymia would not necessarily be expected to have language difficulties. For example, individuals with eating disorders are at increased risk of alexithymia (Westwood et al., 2017), but outperform the general population on the National Adult Reading Test by 10.8 units (Lopez et al., 2010). Language impairments seem unlikely to explain alexithymia in these individuals, therefore interoceptive impairment may be more relevant to alexithymia in eating disorders.

These theoretical predictions are important in evaluating evidence for the language hypothesis, and make it difficult to interpret the results of studies that compare language functioning in groups of individuals with, and without, alexithymia. Small effect sizes could be due to a small contribution of language difficulties to alexithymia in all alexithymic individuals, or a larger contribution in a subsample of individuals. Studies which examine levels of alexithymia in individuals with language disorder in comparison to those without a language disorder are easier to interpret, but rare.

Possible interpretation issues notwithstanding, behavioral studies have generally reported that higher alexithymia is associated with worse language functioning. The majority of empirical evidence comes from descriptive studies that demonstrate an association between individual differences in alexithymia and a reduced propensity to use emotional language, quantified by the relative proportion of emotional words used when invited to speak or write freely about an emotional event (e.g., Camia et al., 2020; Jelinek et al., 2010; Tull et al., 2005). The degree to which reduced/atypical labelling of emotions stems from general narrative language difficulties or emotion understanding difficulties is still debatable (Barrett, 2013; Hoemann et al., 2020; Lindquist et al., 2015b). From a constructionist perspective, it has been suggested that early language milestones, such as pointing to and labelling the surroundings with groups of sounds ("tata") and simple/pseudo words ("choc-choc" for chocolate), are some of the foundations that help children represent abstract concepts psychologically (Hoemann et al., 2019, 2020). This domain-general language process may also apply to emotion concepts (e.g., Beck et al., 2012; Streubel et al., 2020; also see a theoretical piece by Hoemann and Barrett, 2019), such that the more extensive and richer these representations are (e.g., via regular use and retrieval of these emotion concepts), the better the child's emotion understanding is (Cole et al., 2010; Pons et al., 2003). Therefore, these emotional language studies, although they seem partly overlapping with the difficulty expressing emotions domain in alexithymia, highlight the opportunity of testing if emotional language impairments contribute to alexithymia, which may stem from at least two language pathways – (i) impoverished emotion concepts due to disrupted language-mediated concept learning in development, and/or (ii) further difficulty retrieving abstract (emotional) lexicon (Hobson et al., 2018).

Other studies have focused on structural language deficits, such as difficulty reading, literal comprehension, and limited grammatical and lexical access assessed by formal linguistic assessments and neuropsychological tests (e.g., Karukivi et al., 2012; Winstanley et al., 2019; Wood and Williams, 2007). These structural language results are less consistent (e.g., Hobson and van den Bedem, 2021), but nonetheless point to a negative trend between alexithymia and structural language abilities, or higher degrees of alexithymia in the language-impaired group (e.g., in youths with developmental language disorder [DLD] in Hobson and van den Bedem, 2021 and Winstanley et al., 2019). Structural language difficulties in alexithymia may suggest a more fundamental mechanism concerning difficulties communicating emotions in a grammatically comprehensible and coherent manner (e.g., *I* [subject] + *feel* [expressive verb] + *happy* [adjective/emotion concept]).

A smaller body of studies has examined the link between alexithymia and pragmatics, the ability to understand the implicit social messages in language. In Jakobson and Pearson (2021)'s study, participants were asked to judge non-literal statements as jocular, literal, sarcastic, or white lies, and higher alexithymia was associated with lower statement processing speed. Problematically, it remains an open question whether any pragmatic difficulty in alexithymia is indicative of a social language deficit or a broader social cognitive impairment given the high co-occurrence between alexithymia and autistic traits, which have not been dissociated in most empirical studies of pragmatics (Pisani et al., 2021). Empirical issues aside, pragmatic difficulties in alexithymia may hint at a lack of social language learning opportunities in early years, a developmental period when emotion discourses and language activities (e.g., reading and writing about fictional characters) take place frequently with peers and caregivers (Dunn et al., 1991; Harris et al., 2005).

Although in general studies do demonstrate a link between alexithymia and poorer language ability, it should be noted that empirical evidence for the link between alexithymia and language abilities is mixed. Since alexithymia is associated with a wide range of psychiatric conditions, considerable heterogeneity in the demographic and clinical characteristics of participants across individual studies may account for some of the variance observed in the relationships between alexithymia and language abilities (Hobson et al., 2019). Moreover, language is a multifaceted construct. There is limited evidence regarding which specific language domain(s) are related to alexithymia, and it is likely that different language domains serve different functions in emotion processing, as noted above. Examination of the relationships between alexithymia and specific domains of language functioning may inform discussion of the role language plays in emotional awareness (Hobson and van den Bedem, 2021). Furthermore, there are considerable differences between empirical methods and analytical procedures between studies, rendering the interpretation of results across studies difficult. Therefore, a systematic overview and quantitative synthesis of the available evidence is much needed to evaluate the empirical basis of the language hypothesis of alexithymia.

As our primary focus, we first provide a systematic overview of the literature, summarizing the sample characteristics and study methods of empirical studies examining language abilities in alexithymia. We then extracted and synthesized the individual effect sizes that quantify the variances in different domains of language abilities that are associated with individual differences in alexithymia. Where possible, we conducted a synthesis of studies that compared alexithymia in individuals with and without language impairments. We also synthesized the few studies that comprehensively reported the association between structural language difficulties and specific TAS subscales. To further evaluate the applicability of the constructionist idea that language impairments disrupt the representation and development of emotion concepts which leads to alexithymia, we present a follow-up meta-analysis synthesizing the association between alexithymia and emotional granularity – individual differences in perceiving similarities and differences between emotion concepts.

With respect to predictions, if language disorder leads to alexithymia, then there should be a significant negative association between alexithymia and language functioning. Due to heterogenous samples across clinical conditions, and that fact that most studies investigate language function in alexithymia rather than alexithymia in those with language impairment, this association would be expected to be modest. The strength of the association between alexithymia and specific domains of language functioning would be expected to vary, although the lack of specificity at the theoretical level makes predictions relating to the size and nature of the differences difficult. For the few studies that adopted a group-based approach, one would expect language-impaired groups to be more alexithymic than typical individuals, with a larger effect than that observed in the dimensional studies. This corresponds to the prediction of the language hypothesis that language difficulties represent unique risks for developing alexithymia in language-impaired groups, but not all individuals on the alexithymia continuum struggle with language difficulties. Finally, if alexithymia is related to language impairment, and language is necessary for the development of emotion concepts as suggested by constructivist theories of emotion, then one would expect alexithymia to be associated with less granular representation of emotion concepts.

## 2. Systematic review and meta-analysis 1

### 2.1. Method

#### 2.1.1. Search strategy

Following the 2020 Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines (Page et al., 2021), a systematic search was performed in July 2021 to identify empirical studies for this review and meta-analysis. The following search terms and derivatives were used: ((Alexithymia OR "emotional awareness") AND (language OR word OR label*) in four databases: PubMed, PsycINFO, Medline, and Web of Science. These search terms were selected on the basis of previous systematic reviews and/or meta-analyses focused on alexithymia (e.g., Trevisan et al., 2019; Hickman et al., 2020), and theoretical papers on emotion and language (e.g., Lindquist and Gendron, 2013; Lindquist, 2017). Search filters were applied to exclude studies that did not report empirical data (e.g., scoping reviews and commentaries), and articles not in English. No restrictions on publication date were imposed. The same search strategy was used in Google Scholar and WorldCat to identify relevant grey literature (e.g., unpublished doctoral theses). Search results were then crosschecked with studies included in a recent narrative review on cognitive-emotional processing in alexithymia (Luminet et al., 2021). With duplicates removed, 618 articles were identified via the database search, 12 via WorldCat and Google Scholar, and 4 by crosschecking with Luminet and colleagues' (2021) narrative review. To increase study availability, we supplemented the search with one additional dataset from the authors. Together, this resulted in 635 articles. Because of research interruption amid the second wave of COVID-19 pandemic in the UK, neither this review nor the protocol was preregistered.

#### 2.1.2. Study selection

Abstract screening was conducted independently by the first author (KSL), with ambiguous articles resolved through discussion with JM and HH. Articles deemed relevant based on abstracts and keywords were then included for full-text assessment. The initial screening removed a total of 566 articles (555 from database search), resulting in 69 articles (63 from database search) eligible for full-text screening.

Full texts were assessed by KSL and checked by HH and JM independently. Studies were removed if they did not recruit human participants, reported overlapping samples (the study focusing on the use of emotion-related language was retained), presented non-empirical and/or self-reported questionnaire data for language abilities, were not relevant to alexithymia nor language abilities, measured and analyzed language as a control variable/sample characteristic and no further analyses in relation to alexithymia or emotional self-awareness were performed, or were not retrievable for full-text assessment. The full-text assessment resulted in a final collection of 29 studies. Twenty-six studies assessed alexithymia/emotional self-awareness using the 20/26-item TAS (Parker et al., 2003); one study used the Children's Alexithymia Measure (CAM; Way et al., 2010); two studies used the Bermond-Vorst Alexithymia Measure (BVAQ; Vorst and Bermond, 2001). The CAM has shown strong internal reliability ($\alpha = 0.92$; Way et al., 2010), whilst the BVAQ correlates highly with TAS ($rs = 0.60$ to.80; Vorst and Bermond, 2001), supporting the inclusion of these alexithymia measures in the same meta-analysis. Data from nine studies were provided directly from the authors upon request and we are very grateful to those authors. Further details of the literature search history are presented in the PRISMA flowchart (Fig. 1).

#### 2.1.3. Data extraction

Table 1 provides an overview of the identified studies. The following information was extracted and summarized by the first author: (i) sample characteristics including mean age, sample size, indication (e.g., clinical conditions), percentage female, and descriptive statistics (mean, standard deviation, and range) of alexithymia/emotional self-awareness scores of the study samples; (ii) methods including choice of alexithymia/emotional self-awareness assessment, language task or assessment used. To provide a more nuanced understanding of the association between alexithymia and language abilities, language abilities of interest in the identified studies were classified into three language domains, namely (i) Structural language, (ii) Pragmatics, and (iii) Natural use of emotional language.

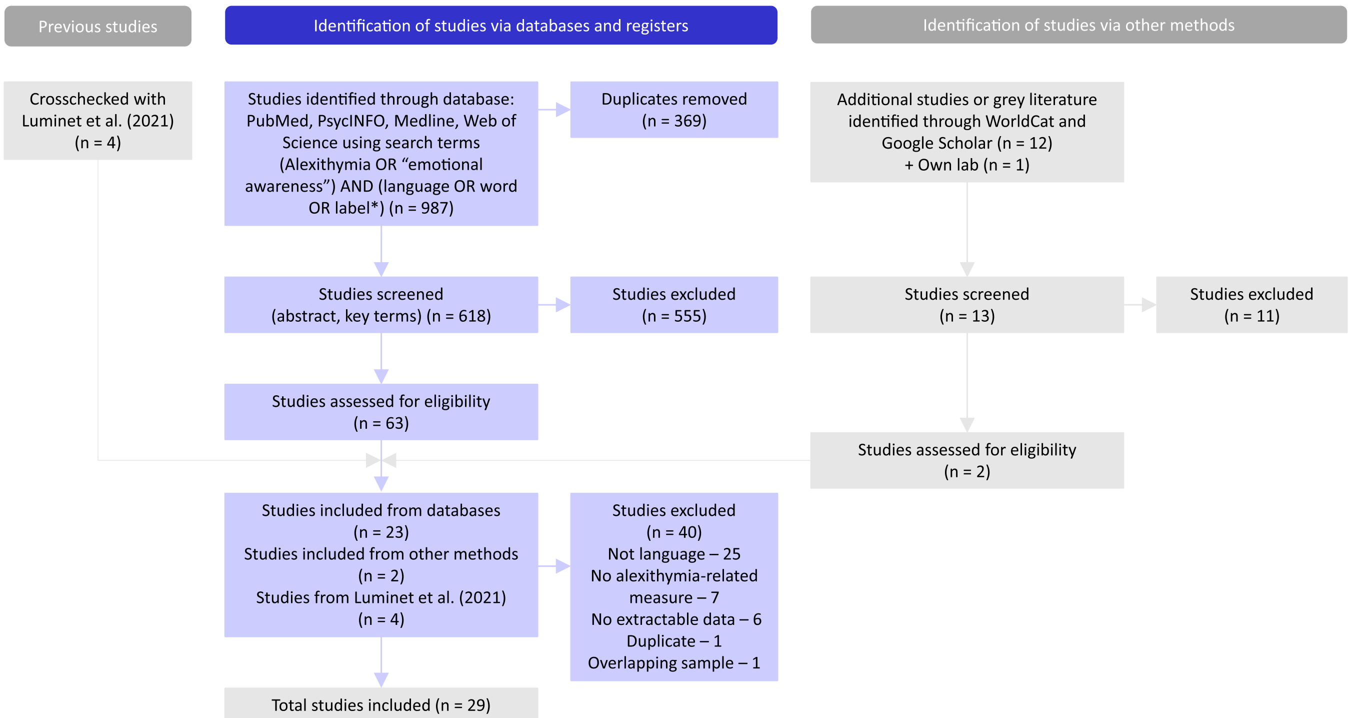


**Fig. 1.** Literature search history of language studies in alexithymia.

*Structural language* refers to language studies that assessed participants' understanding and use of basic language structures, such as grammar, vocabulary, general reading and comprehension, as well as lexical access abilities. Measures extracted from these structural language studies were primarily accuracy variables, such as behavioral task performance (e.g., Hobson et al., 2018, 2020) and competency scoring on standardized language assessments (e.g., Hobson and van den Bedem, 2021; Karukivi et al., 2012; Nishimura et al., 2009).

*Pragmatics* refers to language tasks that required participants to make a judgment of the underlying social information of speech or language stimuli, such as to recognize the emotional content (Lane et al., 1996; Maurage et al., 2009; Swart et al., 2009) or sarcasm/humor (Jakobson and Pearson, 2021; Olkoniemi et al., 2019) of written sentences. These studies primarily reported accuracy measures in an *n*-alternative-forced-choice context (e.g., Lane et al., 1996; Jakobson and Pearson, 2021), while a few also reported measures of efficiency, assessing reaction times when making judgments of the pragmatics stimuli (e.g., Jakobson and Pearson, 2021; Olkoniemi et al., 2019; Swart et al., 2009). Two studies used non-experimental assessments of pragmatics competency in youths (e.g., the parent-reported Children's Communication Checklist in Hobson and van den Bedem, 2021; Snow et al., 2016), which are concerned with one's accuracy of understanding and/or use of pragmatics and are conceptually similar to the pragmatic behaviors tested in those laboratory tasks.

*Natural use of emotional language* refers to narrative tasks that invite participants to speak or write freely about a specific topic or an autobiographical event related to emotions (e.g., Jelinek et al., 2010; Tull et al., 2005), or emotional stimuli presented by the experimenter (e.g., Luminet et al., 2004; Roedema and Simons, 1999). The propensity to use emotional language was then quantified in terms of word frequency using linguistic software, such as the respective proportion of positive and negative emotion words throughout the narrative task (e.g., Vakhrusheva et al., 2020).

It is worth noting that there is no absolute distinction between the three language domains proposed. For instance, the natural use of emotional language would rely on some structural language competence to structure a sentence, whilst the reception of social information via language would require some competence to access lexical devices that often denote a person's emotion. Nonetheless, a systematic classification allows for the comparison of synthesized quantitative findings between language domains, which would be beneficial for hypothesis generation. The classification was initially performed by the first author, and then checked by HH. For the purpose of the meta-analysis, study findings including statistical test(s) used and the relevant statistics for pooling the effect sizes across independent studies were extracted. Further details are discussed below.

#### 2.1.4. *Statistical analysis*

Given the primary interest of this meta-analysis was to synthesize the effect size of the association between alexithymia and language abilities, correlation coefficients were extracted and pooled as an effect size summary. For studies that reported statistics that are not directly convertible to correlation coefficients (e.g., group-based tests and multilevel modeling), authors were first contacted for the appropriate statistics, while unresolved cases were handled by the effect size conversion functions in the esc package (Lüdecke et al., 2019). For prospective studies that conducted multiple measurements over time, the baseline data were extracted.

The meta-analyses were conducted via the R packages meta (Balduzzi et al., 2019), metafor (Viechtbauer, 2010), and dmetar (Harrer et al., 2019). Random-effects models were used for the series of meta-analyses reported here as heterogeneity of effect sizes was expected (Field, 2001; Hunter and Schmidt, 2000), and the conventional restricted maximum likelihood estimator was used (Viechtbauer, 2005). To meet the assumption of the random-effects model that the studies comprised independent groups of participants, a synthesized effect size was computed by averaging the effect sizes in studies that reported multiple measures of a language domain (e.g., Boston Naming and Token Test performance in Hobson et al., 2018; assessment scorings on vocabulary, lexical similarity, and comprehension in Wood and Williams, 2007; and judgement accuracy in Subtasks 1 and 3 in Lane et al., 1996) (Borenstein et al., 2009). Maurage and colleagues (2009) reported separate effect sizes by emotion categories, and the averaged effect sizes in respect of judgements about happy, angry, and sad pragmatics stimuli

**Table 1**
Overview of language studies in alexithymia ($k = 29$).

| Study | N | Mean age (years) | % Female | Indication | Measure | Task | Language domain | Alexithymia mean (SD) | Alexithymia range | Alexithymia as DV between groups? |
|---|---|---|---|---|---|---|---|---|---|---|
| Camia et al. (2020) | 8 | 46 | Not reported | Alcohol dependence | TAS-20 | Toronto structured interview for alexithymia with recalling of related personal life events | Emotional language use | HA (≥ 61) = 64.25 (2.06)<br>LA (≤ 51) = 43.50 (4.66) | HA = 62–66<br>LA = 38–49 | No |
| Costa et al. (2007) | 53 | 63.8 | 27.9 | Parkinson's disease, HV | TAS-20 | Word list recall, sentence construction, phonological verbal fluency from a standardized neuropsychological test battery | Structural | HA (≥ 61) | Not reported | No |
| Edwards et al. (2020) | 96 | 21.2 | 76 | HV (undergrads) | TAS-20 | Emotional writing exercise requiring participants to engage in six autobiographical recall tasks (negative, neutral or positive experiences) and to reflect upon and write about a past experience that fitted the description. Writings were then analyzed with a linguistic software. | Emotional language use | Total = 44.35 (12.05) | Not reported | No |
| Hobson et al. (2018) | 17 | 63.3 | Male only | Traumatic brain injury, HV | TAS-20 | Token test requiring participants to hear and perform a set of instructions; and Boston Naming Task requiring participants to disregard line drawings an name the item in the picture. | Structural | Boston Naming/ Unimpaired = 50.01 (12.50)<br>Boston Naming/ Impaired = 57.55 (12.14)<br>Token Test/ Unimpaired = 50.27 (12.66)<br>Token Test/ Impaired = 53.83 (9.45) | Boston Naming/ Unimpaired = 24–81<br>Boston Naming/ Impaired = 44–74<br>Token Test/ Unimpaired = 24–81<br>Token Test/ Impaired = 24–81 | Yes |
| Hobson et al. (2020) | 118 | 73.1 | 46.6 | Chronic stroke | TAS-20 | Picture naming task asking participants to name the object in the picture; comprehension task instructing participants to point to an item in a picture/to complete a task with no. of repeated instructions needed measured; and sentence reading task requiring participants to read a sentence aloud. | Structural | Total = 49.43 (12.71)<br>Language unimpaired = 48.48 (12.77)<br>Language impaired = 52.03 (12.35) | Total = 27–81<br>Language unimpaired = 27–76<br>Language impaired = 27–81 | Yes |
| Hobson and van den Bedem (2021) | 289 | 12.2 | 54.7 | Developmental language disorder, HV | Children's Alexithymia Measure, parent-report | Parent-reported language assessment, Children's Communication Checklist, inquiring about children's structural language and pragmatic language development, and other communicative impairment. | Structural and pragmatics | Total = 1.64 (0.56)<br>DLD = 2.01 (0.58)<br>Non-DLD = 1.42 (0.42)<br>*Standardized scores were reported | Total = 1–4<br>DLD = 1–3.29<br>Non-DLD = 1–4 | Yes |
| Jakobson and Pearson (2021) | 70 | 20.6 | 51.4 | HV | TAS-20 | Experimental task requiring participants to indicate which of the five labels (literal positive, literal negative, jocular, sarcastic, white lie) describe the type of statement the speaker (in the video) had made | Pragmatics | Total = 47.2 (10.2) | Not reported | No |
| Jelinek et al. (2010) | 79 | 40.1 | 53.2 | Trauma survivors with and without developing PTSD symptoms | TAS-20 | Standardized clinical interview inquiring about traumatic experiences | Emotional language use | PTSD = 54.04 (9.61)<br>Non-PTSD = 43.76 (9.08) | Not reported | No |
| Karukivi et al. (2012) | 723 | 19 | 74 | Adolescents with 1 or more eating disorder symptoms, HV | TAS-20 | Clinical speech development assessment conducted and examined by nurses | Structural | Not reported | Not reported | Longitudinal assessment: Language -> Alexithymia |

(continued on next page)

**Table 1** (*continued*)

| Study | N | Mean age (years) | % Female | Indication | Measure | Task | Language domain | Alexithymia mean (SD) | Alexithymia range | Alexithymia as DV between groups? |
|---|---|---|---|---|---|---|---|---|---|---|
| Kreitler (2002) | 100 | 22.6 | 50 | HV (undergrads) | TAS-20 | Meaning test in which participants were asked to describe stimuli to an imaginary other | Emotional language use | Total = 55.10 (11.53) | Not reported | No |
| Lane at al. (1996) - Subtasks 1, 3 | 380 | 18–80 | 51.6 | HV | TAS-20 | Perception of affect task using sentences that depict a specific emotion that do not include words denoting emotion. Participants then select an item response from a list of seven words denoting emotions. | Pragmatics | Total = 46.1 (11.8) | 21–82 | No |
| Luminet et al. (2004) | 50 | 63.6 | 78.6 | HV | BVAQ | Verbal re-evocation session after viewing emotional movies | Emotional language use | Not reported | Not reported | No |
| Maurage et al. (2009) - Script task | 36 | 47.9 | 22.2 | DSM-IV alcohol dependence, HV | TAS-20 | Script emotion recognition task | Pragmatics | Alcoholics = 43.22 (17.69)<br>HV = 42.73 (14.83) | Not reported | No |
| Meganck et al. (2009) | 32 | 42.7 | 62.5 | Individuals from mental health care centers in Belgium, all met DSM-IV Axis I criteria, while some also met Axis II criteria. All patients received individual psychotherapy, of which half of them were taking prescribed medications | TAS-20 | 2-hour clinical interview encouraging participants to speak about their problems and interpersonal embedment of these problems, with LIWC analysis | Emotional language use | Total = 59.88 (11.85) | 34–81 | No |
| Nishimura et al. (2009) | 234 | 13.7 | 49.5 | HV from junior high schools, adolescent patients with psychosomatic and/or behavioral problems | TAS-20 subscales | Diagnostic literacy test of Japanese reading and vocabulary | Structural | Only the means and SDs of subscales were reported for males and females separately | Not reported | No |
| O'Connor and Ashley (2008) | 87 | 20.3 | 57.5 | HV | TAS-20 | Pennebaker emotional writing paradigm requiring participants to write about their deepest emotions and thoughts about the most upsetting experiences in their life for 15 mins for 3 consecutive days. Writing analyzed with a linguistic software. | Emotional language use | Total = 49.79 (9.40)<br>Writing group = 50.88 (11.26)<br>Control = 48.70 (7.53) | Not reported | No |
| Olkoniemi et al. (2019) | 60 | 24.2 | 76.7 | HV (students) | TAS-20 | Read and interpret dialogue statements underlying sarcasm | Pragmatics | Total = 41.18 (8.87) | 24–63 | No |
| Páez et al. (1999) - Study 3 | 70 | Not reported | Not reported | HV (undergrads) | TAS-26 (DDF) | Intensive and brief expressive writing exercise | Emotional language use | Not reported | Not reported | No |
| Renzi et al. (2020) | 35 | 36.2 | Female only | Women undergoing assisted reproductive treatment | TAS-20 | Writing intervention requiring participants to write about the deepest thoughts and feelings about the experience of the assisted reproduction technology treatment | Emotional language use | Total = 59.63 (9.07)<br>HA = 59.63 (9.07)<br>LA = 35.42 (5.71) | Not reported | No |
| Roedema and Simons (1999) | 65 | Not reported | 52.3 | HV (undergrads) | TAS-26 | Verbally describe one's feelings about the emotional images | Emotional language use | Not reported | Not reported | No |
| Snow et al. (2016) | 100 | 17.1 | 15 | Young people completing custodial sentences in Australia | TAS-20 | Clinical evaluation of language fundamentals, test of language competence, and narrative language task | Structural and pragmatics | Total = 55.0 (10.7) | 59% in the alexithymia likely/possible ($\geq$ 52) ranges | Considered but not performed given that language function was not correlated with TAS scores |
| Suslow and Junghanns (2002) | 31 | 26 | 42.9 | HV | TAS-20 | Lexical decision task of word/nonword stimuli following related/unrelated emotion situation priming | Structural | Total = 40.4 (median = 39)<br>HA = 50.6 (7.4)<br>LA = 29.5 (5.0) | 23–64 | No |
| Swart et al. (2009) - Affective | 34 | 19.7 | 58.8 | HV | BVAQ | Affective prosody task requiring participants to make a response as soon as | Pragmatics | HA $\geq$ 26, 1.5 SD above the overall mean of the | Not reported | No |

(continued on next page)

**Table 1** (*continued*)

| Study | N | Mean age (years) | % Female | Indication | Measure | Task | Language domain | Alexithymia mean (SD) | Alexithymia range | Alexithymia as DV between groups? |
|---|---|---|---|---|---|---|---|---|---|---|
| semantic task | | | | | | they identified the emotion expressed in a sentence, either based on content or tone of voice (congruent, incongruent) | | verbalizing subscale; LA ≤ 17. The means and SDs of BVAQ subscales were reported for HA and LA. | | |
| Tull et al. (2005) | 54 | 27 | 66.7 | HV | TAS-20 | Verbalization task asking participants to speak about a past distressing event, analyzed with a linguistic software | Emotional language use | Total = 45.52 (10.74) | 20–74; only six participants > 61 and nine participants scored between 52 and 60 | No |
| Vakhrusheva et al. (2020) | 72 | 25.5 | 51.5 | Schizophrenia, HV | TAS-20 | Experience sampling with a focus on descriptions of emotional events | Emotional language use | Schizophrenia = 50.54 (14.90) HV = 37.63 (11.31) | Not reported | No |
| Winstanley et al. (2019) | 145 | 15.8 | 22.8 | Young offenders | TAS-20 | Standardized psycholinguistic measures including verbal IQ, formulated sentences and literal understanding spoken paragraphs, test of word reading efficiency, and reading comprehension | Structural | DLD = 56.6 (12.6) Non-DLD = 54.6 (10.7) | DLD = 41% HA, 21% MA, 38% LA Non-DLD = 32% HA, 25% MA, 43% LA | Yes |
| Wood and Williams (2007) | 92 | 38.7 | 45.0 | Traumatic brain injury, orthopedic controls | TAS-20 | Neuropsychological test battery testing reading and comprehension | Structural | Brain injury = 60.71 (14.66) Orthopedic = 47.17 (11.17) | Not reported | No |
| Wotschack and Klann-Delius (2013) | 102 | 35 | 42.2 | HV | TAS-20 | Semi-standardized interviews about emotion knowledge and autobiographic narratives | Emotional language use | HA (> 55) = 67.7 (6.8) LA (< 45) = 38.3 (4.2) | Not reported | No |
| Yao et al. (2018) | 127 | 22.4 | 64.6 | HV (students) | TAS-20 | Lexical decision of word or nonword with emotion (negative, neutral, positive) and concreteness (abstract, concrete) considered | Structural | Total = 46 (11) | 22–74 | No |

*Notes.* BVAQ = Bermond-Vorst Alexithymia Questionnaire; DDF = Difficulty Describing Feelings subscale; DLD = Developmental language disorder; HA/MA/LA = High/Medium/Low alexithymia; HV = Healthy volunteers; PTSD = Post-traumatic stress disorder; TAS = Toronto Alexithymia Scale; – = Not applicable

were used in the meta-analysis, given that these emotional categories are more commonly used in the literature. Where applicable, signs of the correlation coefficients were reversed prior to the meta-analysis such that a negative correlation denoted poorer language function with increasing alexithymia.

Briefly, a Fisher r-to-z transformation was performed to standardize the correlation coefficients extracted, thereby allowing the accurate estimation of a pooled effect size across the studies via inverse variance weighting. Heterogeneity of the data was assessed using the Q statistic, which is the sum of the weighted squared differences between the observed effect size of each study and the fixed effect estimate, relative to the null hypothesis of homogeneity. The $I^2$ statistic was also calculated, which quantifies the percentage of effect size variability not attributable to sampling error (Huedo-Medina et al., 2006). The respective degrees of heterogeneity are low (25%), moderate (50%), and high (75%) (Higgins et al., 2003). Studies that significantly deviated from the 95% confidence interval of the summary effect size were removed. Wherever possible, a publication bias analysis was performed to examine if any null or modest evidence had been excluded from the literature via inspection of asymmetry of the funnel plot and the Egger's test (Egger et al., 1997). For the sake of completeness, publication bias information is reported throughout but should be interpreted with caution given that at least 10 studies are needed for generating reliable estimates. Moreover, influence analysis via the leave-one-out method was used to examine the influence of each individual study on the summary effect size. Baujat plots were generated to depict the contribution of individual studies to overall heterogeneity.

As for the *Main analysis*, an overall analysis inclusive of all individual studies was performed to synthesize the effect sizes indicative of the association between alexithymia and language abilities across domains. To ensure that each independent group of participants contributes to one effect size for the random-effects model, a composite effect size was computed for Hobson and van den Bedem (2021) by averaging the effect sizes for structural language and pragmatics in the same sample. A subgroup analysis was then performed to statistically compare effect size differences between studies classified into structural language, pragmatics, and natural use of emotional language domains. Two studies (Hobson and van den Bedem, 2021; Snow et al., 2016) were removed from this subgroup analysis as their effect sizes fell into both structural language and pragmatics categories. To investigate the association between alexithymia and specific language abilities more closely, follow-up analyses were conducted separately within each language domain. Supplementary analyses examining potential differences between clinical and developmental groups, and association with TAS-20 subscales are described throughout, and presented in the Supplementary Materials.

Finally, we analyzed a subset of 4 studies (4 effect sizes) that compared the degree of alexithymia (as dependent variable) between participant groups with and without language impairments. This analysis, although limited by the low number of studies, provides a more direct test of the idea that there are unique risks among individuals with language impairments/disorders for developing alexithymia. For these group-based studies, the means and standard deviations of alexithymia scores for the language impaired and non-impaired groups were extracted for computing standardized mean difference among individual studies, which were then converted to Hedges' g as a pooled summary

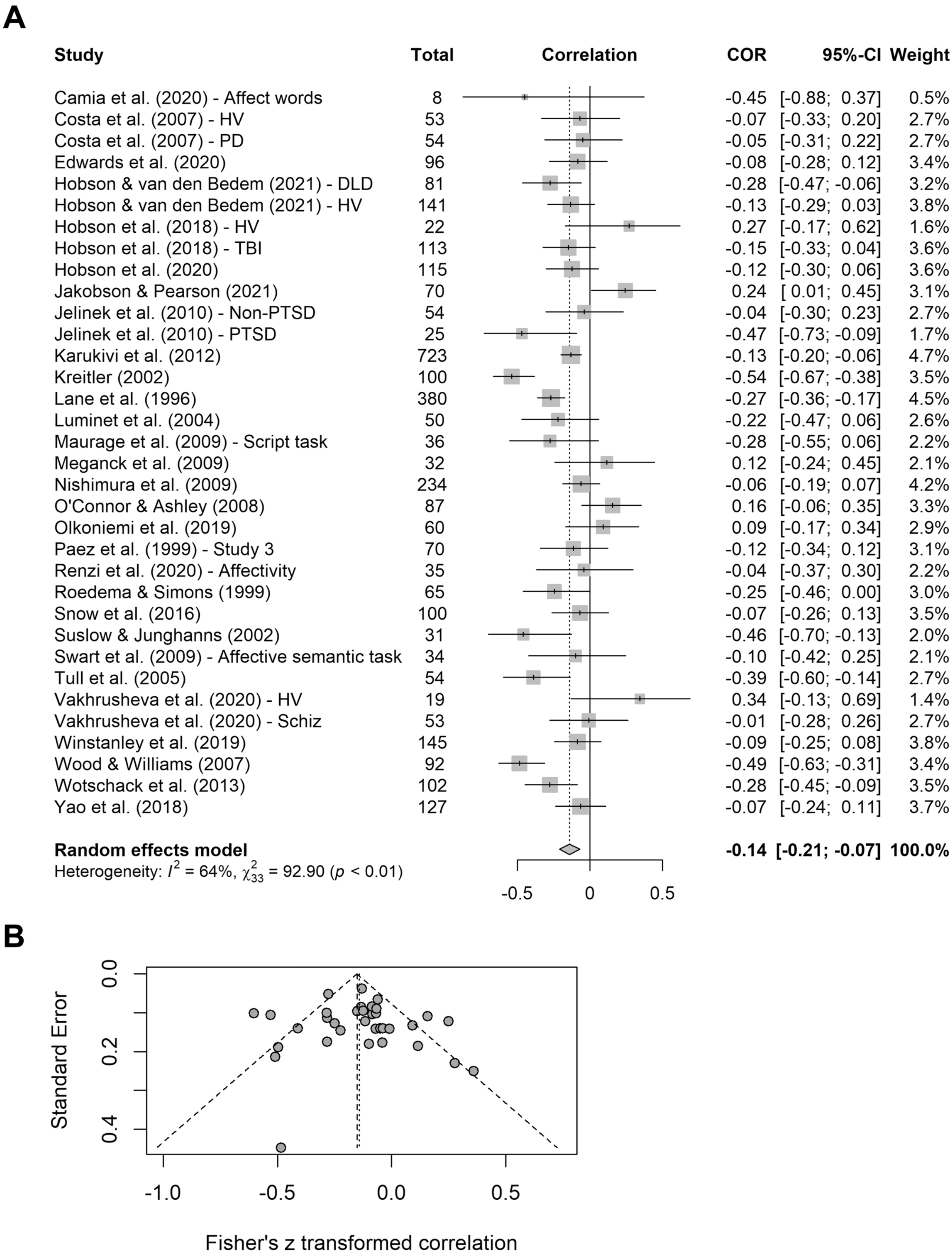


**Fig. 2.** Overall language abilities in alexithymia. *Notes.* (A) Forest plot summarizing the individual effect sizes, confidence intervals, and weighting of each article, and pooled effect size inclusive of outliers across language domains. (B) Funnel plot visualizing the relationship between standard error and Fisher's z transformed correlation for each language study. DLD = developmental language disorder; HV = healthy volunteers; PD = Parkinson's disease; PTSD = post-traumatic stress disorder; Schiz = patients with schizophrenia; TBI = patients with traumatic brain injury.

effect size given the small sample sizes (Hedges and Olkin, 1985).

### 2.2. Results

#### 2.2.1. Systematic review

*2.2.1.1. Sample characteristics.* Of the 29 studies, the average sample size was 115.8 participants, but considerable variation was observed (median = 72, *SD* = 142.2, range = 8–723). A few studies utilized data from large-scale research projects which may have skewed the mean sample size (e.g., Karukivi et al., 2012; Nishimura et al., 2009). The mean age of participants was 33 years (median = 25.8 years, *SD* = 25.8, range = 13.7–80). Two studies did not report the participants' age (Páez et al., 1999; Roedema and Simons, 1999). Of the 27 studies that reported gender proportion, the average percentage of female participants was 51.8% (median = 51.6%, *SD* = 17), ranging from 15% to 76.7%. Two studies included only male (Hobson et al., 2018) or female participants (Renzi et al., 2020).

In terms of participants, 21 studies recruited healthy volunteers as the major study sample (14 studies) or comparison group (7 studies). Six of those 21 studies were from university student populations. All studies sampled Caucasian populations, except for one study that recruited junior high school students in Japan (Nishimura et al., 2009). Among studies that recruited clinical samples, four clinical groups were examined. These include patients with brain injury or related neuropsychological insults (3 studies), neuropsychiatric conditions including schizophrenia and Parkinson's disease (2 studies), affective disorders and related substance misuse (4 studies), and youths with developmental and early behavioral concerns (5 studies).

*2.2.1.2. Alexithymia measures.* As detailed in **2.1.2. Study Selection**, the TAS-20 was the most commonly used measure of alexithymia (24 out of 29 studies); two studies used the older 26-item version (Páez et al., 1999; Roedema and Simons, 1999). Two other studies (Luminet et al., 2004; Swart et al., 2009) used the BVAQ (Vorst and Bermond, 2001) and one developmental study (Hobson and van den Bedem, 2021) used the CAM (Way et al., 2010). Twenty-four studies reported the means and standard deviations of alexithymia or emotional self-awareness scores, but only 12 of those also reported the range of alexithymia or emotional self-awareness scores. Among studies that administered the TAS-20, the mean alexithymia score was 50.01 (median = 49.43, *SD* = 7.91), which corresponds to a low level of alexithymia based on recommended cutoff scores (Parker et al., 2003).

*2.2.1.3. Language assessments.* A summary of the language measures and language domains of interest is detailed in **2.1.3. Data Extraction**.

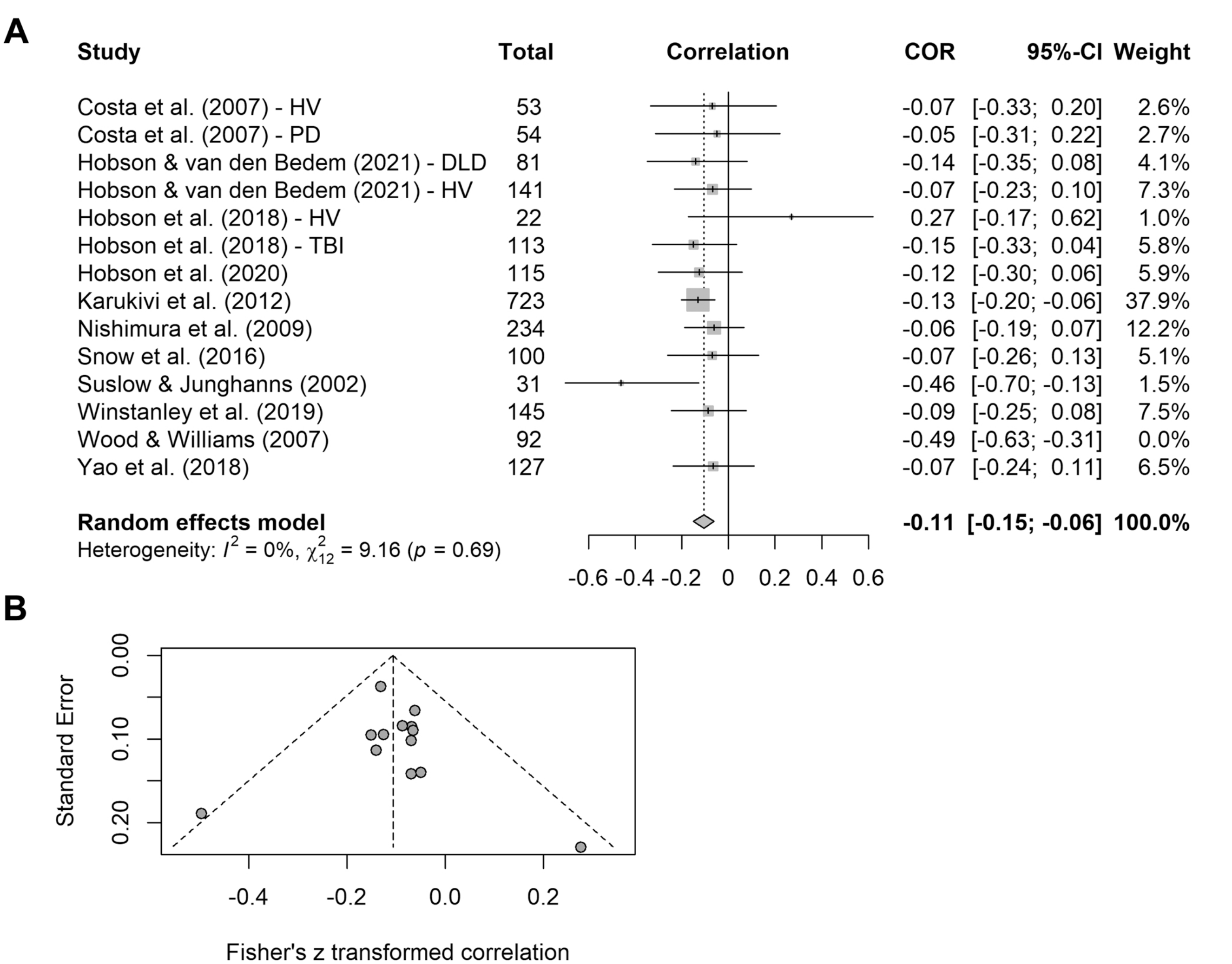


**Fig. 3.** Structural language abilities in alexithymia. *Notes.* (A) Forest plot showing the individual effect sizes, confidence intervals, and weighting of each structural language study, and effect size summary excluding outlying studies. (B) Funnel plot visualizing the relationship between standard error and Fisher's z transformed correlation for each structural language study. DLD = developmental language disorder; HV = healthy volunteers; PD = Parkinson's disease; TBI = patients with traumatic brain injury.

#### 2.2.2. Meta-analysis

*2.2.2.1. Overall language abilities.* The overall analysis of language abilities in alexithymia comprised 29 studies (34 effect sizes) and indicated considerable heterogeneity across studies (Q = 92.90, $p < .001$; $I^2 = 64.5\%$), supporting the use of a random-effects model for the meta-analysis. The analysis generated a summary effect size of − 0.14 [CI: − 0.21; − 0.07], $p < .001$, across language domains. Influence analyses using the leave-one-out method revealed that the summary effect sizes ranged consistently from − 0.13 to − 0.15, all of which indicated a significant association between alexithymia and language. Results remained largely unchanged with outliers removed (25 studies, 30 effect sizes), with a summary effect size of − 0.14 [CI: − 0.19; − 0.09], $p < .001$, and moderate heterogeneity (Q = 41.35, $p = .06$; $I^2 = 29.9\%$). This suggested an $R^2$ value of 0.02, meaning that 2% of the variance in language abilities across domains was associated with alexithymia. Inspection of the funnel plot and a non-significant Egger's test suggested no evidence for publication bias. Fig. 2A and B present the summary effect sizes of the studies, and a funnel plot for detecting publication bias, respectively. A follow-up subgroup analysis (27 studies, 31 effect sizes) was conducted to investigate if the effect sizes significantly differ from each other between the three language domains. However, no significant cross-domain differences were observed regardless of outliers, Q(2) = 0.59, $p = .75$ (see Fig. S1 in the Supplementary Materials).

We present in the Supplementary Materials two other subgroup analyses exploring any group differences in effect sizes between clinical versus non-clinical participants (24 studies, 28 effect sizes), and developmental age groups (26 studies, 30 effect sizes). Both analyses revealed no significant differences.

*2.2.2.2. Structural language.* The analysis of structural language consisted of 11 studies (14 effect sizes) and indicated a statistically significant Q statistic (Q = 24.5, $p = .03$) and an $I^2$ statistic of 46.9%. The analysis generated a pooled effect size of − 0.13 [CI: − 0.19; − 0.06], $p < .001$, with an $R^2$ value of 0.02. That is, 2% of the variance in structural language was associated with alexithymia. Influence analysis indicated that the pooled effect size was not substantially influenced by particular studies, with all effect sizes ranging from − 0.11 to − 0.14. Given the moderate degree of heterogeneity, Wood and Williams (2007), which reported an effect size that significantly exceeded the confidence interval of the pooled effect size, was then removed from the analysis. This analysis revealed a pooled effect size of − 0.11 [CI: − 0.15; − 0.06], $p < .001$ with an $R^2$ value of 0.01, meaning that only 1% of the variance in structural language abilities was associated with alexithymia. Low heterogeneity was observed among studies after the removal of outliers (Q = 9.16, $p = .69$; $I^2 = 0\%$). Inspection of the funnel plot and a non-significant Egger's test suggested no evidence of publication bias in the structural language studies. Fig. 3A and B present the effect size summary and funnel plot.

*2.2.2.3. Pragmatics.* The analysis of pragmatics comprised 7 studies (8 effect sizes), with a statistically significant Q statistic (Q = 26.89, $p < .001$) and an $I^2$ value of 74%. A non-significant pooled effect size of − 0.13 [CI: − 0.28;0.02], $p = .09$ was observed. No outlying studies were detected. However, influence analysis indicated that the summary effect sizes varied from − 0.09 to − 0.19, with 6 out of 8 effect sizes crossing the zero boundary slightly. Visual inspection of the Baujat plot also indicated that Jakobson and Pearson's (2021) and Lane and colleagues' (1999) studies had significant influence on the overall heterogeneity (< 2) and pooled results (< 10), respectively. A sensitive analysis was hence conducted by excluding these two studies (5 studies, 6 effect sizes) and revealed a pooled effect size of − 0.17 [CI: − 0.31; − 0.02], $p = .03$, $R^2 = 0.03$ (Fig. 4A). This suggested that 3% of the variance in pragmatics was associated with alexithymia after removing the influential studies. Low to moderate heterogeneity was observed after the removal of these influential effect sizes (Q = 11.11, $p = .05$; $I^2$

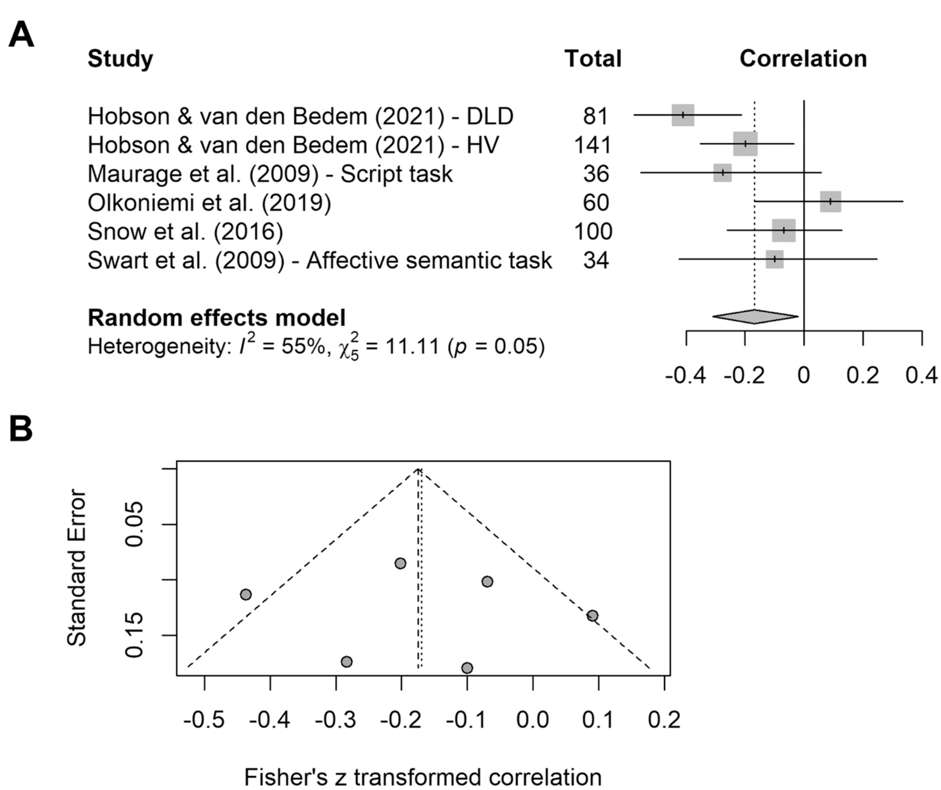


**Fig. 4.** Pragmatics in alexithymia. *Notes.* (A) Forest plot showing the individual effect sizes, confidence intervals, and weighting of each pragmatics study, and effect size summary excluding influential studies. (B) Funnel plot visualizing the relationship between standard error and Fisher's z transformed correlation for each pragmatics study. DLD = developmental language disorder; HV = healthy volunteers.

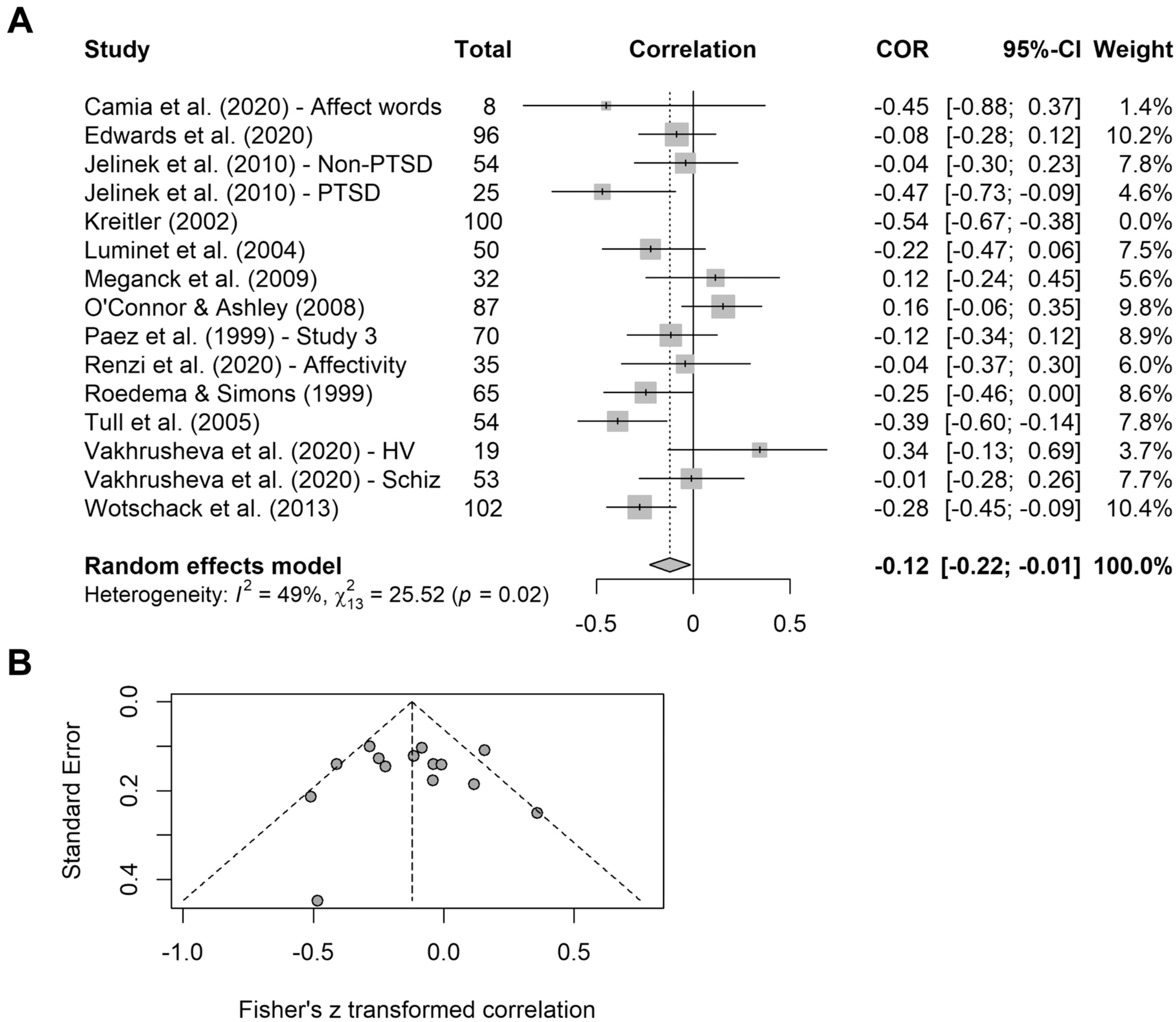


**Fig. 5.** Natural use of emotional language in alexithymia. *Notes.* (A) Forest plot showing the individual effect sizes, confidence intervals, and weighting across individual studies that examined the association between the propensity to use emotional language and alexithymia. Kreitler (2002) was removed from the pooled effect size summary because of outlying data. (B) Funnel plot visualizing the relationship between standard error and Fisher's z transformed correlation for each study. HV = healthy volunteers; PTSD = post-traumatic stress disorder; Schiz = patients with schizophrenia.

= 55%). No evidence of publication bias was observed as depicted in the funnel plot (Fig. 4B); yet low study availability precluded us from validating via the Egger's test.

To supplement the main findings above, an exploratory analysis was performed in a subset of three studies ($N = 450$; Lane et al., 1996; Maurage et al., 2009; Swart et al., 2009) that specifically investigated participants' accuracy of understanding emotional states via language. This analysis yielded a pooled effect size of − 0.26 [CI: − 0.34; − 0.17], $p < .001$. Low heterogeneity was observed (Q =0.91, $p = .63$; $I^2 = 0\%$). Further, we analyzed another subset of three studies (Jakobson and Pearson, 2021; Olkoniemi et al., 2019; Swart et al., 2009) that also reported processing efficiency variables (e.g., reaction times when making judgements of the pragmatics stimuli), and this analysis produced a pooled effect size of − 0.20 [CI: − 0.34; − 0.04], $p = .01$, $R^2 = 0.04$. Low heterogeneity was detected (Q =0.23, $p = .89$; $I^2 = 0\%$). See Figs. S2–3 for forest plots in the Supplementary Materials.

*2.2.2.4. Natural use of emotional language.* Finally, the analysis of natural use of emotional language consisted of 13 studies (15 effect sizes). The resulting Q statistic (Q = 45.38, $p < .001$) and $I^2$ statistic (69.1%) indicated moderate to high heterogeneity among studies. The analysis generated a pooled effect size of − 0.16 [CI: − 0.28; − 0.03], $p = .01$. The summary effect sizes were not substantially influenced by individual studies as reflected in the leave-one-out-method analyses, all of which were significant ranging from − 0.12 to − 0.19. Subsequent removal of Kreitler's (2002) outlying study resulted in a pooled effect size of − 0.12 [CI: − 0.22; − 0.01], $p = .03$, with an $R^2$ value of 0.01, suggesting only 1% of variance was associated with alexithymia (Fig. 5A). No publication bias was observed upon inspection of the funnel plot (Fig. 5B) and via the non-significant Egger's test.

Clinical studies point to an association between alexithymia and suboptimal emotional well-being (Albantakis et al., 2020; Grabe et al., 2004; Gross and Jazaieri, 2014), which often co-occurs with a cognitive bias towards negative emotions as observed in depression and post-traumatic stress disorder (Albantakis et al., 2020; Gross and Jazaieri, 2014; Preece et al., 2022). We therefore speculated that the modest effect observed in the *Natural Use of Emotional Language* analysis might be a product of differential effects of alexithymia on the use of positive and negative emotion language. Two separate follow-up analyses were conducted to synthesize the effect sizes in studies that investigated the propensity to use positive versus negative emotional language. Intriguingly, higher alexithymia was associated with *lower* propensity to use positive emotional language ($r = -0.15$) but *higher* propensity to use negative emotional language ($r = 0.21$) (See

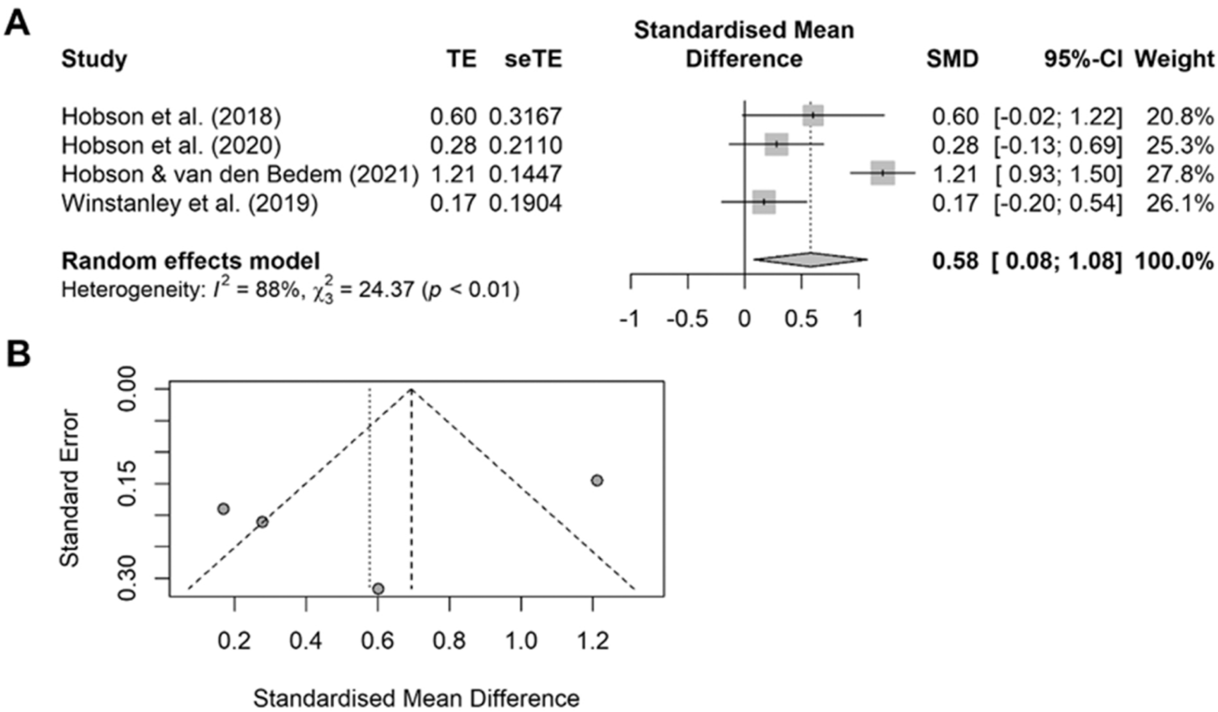


**Fig. 6.** Differences in alexithymia between language impaired and non-impaired groups. *Notes.* (A) Forest plot summarizing the individual effect sizes, confidence intervals, and weighting of each study that analyzed group differences in alexithymia between participants with and without language impairments, and pooled effect size summary. (B) Funnel plot visualizing the relationship between standard error and standardized mean difference for each study. HV = healthy volunteer; TBI = patients with traumatic brain injury; TAS = Toronto Alexithymia Scale.

Figs. S4–S5 in the Supplementary Materials).

*2.2.2.5. Differences in alexithymia between language impaired and non-impaired groups.* We examined a theoretically more relevant subset of four studies that directly compared the degree of alexithymia (as a dependent variable) between language impaired and non-impaired groups. These studies mostly focused on structural language deficits. Results indicated that participants with language impairments showed significantly higher levels of alexithymia than those without language impairments (standardized mean difference = 0.58 [CI:.08; 1.08], $p$ = .02, Fig. 6), a moderate effect size that was markedly larger than those found in the studies synthesized above. While no outliers were detected, moderate to high heterogeneity was present among individual studies (Q = 24.37, $p < .01$; $I^2$ = 87.7%).

*2.2.2.6. Supplementary TAS subscales analyses.* Presented in the Supplementary Materials, we analyzed studies that also reported the association between structural language abilities and TAS subscales. Results suggested that only Externally Oriented Thinking and Difficulty Identifying Feelings were associated with structural language difficulties (Figs. S6–S8).

## 3. Meta-analysis 2

### 3.1. Method

#### 3.1.1. Search strategy

A similar search strategy as described in *Meta-Analysis 1* was used to identify potential empirical studies of the association between alexithymia and emotional granularity. Specifically, based on the 2020 PRISMA guidelines (Page et al., 2021), a systematic search was conducted in PubMed, PsycINFO, Medline, and Web of Science using the search terms and their derivatives: (Alexithymia OR "emotional awareness") AND "emotional granularity" in August 2021. A systematic literature search was conducted in Google Scholar and WorldCat to identify any additional studies or grey literature. Searches were restricted to empirical studies written in English, with no restrictions on publication date. With duplicates removed, 39 studies were identified via the systematic search of databases, and 8 studies were identified from the other sources. On an exploratory basis, we also compared our search results with alternative search terms and their derivatives in the same databases: (Alexithymia OR "emotional awareness") AND ("categorisation" OR "categorization" OR "differentiation" OR "generalisation" OR "generalization"), and retrieved the same set of articles as discovered in the initial search, but with more irrelevant literature. The initial search results were then compared with a meta-analysis on emotion differentiation and individual differences in well-being (Erbas et al., 2019), and this provided one additional study (Erbas et al., 2014). Together, this yielded a collection of 28 studies for screening and full-text assessment for eligibility.

#### 3.1.2. Study selection

Screening of titles, abstracts, and keywords, and full-text assessment were conducted independently by KSL. Ambiguous studies were discussed with JM. Eight studies from the database search were removed following initial screening, leaving 19 studies for full-text assessment. Studies were considered not eligible for data extraction if there were no measures of emotional granularity, no measures of alexithymia/emotional self-awareness, or no extractable data, such as those reporting alexithymia as a sample characteristic without further analyzing its association with emotional granularity. This full-text assessment led to a final collection of 12 studies for the meta-analysis. Eleven studies used the TAS-20 and/or its subscales to index individual differences in alexithymia, while one study (Boden et al., 2013) opted for the Trait Meta-Mood Scale (Clarity) to assess emotional self-awareness more broadly. This study was retained as we found no evidence that any of the pooled effect sizes as summarized below were substantially influenced by the measurement choice. The means and standard deviations of

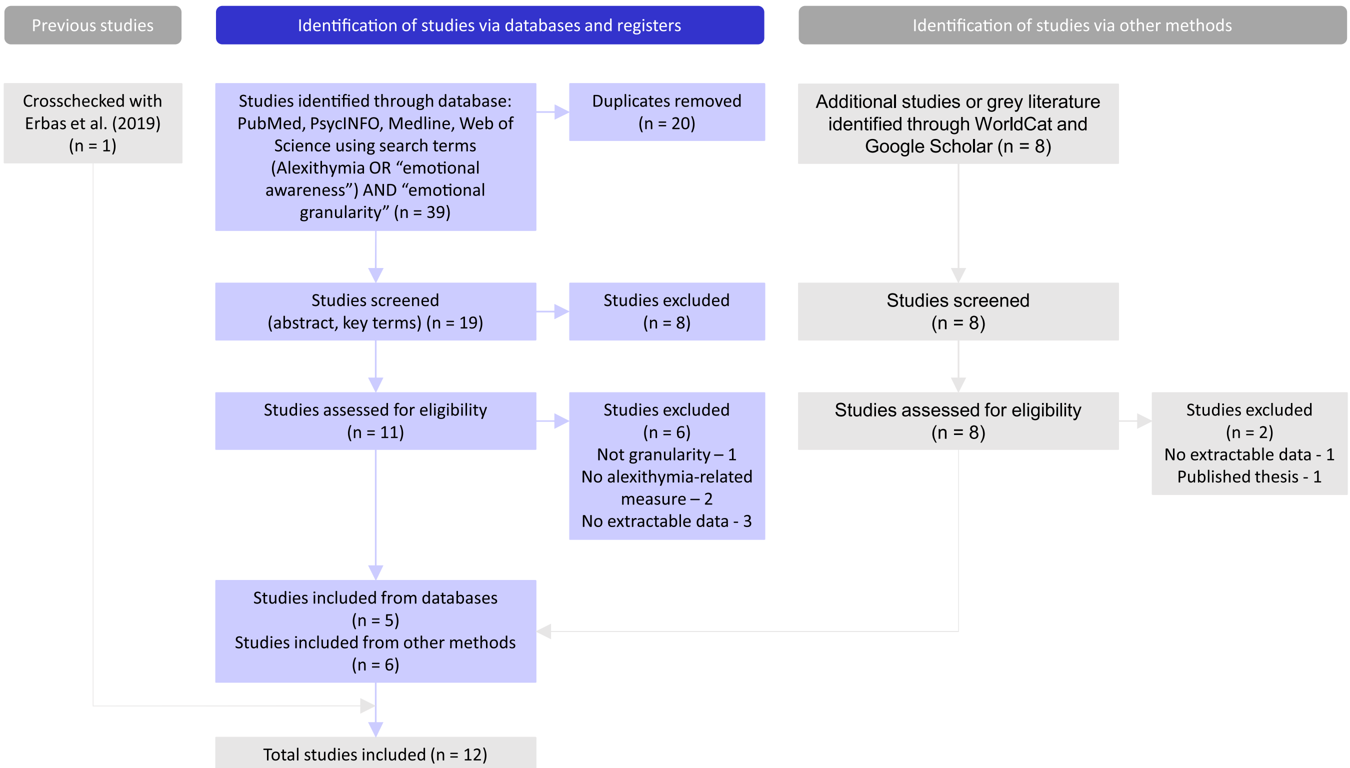


**Fig. 7.** Literature search history of emotional granularity in alexithymia.

alexithymia/emotional self-awareness were reported in 11 studies, four of which also reported the score ranges. Two studies (Experiment 2 in Boden et al., 2013; Ottenstein and Lischetzke, 2020) assessed emotional granularity via conventional experience sampling techniques, in which participants received text prompts to report their daily emotional experiences in terms of valence and arousal. The remaining studies primarily used laboratory-based tasks which required participants to evaluate their feelings in response to a series of emotional stimuli (e.g., pictures, musical excerpts) pre-selected by the experimenters. Fig. 7 details the literature search history. Data from one study (Edwards and Wupperman, 2017) were provided by the authors.

#### 3.1.3. *Data extraction*

Table 2 provides a summary of the emotional granularity studies. Sample characteristics, as in *Meta-Analysis 1*, and the emotional granularity measures were extracted. In these studies, emotional granularity was primarily operationalized as the within-person intra-class correlation between different emotions of similar valence across different contexts (e.g., Boden et al., 2013; Erbas et al., 2014, 2019; Ottenstein and Lischetzke, 2020). By reversing the signs of the correlations for ease of interpretation, lower within-person correlations indicated that the participants did not strongly distinguish between emotion terms when reporting their feelings across contexts, hence lower emotional granularity. Higher within-person correlations, in contrast, were seen as more divergent reporting of emotions, thus higher emotional specificity across situations. A novel emotion consistency task was used in one study (Huggins et al., 2021), in which participants were asked to indicate the image that evokes the stronger emotion within a pair. This produced rank scores for the images, and the differences in rank scores between the chosen and unchosen images were summed to produce emotion consistency scores for each participant. Higher consistency scores indicated higher emotional specificity.

#### 3.1.4. *Statistical analysis*

The same statistical procedures were conducted as described previously in *Meta-Analysis 1*. Random-effects models (Field, 2001; Hunter and Schmidt, 2000) and the conventional restricted maximum likelihood estimator were used (Viechtbauer, 2005). Similarly, correlation coefficients of the association between emotional granularity and emotion awareness/alexithymia were extracted, and pooled as a summary effect size of the individual studies. For studies that reported separate effect sizes for positive and negative emotional granularity, the averaged effect size was calculated as a proxy of the effect size of global emotional granularity (Borenstein et al., 2009). A similar approach was used for Larwood and colleagues (2021) who reported separate effect sizes for valence and arousal judgements for musical stimuli, and the averaged effect size was calculated. Two studies (Erbas et al., 2014; Ottenstein and Lischetzke, 2020) reported effect sizes using the TAS-20 subscales, and the averaged effect sizes across subscales were used in the meta-analyses. Erbas and colleagues (2019) was removed from the following analyses as their effect sizes were aggregated across six datasets. Instead, data from one of the datasets was used (Erbas et al., 2014).

An overall analysis of global emotional granularity was first conducted, which summarized the extent to which individual differences in perceiving the similarities/differences between emotion concepts is associated with alexithymia regardless of emotional valence. Studies that only reported effect sizes for either positive or negative emotional granularity were removed from this analysis. Two separate analyses aggregating studies that specifically investigated positive and negative emotional granularity were then performed in order to clarify whether alexithymia is differentially associated with emotional granularity for positive and negative emotions. A subgroup analysis comparing clinical and non-clinical participants was not performed, given that 8 out of 11 studies recruited healthy student (undergraduate) samples.

### 3.2. *Results*

#### 3.2.1. *Global emotional granularity*

The analysis of global emotional granularity comprised 11 studies

**Table 2**
Overview of emotional granularity studies in alexithymia ($k = 12$).

| Study | N | Mean age (years) | % Female | Indication | Measure | Method | Task | Alexithymia mean (SD) | Alexithymia range |
|---|---|---|---|---|---|---|---|---|---|
| Aaron et al. (2018) | 108 | 19.3 | 67.6 | HV (undergrads) | TAS-20 | Lab | Emotion induction task requiring participants to identify which of the 16 emotions they experienced the most and rated the intensity of their emotions after watching some emotion inducing clips. | Total = 45.60 (8.53) | 30–73 |
| Boden et al. (2013) - Experiment 1 | 201 | 19.4 | 57.9 | HV (undergrads) | TMMS (Clarity) | Lab | Scenario rating task requiring participants to read descriptions of emotion-eliciting situations, and rate how they would feel. | Total = 3.31 (0.56) | 1.55–5 |
| Boden et al. (2013) - Experiment 2 | 99 | 19.1 | 60.6 | | | Sampling | Classic experience sampling exercise in which participants were prompted to record their daily affective experiences (valence, arousal) for 15 days. | Total = 3.34 (0.70) | 1.18–4.80 |
| Edwards and Wupperman (2017) | 96 | 20 (median) | 76 | HV (undergrads) | TAS-20 | Lab | Emotion differentiation written exercise requiring participants to engage in autobiographical recall tasks (negative, neutral or positive experiences) and to reflect upon through writing a past experience that fitted the description. Participants then reported how they felt during writing with the Positive and Negative Affect Schedule. | Total = 44.35 (12.05) | Not reported |
| Erbas et al. (2014) - Experiment 2 | 131 | 18.5 | 84.7 | HV (undergrads) | TAS-20 subscales | Lab | Negative emotion differentiation task requiring participants to write down pre-defined descriptions of people and then rate them on emotion terms. | DDF = 2.02 (0.94)<br>DIF = 1.32 (0.79)<br>EOT = 2.43 (0.58) | Not reported |
| Erbas et al. (2014) - Experiment 3 | 170 | 18.4 | 81.2 | | | Lab | Negative emotion differentiation task requiring participants to rate their emotional responses to a set of standardized emotional stimuli on some emotion terms. | DDF = 2.50 (1.40)<br>DIF = 1.91 (1.24)<br>EOT = 2.18 (0.62) | Not reported |
| Erbas et al. (2019)* | 343 | 17–19 | 33.3–81.2 | HV (undergrads) | TAS-20 (DIF) | Lab | Negative emotion differentiation tasks asking participants to rate their feelings about some emotional pictures on a list of emotion labels and rating scales (valence, arousal). | Study 1: 1.91 (1.24)<br>Study 2: 1.87 (1.26)<br>Study 6:.94 (0.66) | Not reported |
| Huggins et al. (2021) | 96 | 21 | 81.3 | HV | TAS-20 | Lab | Emotional consistency task requiring participants to choose the image that evokes the stronger emotional response within a pair. | Not reported | Not reported |
| Koven (2014) | 96 | 18.9 | 59.4 | HV (undergrads) | TAS-20 | Lab | Affective judgement tasks requiring participants to evaluate the valence and then intensity of the word (appetitive, neutral, or aversive words from the Affective Norms for English Words) and standardized picture stimuli (representative of appetitive, neutral, or aversive images) on a Likert scale. | Total = 47.1 (10.1)<br>HA ($\geq$ 60) = 64.1 (6.2)<br>LA = 33.7 (2.5) | Not reported |
| Larwood et al. (2021) - Task 2 | 162 | 21.5 | 43.8 | HV | TAS-20 | Lab | Affective judgement task requiring participants to rate the emotion of musical excerpts on a valence scale and an arousal scale. | Total = 54.31 (11.91) | 26–81 |
| Nandrino et al. (2012) - Task 2 | 70 | 21.7 (AN)<br>19.9 (DEP)<br>18.8 (HA)<br>20.5 (HV) | Not reported | AN, DEP, HA, HV | TAS-20 | Lab | Subjective evaluation of emotional reactions (valence, arousal) to the pictures. | AN = 59.4 (3.5)<br>DEP = 60.9 (3.5)<br>HA (> 56) = 59.2 (9.7)<br>HV (< 44) = 45.5 (5.4) | Not reported |
| Ottenstein and Lischetzke (2020) - Study 1 | 111 | 35 | 73 | HV | TAS-20 (DDF, DIF) | Sampling | Experience sampling requiring participants to describe their affective states during the reported events with an open-response | DDF = 2.01 (0.56)<br>DIF = 1.88 (0.55) | Not reported |

(continued on next page)

**Table 2** (*continued*)

| Study | N | Mean age (years) | % Female | Indication | Measure | Method | Task | Alexithymia mean (SD) | Alexithymia range |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | format, instead of a provided list of emotion terms. | | |
| Ottenstein and Lischetzke (2020) - Study 2 | 190 | 40.4 | 74 | | | Sampling | Experience sampling requiring participants to describe their affective states during the reported events with an open-response format first, and then a closed-ended response format. | DDF = 1.85 (0.52) DIF = 1.72 (0.45) | Not reported |
| Ready et al. (2019) | 83 | 20.2 (undergrads) 71.3 (older adults) | Not reported | HV (undergrads, older adults) | TAS-20 | Lab | Emotion differentiation task requiring participants to rate the difference and similarity (valence, arousal) of some affect terms from the Kessler and Staudinger scales. | Undergrads = 39.48 (8.99) Older adults = 39.04 (9.63) | Not reported |
| Zhang et al. (2021) | 318 | 22.8 | 50.6 | HV (undergrads) | TAS-20 | Lab | Positive emotional granularity task requiring participants to view some standardized movie clips of positive themes and rate how intensely they experienced each emotion. | Total = 50.62 (9.54) | Not reported |

*Notes.* * Erbas et al. (2019) is a meta-analysis of six datasets examining the association between emotion differentiation and well-being, in which Erbas et al. (2014) was included. Effect sizes reported in Erbas et al. (2014) were used in the meta-analyses reported here. AN = Anorexia nervosa; DDF = Difficulty Describing Feelings subscale; DEP = Depression; DIF = Difficulty Identifying Feelings subscale; EOT = Externally Oriented Thinking subscale; HA/LA = High/Low alexithymia; HV = Healthy volunteers; TAS = Toronto Alexithymia Scale; TMMS = Trait Meta-Mood Scale.

(14 effect sizes), which indicated a pooled effect size of − 0.10 [CI: − 0.14; − 0.05], $p < .001$, with low heterogeneity observed among individual studies ($Q = 7.92$, $p = .85$; $I^2 = 0\%$). No outliers were detected. The synthesized effect size therefore suggested that only 1% of the variance in emotional granularity was explained by alexithymia. Influence analysis showed that the pooled effect sizes were not substantially driven by any of the individual studies, all of which were statistically significant and ranged from − 0.09 to − 0.10. No publication bias was observed as indicated in the funnel plot and non-significant Egger's test. Fig. 8A and B present the individual effect sizes and funnel

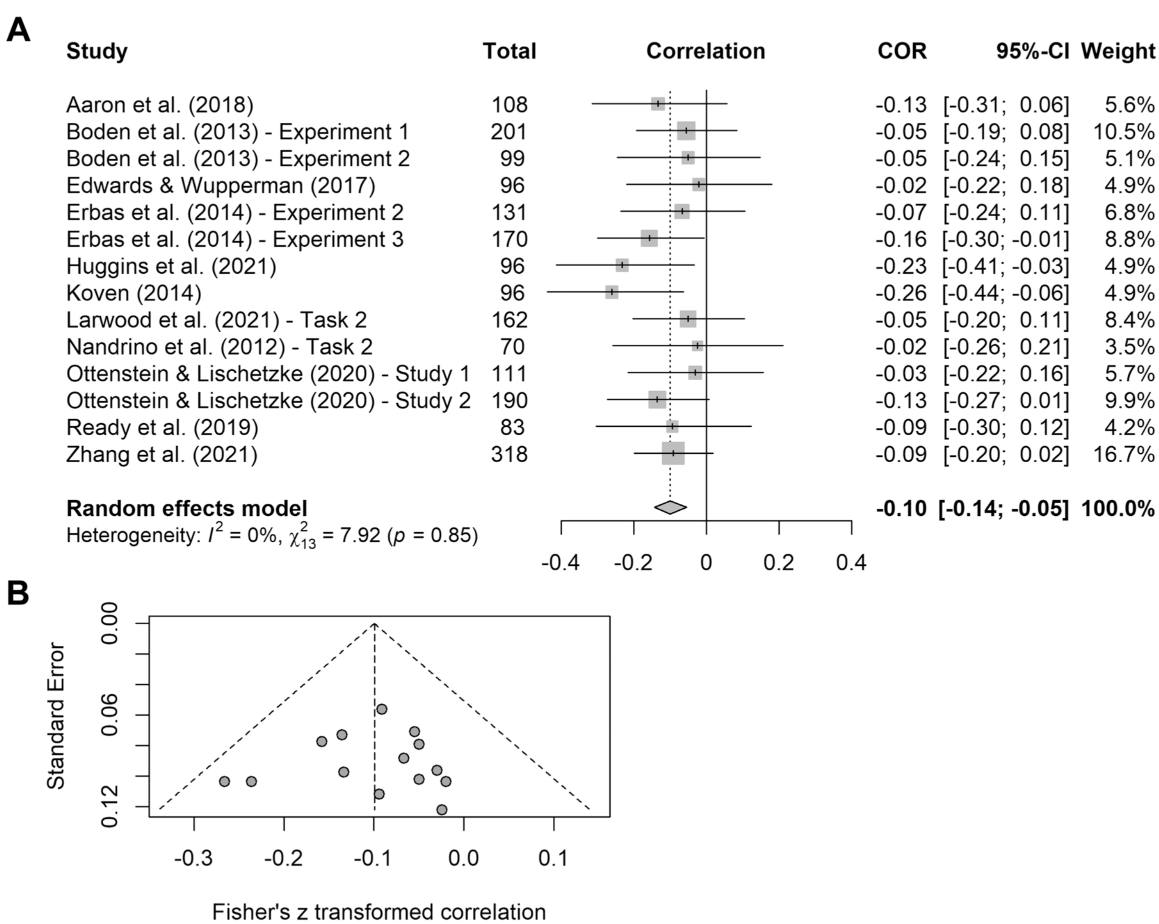


**Fig. 8.** Global emotional granularity in alexithymia. *Notes.* (A) Forest plot summarizing the individual effect sizes, confidence intervals, and weighting of each study, and pooled effect size across emotional valence. (B) Funnel plot visualizing the relationship between standard error and Fisher's z transformed correlation for each global emotional granularity study.

plot, respectively.

### 3.2.2. Positive emotional granularity

The analysis of positive emotional granularity consisted of 8 studies (9 effect sizes), with a borderline significant summary effect size of − 0.06 [CI: − 0.11;0.00], $p = .05$. The individual studies were relatively homogeneous (Q = 4.03, $p = .85$; $I^2 = 0\%$). No outliers were observed. Influence analysis revealed that 8 out of 9 pooled effect sizes crossed the zero boundary, ranging from − 0.04 to − 0.07, which likely suggested a lack of association between positive emotional granularity and alexithymia. Fig. 9A and B present the study effect sizes and funnel plot, respectively.

### 3.2.3. Negative emotional granularity

The analysis of negative emotional granularity comprised 9 studies (12 effect sizes), which produced a pooled effect size of − 0.09 [CI: − 0.15; − 0.04], $p < .001$. Low heterogeneity was observed (Q = 6.68, $p = .82$; $I^2 = 0\%$). No outliers were detected. Influence analysis revealed that the pooled summary effect sizes ranged consistently between − 0.09 to − 0.11, all of which were statistically significant. Similar to the case of global emotional granularity, this suggested that approximately 1% of the variance in negative emotional granularity was associated with alexithymia; yet low study availability precluded us from performing the Egger's test for detecting any publication bias. Fig. 10A and B present the effect size summary and funnel plot, respectively.

### 3.2.4. Supplementary analysis

Three supplementary analyses were performed separately to explore the association between negative emotional granularity and the three TAS subscales. Results showed that only Difficulty Identifying Feelings and Difficulty Describing Feelings were associated with lower negative emotional granularity (see Figs. S9–S11 in the Supplementary Materials).

## 4. Discussion

The current work critically evaluated the empirical literature on language abilities in alexithymia. Our systematic review and meta-analysis provides initial support for the language hypothesis of alexithymia (Hobson et al., 2019), that alexithymia is associated with cross-domain language difficulties. These alexithymia-language associations are modest, consistent with the idea that alexithymia may be a product of language difficulties in a subgroup of individuals, rather than a feature of all alexithymic individuals. Further, follow-up analyses suggested that alexithymia is associated with low emotional granularity, which is in line with constructivist theories which would suggest that the alexithymia-language link is a consequence of disrupted conceptualization of ambiguous affective states (e.g., Lindquist et al., 2015a, 2015b). Nonetheless, considerable heterogeneity in sample characteristics, clinical presentations, and methodological approaches likely contributes to the sometimes mixed, and modest, findings.

We discuss these findings first with respect to the original language hypothesis of alexithymia (Hobson et al., 2019). We then evaluate the applicability of the constructionist model to the language-alexithymia link, and put forth further theoretical considerations for refining the multi-route model of alexithymia. Finally, we discuss future directions for research on the etiology of alexithymia.

### 4.1. Refining the language hypothesis of alexithymia

The language hypothesis of alexithymia proposes that, in some individuals, alexithymia may develop as a result of impaired language function. In other individuals, alexithymia may be a product of non-linguistic variables, such as atypical interoception (Hobson et al.,

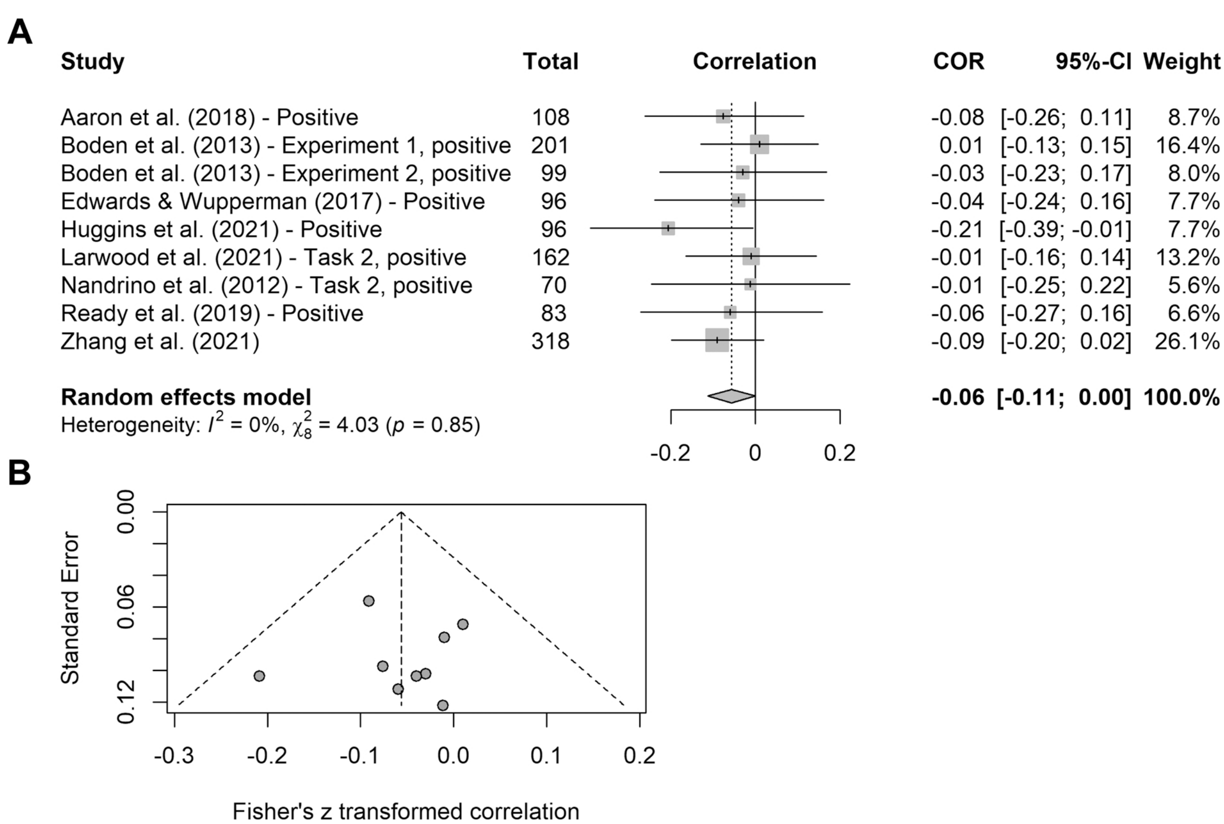


**Fig. 9.** Positive emotional granularity in alexithymia. *Notes.* (A) Forest plot summarizing the individual effect sizes, confidence intervals, and weighting of each study, and effect size summary. (B) Funnel plot visualizing the relationship between standard error and Fisher's z transformed correlation for each positive emotional granularity study.

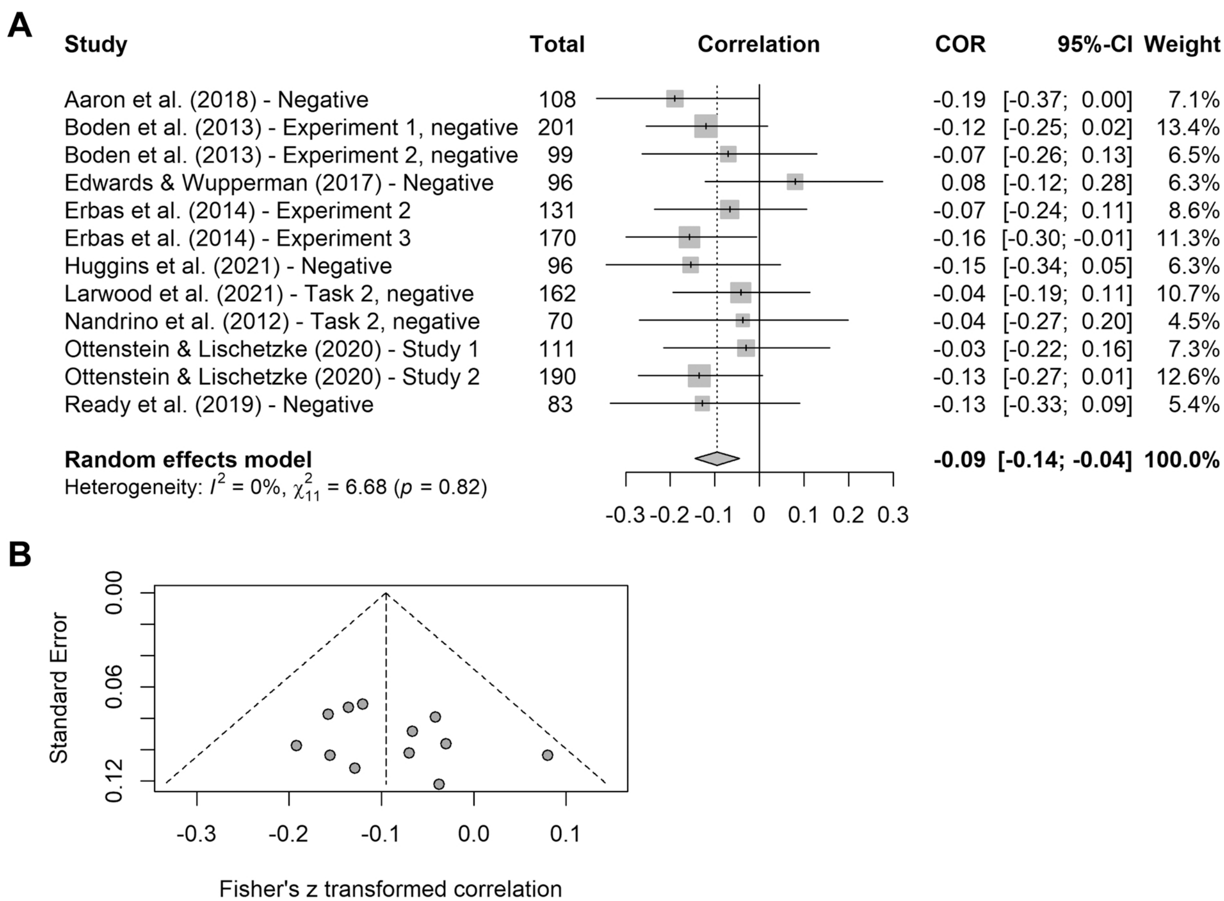


**Fig. 10.** Negative emotional granularity in alexithymia. *Notes.* (A) Forest plot summarizing the individual effect sizes, confidence intervals, and weighting of each study, and effect size summary. (B) Funnel plot visualizing the relationship between standard error and Fisher's z transformed correlation for each negative emotional granularity study.

2019). Thus, according to the language hypothesis, the majority of individuals with language impairments will likely exhibit higher degrees of alexithymia than those with typical language functioning, but not all individuals with alexithymia would show significant language impairments. This is reflected in our results: when aggregating all studies that analyzed individual differences in alexithymia and language abilities dimensionally, the effect sizes of these associations were modest, whereas in a subset of studies comparing language-impaired (e.g., DLD) and non-impaired groups, a larger effect was found where participants with language impairments showed markedly higher degrees of alexithymia than non-impaired participants.

This pattern of results suggests that the link between language function and alexithymia/emotional awareness is unidirectional – poor language leads to alexithymia but alexithymia does not lead to poor language – however, this may not apply if levels of alexithymia pass a critical threshold where they severely impact the opportunity for socialization. If severe alexithymia results in individuals becoming socially isolated, then opportunities for typical language development in childhood, or the development of advanced understanding of pragmatics in adulthood, will be reduced. Indeed, recent studies utilizing ecological momentary assessments have found that alexithymia was robustly associated with fewer (Gerber et al., 2019) and poorer quality social interactions (Kafetsios and Hess, 2019). Developmentally, studies have suggested that social interactions provide children with the opportunities to attend to diverse social cues, which support the uptake of linguistic input and language development (see Rowe and Weisleder, 2020). Consistent with the existence of a causal link between alexithymia and impaired language, as well as between impaired language and alexithymia, are results from a large longitudinal study of 114,000 mother-child dyads. This study reported bi-directional relationships between language difficulties and child internalizing symptoms from 18 months to 8 years, including anxious and depressive symptoms (Helland et al., 2018), which commonly co-occur with alexithymia. It is clear that longitudinal data measuring alexithymia is urgently needed to clarify the causal direction(s) of the alexithymia-language relationship.

### 4.2. Alexithymia and cross-domain language deficits

The empirical literature suggested alexithymia is linked to impairment in several language domains, including structural language, pragmatics, and propensity to use emotional language. The association between alexithymia and multiple language domains may reflect 1) the fact that language domains interact (or that tests of language function are not domain specific), 2) that alexithymia is associated with a core language component common to a number of different domains of language functioning, or 3) that language domains are independent, but each is necessary for typical levels of emotional awareness (i.e., low levels of alexithymia). The potential for different domains of language functioning to play differential roles in emotional awareness is an exciting avenue for future research; here we briefly outline what these roles may be (visualized in Fig. 11).

Structural language is key to the development of concepts generally, including emotion concepts. This is demonstrated in a wealth of studies that demonstrate language-mediated acquisition of abstract concepts and vocabulary, including emotion labels, by manipulating semantic and syntactic structures that were more/less useful in signaling the possible meaning and part of speech of novel words (e.g., Marchman et al., 2004; Naigles and Hoff-Ginsberg, 1995; Shablack et al., 2020; see

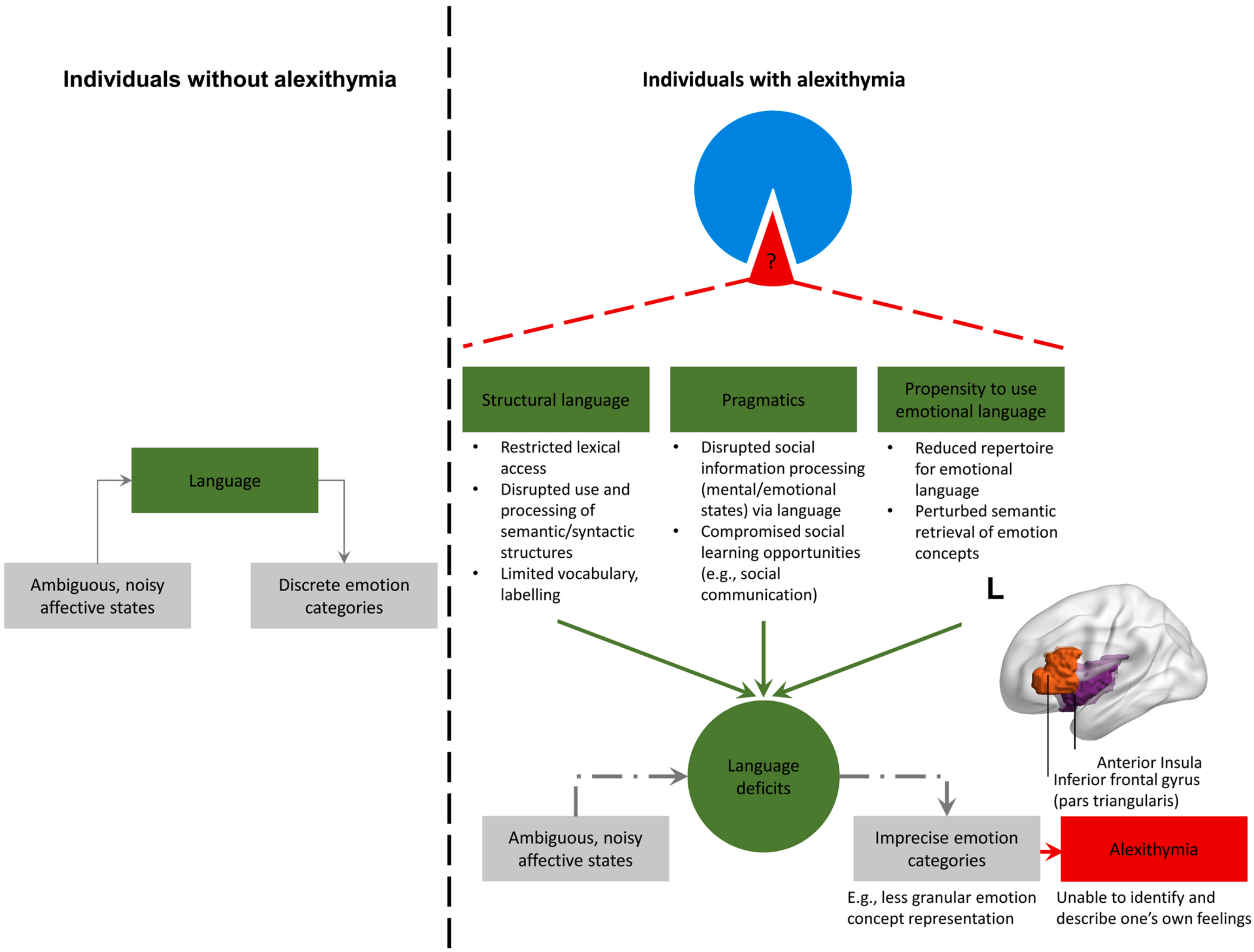


**Fig. 11.** The language hypothesis of alexithymia. *Notes.* Left: The constructionist model of emotion suggests that language facilitates the conceptualization of ambiguous and noisy affective states to discrete emotion categories (e.g., unpleasant sensations → fear, anger). Right: Informed by the constructionist model, the language hypothesis of alexithymia posits that language impairment disrupts the development of discrete emotion concepts from ambiguous affective states, leaving individuals unable to identify and describe their own feelings. A previous study (Hobson et al., 2018) reported that individual differences in alexithymia and language (naming) task performance were most robustly associated with the extent of brain damage in the pars triangularis subregion of inferior frontal gyrus (IFG) and anterior insula (AI), which are regions consistently implicated in emotion word and semantic processing (Brooks et al., 2016; Oosterwijk et al., 2012) and constituent parts of a shared neural network supporting emotional awareness, conceptualization, and interoception (Oosterwijk et al., 2012).

a computational account by Abend et al., 2017). Increased verbal repertoire has also been shown to predict multidimensional representation of emotion concepts from childhood (Nook et al., 2017a). While it remains unknown if a domain-general concept acquisition deficit is present in alexithymia (Hobson et al., 2018), individuals with structural language impairments may lack the necessary linguistic tools for acquiring emotion concepts, exacerbating the risk of developing alexithymia. These impairments include difficulties extracting and learning linguistic structures that signal emotion-related words and information, while limited access to these linguistic structures also reduces one's competence to construct coherent language for communicating one's own feelings.

Social communication is a key milieu for developing one's ability to make mental and emotional state inferences via language (Dunn et al., 1991; Harris et al., 2005; Matthews et al., 2018). For instance, quality parent-child discourse on desires and emotions predicts better emotion understanding in children (Tompkins et al., 2018). Results of studies on the link between alexithymia and pragmatic difficulties were mixed, although all pointed to impairments in alexithymia. As noted above, it is difficult given the current evidence base to determine if alexithymia is related to difficulties understanding language pragmatics specifically, or whether problems with pragmatics reflect a larger problem with theory of mind. A recent review of the theory of mind literature in alexithymia revealed that alexithymia was not generally associated with theory of mind difficulties, but the strength of association depended on the behavioral dimension of interest (efficiency vs. accuracy vs. propensity) and stimulus type (emotional vs. non-emotional) (Pisani et al., 2021). These data suggest that a wider range of studies, utilizing a range of stimuli and requiring a range of response strategies, are necessary in order to provide further clarity on the link between alexithymia, language pragmatics, and theory of mind.

One suggestion to dissociate a general effect of alexithymia on theory of mind versus language specifically, is to test other speech or linguistic elements that specifically aid emotional state inference in language, such as prosody and contextual information. It has been empirically shown that young children were able to acquire unfamiliar emotion concepts more effectively when contextual information about the cause and consequence of an emotional instance was provided alongside structural language cues, such as action verbs and sentence structures cueing emotion-related words (Shablack et al., 2020; also see Ponari et al., 2020 for emotional valence).

Alexithymia is associated with a decreased propensity to use

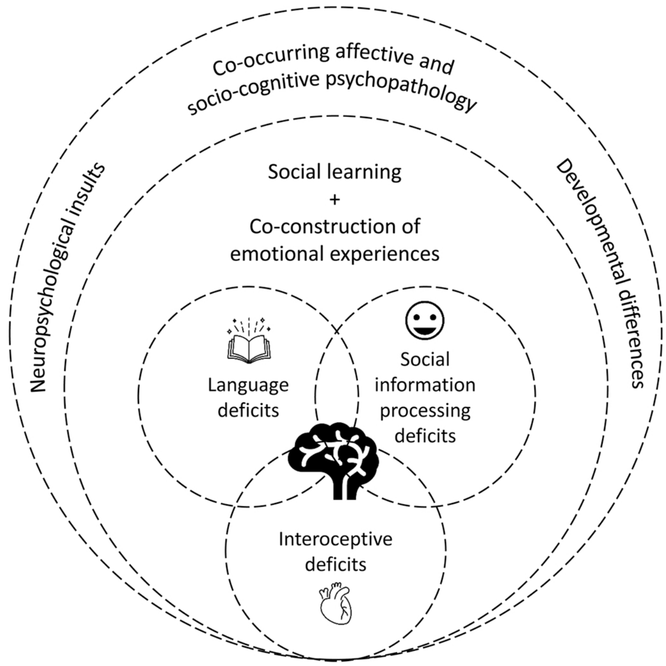


**Fig. 12.** A multi-route model of alexithymia. *Notes.* Beyond interoception and language, the multi-route model of alexithymia suggests that heterogeneity in alexithymia is subserved by multiple etiological pathways, including but not limited to cross-domain language deficits, interoceptive deficits, and disrupted processing of external socioemotional signals. These disrupted psychological processes do not unfold in a vacuum, but also pertain to suboptimal social learning opportunities that compromise the co-construction of emotional experiences with others. Future studies should clarify the confounding effects of co-occurring psychopathology, neuropsychological insults, and developmental differences on elucidating the etiology of alexithymia.

emotional language. This decreased propensity does not necessarily reflect a reduced motivation to use emotional language in individuals with alexithymia, because alexithymia was associated with an *increased* propensity to use negative emotional language. An alternate possibility is that the bias towards the use of negative emotional language (and away from positive emotional language) may reflect negatively biased semantic retrieval of emotion concepts in alexithymia. This possibility, though only speculation at present, is in line with the previous finding (Hobson et al., 2018) that the extent of penetrating brain damage in the inferior frontal gyrus, a functional hub implicated in semantic retrieval (Oosterwijk et al., 2012) and emotion word processing (Brooks et al., 2016), was positively associated with individual differences in alexithymia. The methodologies used in most of the existing studies on the use of emotional language in alexithymia such as free writing paradigms and interviews often lack the necessary design features to isolate the effects of confounding psychological processes and co-occurring affective symptoms, and so the semantic retrieval hypothesis remains an open question for future research. In addition, inviting participants to discuss a past emotional event requires some autobiographical memory capacity and may trigger the bias to recount negative events, especially in those with depressive and PTSD symptoms, making the unique effects of alexithymia difficult to determine (Albantakis et al., 2020; Grabe et al., 2004; Preece et al., 2022). Using an emotional semantic retrieval task, a recent study (Souter et al., 2021) was able to demonstrate that while false semantic cues impair emotion categorization in both patients with semantic aphasia (who lack flexible control over access to semantic knowledge) and healthy controls, patients showed larger benefits from cues that reduced semantic retrieval demand. This suggests the role of semantic control in the perception of ambiguous/conceptually-similar emotional inputs, which may be useful to test the semantic retrieval hypothesis and its interaction with emotion perception in alexithymia.

Despite the empirical issues concerning the study of pragmatics and emotional language in alexithymia detailed above, we consider that it is still premature to conclude that structural language measures are of most use in testing the language hypothesis of alexithymia. This is due to three reasons. First, the three language domains are not functionally independent. For instance, structural language deficits such as restricted lexical access not only disrupt sentence understanding and formation (which impairs narrative emotional language), but also compromise the social competence to engage in and maintain conversations with typically developing peers, as observed in youths with DLD (Hobson and van den Bedem, 2021). Second, individuals with language disorders and related learning difficulties often show cross-domain language impairments, such that having "pure" deficits in a single language domain is clinically unlikely (Moll et al., 2019; Snowling et al., 2019). Third, clinical structural language assessments often have measurement units that are diagnostic (e.g., Token test used in Hobson et al., 2018), whilst lab-based tasks are designed to test specific hypotheses. Task design differences may contribute to different distributions of language variances, thereby affecting the correlation strength with self-ratings of alexithymia, which are subject to other measurement variances from survey artefacts (e.g., question wording and interval scaling) and reporter bias. Nevertheless, ongoing research in cross-domain language deficits and alexithymia has theoretical and clinical implications as it specifies the different aspects of language that contribute to alexithymia. Structural language difficulties may suggest the need for speech and language therapy that improves comprehension and use of lexical devices, whilst pragmatic difficulties may underscore the importance of peer support programs that foster social communication skills.

### 4.3. *Incorporating a constructionist perspective*

Constructionist models of emotion suggest a language-mediated mechanism that enacts the conceptualization of ambiguous and noisy affective sensations into discrete emotion categories, a mechanism scaffolding emotion concept development (Hoemann et al., 2020; Lindquist et al., 2015a, 2015b; Lindquist, 2017). Under such models, language deficits would be expected to lead to alexithymia, and specifically to the reduced granularity of emotion concepts observed in alexithymia. This collection of granularity studies mostly sampled healthy student participants (see Nook et al., 2018 for potential age differences) and were relatively homogeneous in their methods (see a meta-analysis by Erbas et al., 2019). Therefore, while the current findings were consistent with this constructionist idea that alexithymia is associated with less granular representation of emotion concepts, it is possible that the current estimates would vary in different clinical groups and emotion sampling methods (e.g., ecological momentary assessments vs. stimulus induction techniques), warranting future research.

### 4.4. *Limitations and other considerations*

Several limitations should be noted. First, the present study focused on the association between alexithymia and language abilities; only a small subset of studies analyzed differences in alexithymia between language-impaired and non-impaired groups, which would provide a more direct test of the idea that clinically significant language impairments exacerbate the risk of developing alexithymia.

Second, low study availability ($k < 10$) precluded the assessment of publication bias for pragmatics and the subscale supplementary analyses, and likely rendered some of the subgroup analyses underpowered. Therefore, although our subgroup analysis suggested no significant differences in effect sizes between the language domains, more studies are required to make any further interpretation of the relative significance between these language deficits in alexithymia. We also acknowledge that this meta-analysis was not pre-registered, however we followed the PRISMA guidelines closely to ensure the robustness of our methods and all materials and data are openly available.

Third, considerable heterogeneity was observed in the clinical presentation of study participants, including participants with mood-related disorders (e.g., depression and PTSD), neuropsychological conditions (e.g., traumatic brain injury), eating disorders (e.g., anorexia nervosa), and complex psychiatric conditions (e.g., schizophrenia). This is likely to lead to heterogeneity of results across studies, but testing the alexithymia hypothesis in different clinical groups is crucial because alexithymia and language deficits can be a product of psychopathology or brain trauma (Frewen et al., 2008; Hogeveen et al., 2016; Wood and Williams, 2007). Alexithymia and language deficits arising after otherwise typical development, in response to psychopathology or brain injury, are likely to involve different etiological pathways than occur in populations with a developmental history of language problems and/or alexithymia (Hobson et al., 2019). In addition, study participants vary in their developmental stages. Given that core language development happens in early life stages (as early as the first year of life, see Friedmann and Rusou, 2015) and language deterioration may emerge because of ageing (e.g., lexical retrieval in Connor et al., 2004), it is likely that the alexithymia-language association would be moderated by these age-related differences if investigated systematically. Future studies may also consider measuring alexithymia among a subset of individuals at the opposite end of the language spectrum, such as high-achieving novelists and language experts. This would allow it to be determined if emotional awareness is associated with language competence across the whole competence spectrum.

Fourth, the review revealed that the vast majority of studies did not provide sufficient descriptive information as to the range of alexithymic traits in their samples. To allow for a reliable and generalizable understanding of the association between alexithymia and language abilities, one would need a wide range of alexithymic traits. In addition, ideally recruitment strategies would be such that alexithymia can be dissociated from any co-occurring clinical condition (e.g., a study might include depressed individuals with and without alexithymia, and non-depressed individuals with and without alexithymia). More broadly, studies that test the language hypothesis in non-Western cultural contexts are rare, despite the various language adaptions of the TAS-20 as highlighted by the 25-year review (Bagby et al., 2020). We emphasize that cross-cultural studies are pivotal to examine the specificity and commonality of the language-alexithymia association, as there are considerable differences in linguistic structures and customs across cultures.

Fifth, the TAS-20 (Parker et al., 2003) and BVAQ (Vorst and Bermond, 2001) remain the most widely adopted measures of alexithymia, but norming and measurement invariance in different sociocultural and developmental populations, and longitudinal stability are some outstanding measurement issues to be addressed. Informant discrepancy in alexithymia ratings has also been observed in small developmental samples (e.g., parent vs. child self-ratings in an ASD sample in Griffin et al., 2016; and in a DLD sample in Hobson and van den Bedem, 2021). Furthermore, it is crucial to test the specificity of the measurement of alexithymia in the presence of other co-occurring socioemotional symptoms (e.g., autistic traits in Cuve et al., 2021; depressive symptoms in Hintikka et al., 2001), and investigate if existing alexithymia assessments capture comparable information between general and clinical populations (for example using item response theory; Williams and Gotham, 2021; Guillén et al., 2014). The latter is especially relevant to estimating the prevalence of alexithymia in language-impaired populations, as linguistic difficulties can influence the comprehension of assessment items, hence compromising the reliability and validity of symptom reporting (Nishimura et al., 2009; Snow et al., 2016).

Finally, the current meta-analyses included studies that utilized various methodologies to measure language abilities, leading to moderate to high heterogeneity in the results. However, over-reliance on a single language task/assessment can also lead to measurement bias, and most heterogeneity issues were remedied with the removal of outlying studies.

### 4.5. A multi-route model of alexithymia

A central tenet of the language hypothesis of alexithymia is that there are multiple routes to developing alexithymia. While the current study focuses on the multifaceted nature of language domains and their putative roles in exacerbating and/or contributing to alexithymia, there are alternative pathways which remain to be investigated (see Fig. 12). To name a few, inaccurate and insensitive interoception may contribute to noisy affective signals in the body, rendering language-mediated conceptualization more difficult. Disturbed perception of external socioemotional cues, such as facial cues, also disrupts the processing of social signals from the environment (e.g., Cuve et al., 2021), which are elements in forging emotion concepts (e.g., a frowning face → anger/-disapproval) and can be influenced by language (Doyle et al., 2018; Gendron et al., 2012; Nook et al., 2015). Relatedly, it has been suggested that certain facets of alexithymia, such as the lack of emotional clarity, are related to executive dysfunctions which may have downstream effects on emotion processing (Koven and Thomas, 2010). Although alexithymia research has primarily focused on individual processing of emotion, emotion concepts can be co-identified and distilled with others, in particular via emotion-related dialogue with significant others (Gendron and Barrett, 2018; Hoemann et al., 2019), suggesting a novel research angle.

A multi-route model of alexithymia has important clinical implications as it elucidates potential mechanisms of change. With language being a key medium of delivery in most evidence-based interventions for affective psychopathology and potentially having emotion regulation properties (e.g., Nook et al., 2017b, 2020), rethinking the etiological role of language in alexithymia promotes tailored interventions for individuals with clinically significant alexithymia and co-occurring language impairments.

## 5. Conclusion

The current review found initial evidence that alexithymia is associated with deficits in multiple language domains, and less granular representation of emotion concepts. Findings support the language hypothesis of alexithymia, and are supportive of the constructionist perspective on language-mediated emotion concept acquisition. Considerable heterogeneity in clinical presentations and study methods calls attention to alexithymia and language function measurement issues, and the need for a theoretical framework outlining the relevant language constructs.

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## Data statement

Data, analysis script, and all PRIMA materials will be made openly available via OSF: https://osf.io/q6ab8/?view_only= 4c13a8fd6fda40178548746fb44a6589.

## Declarations of interest

None.

## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.neubiorev.2022.104864.

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