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Review

The impact of bilingualism on theory of mind in children with and without developmental disorders: A scoping review

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ABSTRACT

Findings across studies investigating the impact of bilingualism on Theory of Mind (ToM) in children have been mixed, potentially due to methodological differences, including variations in the characterization of bilingualism. At the same time, researchers express the need to take into account the heterogeneity of bilingualism by measuring it in a continuous manner.

This scoping review aimed to explore how previous research identifies important bilingualism variables for future studies on its effects on ToM in children with and without developmental disorders. It analysed the studies' 'reasoning frameworks' to assess these insights. Bilingualism is suggested to influence ToM directly or via factors like executive functioning or metalinguistic awareness. Of 37 studies analysed, few fully tested these hypotheses. Those reporting positive outcomes often involved bilinguals with significant language exposure, supporting the idea that bilingualism impacts ToM, particularly when exposure is considered.

Introduction

Bilingualism, affecting more than half of the world's population (Bialystok, 2018), is defined as the ability to understand or speak more than one language (Grosjean, 1982). The bilingual experience is a complex and heterogenous phenomenon, varying in the age of the first exposure to a second language (L2), the amount of use of and exposure to the L2 and the proficiency in the L2 (DeLuca et al., 2019). Given the prevalence of bilingualism, researchers from different domains and the public have been interested in its cognitive, communicative and linguistic outcomes, including Theory of Mind (ToM). ToM encompasses the ability to understand that others may have different mental states than oneself (Premack & Woodruff, 1978) and it is important for social communication (Slaughter et al., 2015). A *meta*-analysis by Schroeder (2018) on the effects of bilingualism on ToM in neurotypical (NT) children has shown a small- to medium-size effect with bilinguals generally performing better than monolinguals. However, not all studies show positive effects of bilingualism (e.g., Dahlgren et al., 2017). At the same time, the impact of bilingualism on ToM is of particular interest in clinical populations, such as children with Developmental Disorders (DD), including Autism Spectrum Disorder (ASD), Developmental Language Disorder (DLD) and Attention Deficit Hyperactivity Disorder (ADHD), since children with DD have been shown to present ToM deficits (in ADHD: Berenguer et al., 2018; in ASD: e.g., Bulgarelli et al., 2022; in DLD: e.g., Nilsson & de López, 2016). The first studies

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exploring impacts of bilingualism on ToM with children with DD have yielded similar results as those reported for NT children (in DLD: e.g., Peristeri et al., 2019; in ASD: e.g., Peristeri et al., 2021). Different reasons have been put forth to account for the heterogeneous findings in the current state of research on the impact of bilingualism on ToM in children with and without DD. Amongst these reasons is the variation in characterization and operationalization of the bilingual experiences. Researchers are thus calling for enhancing comparability across studies by applying consistent methodologies to measure bilingualism according to relevant characteristics of this experience (Beaudoin et al., 2020; Feng et al., 2023). While there is wide agreement on the need for a systematic approach, such studies are still lacking. In order to identify relevant characteristics of the bilingual experience in research on the effects of bilingualism on ToM, one needs to consider the specific hypotheses proposed about why and how bilingualism influences ToM, in both NT children and children with DD. Once these are validated, the results could serve the ultimate practical purpose of helping clinical practitioners identify important aspects of bilingualism to consider.

The goal of this scoping review is to focus on these hypotheses, and more specifically (1) to determine the extent to which research on the impact of bilingualism on ToM in children with and without DD allows postulating potential pathways from bilingualism to enhanced ToM, and (2) to closely inspect the outcomes and operationalization of bilingualism in studies claiming bilingualism pathways to ToM. This review is organized as follows: We first provide background information on ToM and its links to other cognitive and linguistic abilities (Section 1.1), the effects of bilingualism on ToM (Section 1.2) and the theoretical claims regarding how bilingualism would impact ToM (Section 1.3). This is followed by the review (Sections 2 and 3) and the conclusions that can be drawn from it (Section 4).

Theory of mind in neurotypical children and children with developmental disorders

ToM refers to the ability to understand and infer mental states such as desires, beliefs, and intentions. It involves recognizing that these mental states can vary between oneself and others, and being able to anticipate resulting behaviors (Premack & Woodruff, 1978). Consequently, ToM helps in fostering peer collaborations, and in minimizing miscommunications (Slaughter et al., 2015). ToM has been found to be closely associated with other cognitive abilities, such as executive functioning (EF; Joseph & Tager-Flusberg, 2004), a set of higher-order cognitive-control processes regulating goal-directed thoughts, emotions and actions, such as inhibition (Diamond, 2013). Indeed, the regulation of attention, inhibition, and flexible thinking would be useful for interpreting and responding to others' mental states accurately. Another skill that has been found to relate to ToM is metalinguistic awareness (MLA), which is the understanding that the formal properties of language carry meaning (Doherty & Perner, 1998). Reflecting on language would arguably enable individuals to understand how language conveys thoughts, emotions, and intentions, and such an awareness would lead to the realization that words can represent ideas that may differ from one's own.

Children with DD have been shown to demonstrate delays in ToM (American Psychiatric Association, 2013; World Health Organization, 2022). ASD[1] for example is characterized by persistent deficits in social communication and interaction and children with ASD have been shown to perform weaker on ToM tasks than their NT peers (e.g., Bulgarelli et al., 2022). Children with DLD, previously referred to as Specific Language Impairment (SLI; Bishop, 2017), present primary difficulties in language which may interfere with social communication (Hanley et al., 2014), although secondary difficulties in ToM have also often been attested (Nilsson & de López, 2016) and these can impact their social skills as well (Botting & Conti-Ramsden, 2008). Finally, children with ADHD have been shown to present difficulties in EF and ToM, but not in language (Berenguer et al., 2018).

Given the potential difficulties children with DD may face with ToM, language acquisition, and EF, the question of a potential impact of bilingualism is even more prominent: Caregivers for children with DD often fear that bilingualism may exacerbate difficulties in language acquisition (Beauchamp & MacLeod, 2017; Hampton et al., 2017; Howard et al., 2021), and sometimes opt, as a result, for a "monolingual" environment to guarantee a uniform linguistic environment for their child both at home and in society. This approach, however, does not come without potential negative repercussions: If caregivers have to use a non-native language, this can affect the quality and quantity of the child's language input (Place & Hoff, 2011; Ross & Newport, 1996), as well as the family's level of well-being (Fernandez y Garcia & Fernandez y Garcia, 2012).

Given these concerns about bilingualism and its potential challenges for children with DD, it is important to explore how bilingualism might influence aspects of development, such as ToM, in empirical research conducted so far.

Effects of bilingualism on theory of mind and research gaps

Bilingualism as a potential *natural* booster for ToM in children with DD has been investigated in both children with ASD (e.g., Peristeri et al., 2021; Peristeri et al., 2024a) and DLD (e.g., Peristeri et al., 2019), reporting better performance in bilinguals in comparison to their monolingual peers. However, research on bilingualism effects in children with DD is still scarce. As for NT children, studies investigating the impact of bilingualism on ToM suggest that bilingualism can be advantageous for them as well, with bilingual NT children often performing better than their monolingual peers on tasks assessing ToM (Schroeder, 2018). Crucially, however, while Schroeder (2018) reported a small- to medium-size effect in a *meta*-analysis including studies investigating the impact of bilingualism on ToM in NT children, not all studies report positive effects of bilingualism on ToM (e.g., Dahlgren et al., 2017).

Different reasons have been put forth for the heterogenous findings regarding the impact of bilingualism on ToM: On one hand,

[1] We will employ both person-first and identity-first language interchangeably when describing individuals diagnosed with ASD, to recognize the diverse preferences within the autistic community (Bottema-Beutel et al., 2021; Buijsman et al., 2023; Vivanti, 2020).

critics of the bilingual advantage perspective argue that reported benefits are often artifacts of methodological limitations, such as inadequate matching of participant groups on cultural, demographic, or socioeconomic factors and that there is no effect of bilingualism per se on cognition (Paap et al., 2017, 2024; Paap & Greenberg, 2013). On the other hand, the reason for divergent findings in the current state of research of the impact of bilingualism on children's ToM may be the oversimplification of complex bilingual experiences. Specifically, in studies comparing monolinguals to bilinguals, the bilingual groups present distinct characteristics. They are for example recruited and characterized according to their fluency in different languages (e.g., Díaz & Farrar, 2018), their age of first exposure (AOFE) to the second language (L2; e.g., Kovács, 2009) or their amount of exposure to the L2 (e.g., Yow & Markman, 2015). This observed oversimplification had been claimed as a potential source of variation in study outcomes in the investigation of the impact of bilingualism on another aspect of cognition as well, namely EF (Grundy, 2020). This criticism on studies investigating the effects of bilingualism on EF may also apply to the research on ToM. For example, studies assessing bilinguals' ToM might have overlooked whether the bilingual children have had sufficient exposure to both languages to facilitate the hypothesized cognitive benefits or whether their AOFE in the L2 affects the development of ToM-related skills. Such variations in bilingual profiles in studies comparing monolingual and bilingual children could lead to inconsistent findings, as they introduce heterogeneity that complicates cross-study comparisons and interpretations.

A characterization and operationalization of the bilingual experience in a continuous manner is therefore crucial to allow future study comparisons (Feng et al., 2023). Consequently, the question arises which continuous measures should be used to investigate a potential effect. Close consideration of the hypotheses would be informative to meaningfully select the bilingual characteristics to be considered in the investigation of the impact of bilingualism on ToM. Indeed, it is crucial to understand why and how bilingualism should have an effect on ToM at all in order to decide on which aspects of bilingualism may impact ToM outcomes.

Hypotheses about the nature of the impact of bilingualism on theory of mind

To address this question, researchers have proposed several accounts that aim to explain the mechanisms through which bilingualism could shape ToM development. Bilingualism may have a positive influence on ToM for different reasons. Three main hypotheses exist (Yu et al., 2021), as schematized in Fig. 1.

All three accounts are based on two claimed links: first, how ToM is thought to develop, and second, how bilingualism may interact with these developmental processes to influence ToM. The development of ToM has been connected to three key mechanisms: social interaction, language acquisition, and EF. Social interaction, as proposed by Brown and colleagues (1996), plays a foundational role in ToM development, as children actively construct *mental models*, that is internal representations of human behavior and mental states, through their encounters in the social world. By observing and participating in social interactions, children learn to infer others' thoughts, feelings, and desires, linking behaviors to underlying mental states. Language acquisition is considered to further support ToM development by providing the tools to articulate and reason about mental states (De Villiers & Pyers, 2002; Durrleman et al., 2016). EF, on the other hand, is considered to underpin ToM development by enabling children to inhibit their own perspectives and consider others' viewpoints (Carlson et al., 2001; Moses, 2001). However, for children with DD, such as those with ADHD or ASD, attention deficits may hinder their ability to engage with social cues in the same way. These children may struggle to notice or interpret subtle social signals, such as facial expressions or tone of voice, which are crucial for constructing accurate mental models of others' behaviors and mental states (Berenguer et al., 2018). Consequently, their ToM development may follow a different trajectory, potentially limiting the extent to which they benefit from social interaction as a mechanism for ToM development. For children with DLD, delays in expressive and receptive language skills may limit their ability to acquire and use the linguistic structures necessary for reasoning about others' mental states. Similarly, children with ASD with additional language impairments, may face challenges in using language as a tool to understand and infer others' thoughts and emotions, further impacting their ToM development (World Health Organization, 2022).

Bilingualism has been proposed to influence these mechanisms by enhancing sociolinguistic, EF, or MLA skills, which could subsequently lead to advanced ToM abilities. Three accounts have been suggested to explain how bilingualism could impact ToM, based on these hypothesized links. As per the first account (1), bilingualism may have a direct impact due to enhanced sociolinguistic

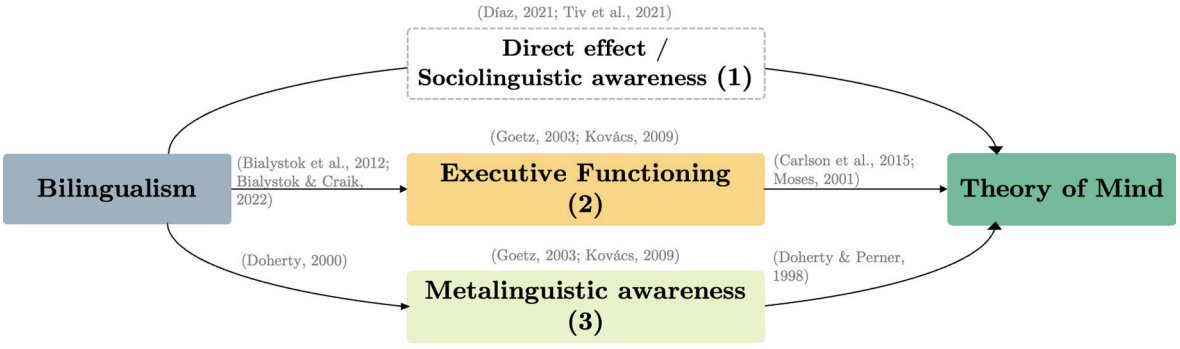

Fig. 1. Hypotheses about the nature of the impact of bilingualism on ToM.

awareness. The foundation of this explanation lies in the so-called *Competence Account* of ToM development and builds on the role of social interaction in ToM development. As outlined by Brown and colleagues (1996), social interactions are foundational to the development of mental models – internal representations of human behavior and mental states – that children construct through observation and engagement with others. These models enable children to link observed behaviors to underlying thoughts, feelings, and desires, ultimately helping them understand and predict others' actions. For instance, through these experiences, children learn to reason that other people's perceptions of reality could be subjective and therefore sometimes inaccurate. Bilingual children are thought to naturally encounter richer and more diverse social experiences, as they gain sensitivity to communicative circumstances with interlocutors speaking multiple languages at different levels and in different contexts (Fan et al., 2015). For example, they may frequently adjust their language use based on the linguistic background of their conversation partner, promoting an awareness of others' communicative needs and mental states. Consequently, this heightened sociolinguistic awareness would promote the comprehension that individuals not only speak different languages but also possess diverse mental states (e.g., Díaz, 2021). According to Díaz's theory, the extent of exposure to several languages is therefore the primary factor contributing to these improved learning possibilities.

The second account (2), proposed by Goetz (2003), posits that enhanced ToM abilities observed in bilingual individuals can be attributed to an indirect influence through EF (Goetz, 2003; Kovács, 2009). As outlined above, EF is considered a critical mechanism in ToM development, as it enables children to manage cognitive tasks that require perspective-taking, such as inhibiting their own viewpoint, retaining relevant information, and updating mental representations of others' perspectives (Carlson et al., 2001; Moses, 2001). This aligns with the *Performance Account* of ToM development, which emphasizes the importance of cognitive control in successfully completing ToM tasks. The connection between bilingualism and EF is established on the idea that bilingual individuals constantly activate their languages (Kroll et al., 2014). Consequently, they would enhance their ability to control inhibitory processes by suppressing non-target languages when they are not needed (Bialystok & Craik, 2022). The claim of the Performance Account, combined with research indicating that bilingualism impacts EF (Bialystok & Craik, 2022; Bialystok et al., 2012), suggests that EF could serve as a mediator of bilingualism on ToM. The question of which characteristics of the bilingual experience could trigger effects on EF, and in turn impact ToM, is less obvious than for a potential direct effect through the amount of exposure: Different potential characteristics, such as L2 proficiency, L2 use or switching habits have been put forth depending on the claimed underlying hypothesis (Bialystok, 2017; Green, 1998; Green & Abutalebi, 2013; Hilchey & Klein, 2011). However, it is important to note that this account is based on the premise that bilingualism has a general effect on EF, which, as outlined in Section 1, remains a matter of ongoing debate (Paap et al., 2024).

The third account (3) suggests that MLA, the ability to reflect upon the characteristics of language (Doherty & Perner, 1998), predicts ToM advantages in bilingual children (Kovács, 2009). Doherty and Perner (1998) contend that there is a connection between MLA and ToM, as both include the recognition that circumstances or objects can be perceived in different ways. The connection between bilingualism and MLA is founded on the idea that proficiency in two languages is believed to improve *meta*-representational capabilities (Doherty, 2000). Using two languages for communication nurtures metalinguistic and metacognitive skills, such as the capacity to analyse and understand one's own and others' linguistic and cognitive processes, thereby enhancing ToM development (Farhadian et al., 2010; Kovács, 2009).

To date, no clear answer has been found to address the potential explanation how bilingualism should enhance ToM and different explanations are possible (Yu et al., 2021).

For children with DD, potential effects of bilingualism on ToM may vary, although no theoretical claims have been published so far on differential effects of bilingualism on ToM in children with DD. On one hand, bilingualism might be hypothesized to exacerbate existing challenges, despite no clear empirical evidence to this effect to date. Nevertheless, preliminary research on adults with ADHD reported weaker performance in an executive control task by bilinguals in comparison to their monolingual peers (Bialystok et al., 2017). The authors suggested a greater burden of bilingualism on EF in individuals with ADHD. To the extent that EF may influence ToM, a detrimental effect of bilingualism on ToM may be hypothesized in children with ADHD. Consequently, a potential pathway of bilingualism effects on ToM via EF may be different in nature than in NT children. A potential direct effect of bilingualism on ToM or a mediated effect via MLA are also still "possible" in DD, as has been claimed for NT children.

Similarly, children with DLD, characterized by delays and impairments in some linguistic domain, may also present lower or delayed proficiency in an L2 (Tribushinina et al., 2020), compared to NT children. Thereupon, one may hypothesize that if bilingualism affects ToM via mediation through MLA, which relates to proficiency, this pathway may differ in nature for children with DLD: More specifically, if bilingualism affects MLA due to higher L2 proficiency, the generally lower L2 proficiency in children with DLD may not allow for a thorough boost in MLA, and consequently not in ToM either. However, these potential differences in bilingualism effects' pathways on ToM in children with DD remain purely hypothetical and need to be tested.

On the other hand, bilingualism could provide cognitive and social advantages, as suggested by research in NT children, potentially supporting ToM development either directly or indirectly. Namely, emerging evidence, such as the recent findings by Peristeri and colleagues (2024a; 2024b), suggests that bilingualism does not necessarily impede ToM development in children with DD and may even confer advantages in certain contexts. This underscores the need for further research to disentangle these complex interactions and to better understand how bilingualism interacts with the unique developmental profiles of children with DD. Finally, it is also possible that bilingualism may have no significant effect, with outcomes depending on individual differences and the specific characteristics of bilingual experience.

Present study

Research conducted so far on the impact of bilingualism on ToM in children with and without DD has led to divergent findings, potentially due to different and inconsistent characterizations of the bilingual experience. To address these inconsistencies and to extend the existing line of work and reviews on studies investigating the impact of bilingualism on ToM in children (Feng et al., 2023: scoping review on ToM tasks used and bilingual characterizations; Schroeder, 2018: *meta*-analysis; Yu et al., 2021: narrative presentation of hypotheses claimed about the impact of bilingualism on ToM), the overarching goal of this review is to critically evaluate the current state of research on the effects of bilingualism on ToM in children with a specific focus on the characterization of bilingualism. Our aim is to identify which specific aspects of the bilingual experience should be measured or accounted for in future research, potentially through a continuous approach.

To achieve our aim of pinpointing potentially key aspects of bilingualism for ToM effects to arise, we propose to analyze previous studies through a specific lens. First (Objective 1), we examine the hypotheses proposed about the relationship between bilingualism and ToM. This is because the hypotheses claimed in each study may provide initial insights into which aspects of the bilingual experience are considered relevant. Second (Objective 2), we assess whether studies define and characterize bilingual groups in line with the specified hypotheses. Alternatively, we consider which aspects of the bilingual experience are generally reported, regardless of the hypothesis. Finally (Objective 3), we explore whether mediation analyses are conducted in studies hypothesizing mediated effects via EF or MLA. Mediation analyses are important for the issues at hand because they offer a statistical method to examine whether the relationship between an independent variable and a dependent variable is explained by a third variable, called the mediator. They quantify both the direct effect of the independent variable on the dependent variable and the indirect effect through the mediator (Tingley et al., 2014). Consequently, in bilingualism research, mediation analysis is particularly relevant because it allows researchers to investigate not just whether bilingualism affects ToM, but also the mechanisms through which this effect occurs. For example, if bilingualism is hypothesized to enhance ToM through improved EF, a mediation analysis would examine whether EF indeed mediates the relationship between bilingualism and ToM. Where mediation analyses are performed, their results may provide further evidence supporting specific pathways through which bilingualism influences ToM.

The investigation of the studies' 'reasoning frameworks' in both NT children and children with DD, that is whether they have a clear rationale for *why* and *how* bilingualism might influence ToM, should consequently inform future research by highlighting specific bilingual characteristics that are most relevant for ToM development. To illustrate, if studies investigating the mediating role of MLA consistently operationalize bilingualism in terms of L2 proficiency and demonstrate mediation effects, this would highlight the importance of L2 proficiency for ToM. Such insights would moreover be particularly valuable for clinicians working with children with DD, as they can guide interventions and recommendations regarding bilingualism, but are also important to further inform education in NT children.

We asked the following primary questions[2] to reach this study aim:

RQ1: Which hypothesis/hypotheses do the study authors claim about a potential impact of bilingualism on ToM? Are there differences in how bilingualism is claimed to impact ToM in different (clinical) populations?

RQ2: How do the study authors measure and operationalize bilingualism?

RQ3: Which mediators do the study authors measure following the claimed hypothesis about potential mediators allowing the bilingual impact?

RQ4: Do study authors hypothesizing an indirect effect of bilingualism on ToM and testing the potential mediators include a mediation analysis?

RQ5: Among those studies that claimed an impact of bilingualism on ToM via EF or MLA (as identified in RQ1) – and which also (1) measured EF or MLA (as identified in RQ3), (2) found an effect of bilingualism on ToM (as identified in RQ6), and (3) included a mediation analysis (as identified in RQ4) – how many report a mediated effect of bilingualism on ToM via EF or MLA?

RQ6: Which outcomes do the study authors report?

RQ7: Which bilingual characteristics do the studies with different outcomes present?

Methods

Search strategy and study selection

The protocol for this scoping review was registered with the Open Science Framework (OSF) on May 28, 2024, and is accessible via the following link: https://doi.org/10.17605/OSF.IO/H6B34. This study was conducted in adherence to the JBI guidelines (Aromataris et al., 2024) to ensure replicable methodology and was written in accordance to the Preferred Reporting Items for Systematic Reviews and Meta-analysis extension for Scoping Reviews (PRISMA-ScR; Tricco et al., 2018). The PRISMA-ScR checklist is provided in the Appendix 1.

A comprehensive search for potentially relevant documents was carried out on May 28, 2024, in databases housing published research in the fields of psychological, linguistic, and clinical research (PsycInfo, ERIC, Child Development & Adolescent Studies, Medline, Pubmed, Web of Science, Linguistics and Language Behavior Abstracts). All synonyms of the three main constructs

[2] The registration included a slightly different order of the RQs and RQ5 was added to this review. Also, one RQ on hypotheses about ToM emergence were left out as this question turned out to not be relevant to the investigation of the primary review objective.

"bilingualism", "social cognition/Theory of Mind", and "children" were linked with the help of a Boolean operator *OR* before combing these three constructs with the help of the operator *AND* as follows: (bilingualism) *AND* (social cognition/Theory of Mind) *AND* (children).

Specifically, for "bilingualism", we used *bilingual*, trilingual*, multilingual*, "dual language*", "two languages", "second language", "heritage language*", "home language*", "societal language*", "minority language*", "majority language*", "dominant language*", "weak language*", "foreign language*", BFLA, "English as an additional language", EAL, "English language learner", ELL, L1, L2, L3, "language dualism", bimodal, "sequential* bilingual*", "simultaneous* bilingual*", diglot*, polyglot*, multi-tongued* to identify relevant papers. For "social cognition/Theory of Mind", our keywords included *"social cognit*", "theory of mind", ToM, TOM, "diverse desire*", diverse-desire*, "diverse belief*", diverse-belief*, "false belief*", false-belief*, FB, "Sally-Ann task", mindreading*, mentalizing*, mentalising*, "perspective taking*", perspective-taking*, mental-state**, and *"understanding of emotion*"*. For "children", we used *child*, kid*, school-age** and *preschooler** as search terms.[3]

As illustrated in the PRISMA flow chart of the search strategy and study selection procedure in Fig. 2, our search yielded 319 papers published through May 28, 2024. The search results were extracted from each database and transferred into "Covidence" (Covidence Systematic Review Software, 2024) which was used for the removal of duplicates, for the first and second screening phases and for the data extraction. After removing duplicates (n = 129), we conducted a first screening phase and evaluated the titles, abstracts, and keywords of the remaining 190 papers. We included papers that examined the impact of some form of bilingualism on Theory of Mind in children. From this first screening, 81 papers were eligible for a full-text review in the second screening phase; after removal of seven papers that could not be retrieved, 74 papers were sent to the second screening. In both screening phases, FB screened all papers, while DB screened approximately 90 % and LR 10 % of the papers. FB, DB and LR resolved conflicting decisions through discussion. Eighteen papers did not include a specific investigation of the effect of bilingualism, eight papers did not include an investigation of some form of ToM, eight papers presented dissertations and used the same dataset and methodology as another paper, five papers lacked a methods section, three papers included children with other disabilities than DD, and one paper did not include children. We therefore excluded these 43 studies from further data extraction. Thirty-one papers remained in the analytical sample. Following the second screening phase, we screened all included papers with respect to potential grey literature by checking citations and references in the introductions and literature reviews of the selected papers and conducted a search in PsyArxiv. Six additional studies were included. None of these studies were initially present in the dataset obtained from the literature search, likely due to publication in journals that were not part of the databases. The inclusion of these studies brought the total number of studies included for data extraction to 37.

Data extraction and coding

Data from the studies were extracted with the help of a developed data extraction form within Covidence. FB extracted data from all papers, while DB extracted data from approximately 10 % and LR from 90 % of the papers. FB, DB and LR discussed conflicts and further questions until consensus was reached. There were no conflicts that were unresolved.

First, we extracted basic study characteristics, such as author name(s), publication year, population included (neurotypical (NT), Autism Spectrum Disorder (ASD), Developmental Language Disorder (DLD), or other), language groups (monolingual, bilingual in case of a group comparison, only bilingual in a study of specific bilingual predictors), number of participants in population and language groups, age ranges of participants within population and language group, and the names of the languages of the population and language groups. Second, we assessed whether the investigation of the impact of bilingualism on ToM presented the study's main objective or if the impact of bilingualism on another cognitive or communicative ability was the paper's primary goal. Third, we gathered relevant data for the main objectives of this scoping review. These included whether the authors claimed hypotheses about the impact of bilingualism on ToM and if so, which ones. These data also included how the authors characterized the participants with respect to their bilingual experience (age of first exposure, proficiency, amount of exposure and use, place of first exposure, etc.), whether (and how) potential mediators (EF or MLA) were measured, and whether a mediation analysis was undertaken. With respect to the study outcome(s), we retrieved information on whether the authors found an effect and, if so, in which task(s). In addition, we took information on results by any mediation analyses which may have been conducted. The summarized overview of extracted information can be found in Table 1.

Results

Study and participant characteristics

As shown in Table 1, among the 37 papers published between 2003 and 2024, 33 (89 %) included NT children, four (11 %) included children with ASD, and two (5 %) included children with DLD / SLI.[4] Nineteen and therefore more than half of the studies included English-speaking participants (51 %). Thirty-one (84 %) studies investigated ToM including First-order False Belief tasks, four included

[3] The precise strings for each database can be found in the Appendix 2. Furthermore, our search strategy did not specify particular developmental disorders, as it aimed to broadly capture studies involving children, with subsequent exclusions applied to studies that addressed the effects of bilingualism on ToM in children with other types of disorders.

[4] As two studies included both NT children and children DD (Studies 23 and 30 in Table 1), the total number of studies mentioned here ($N = 39$) exceeds the number of papers included in this review ($N = 37$).

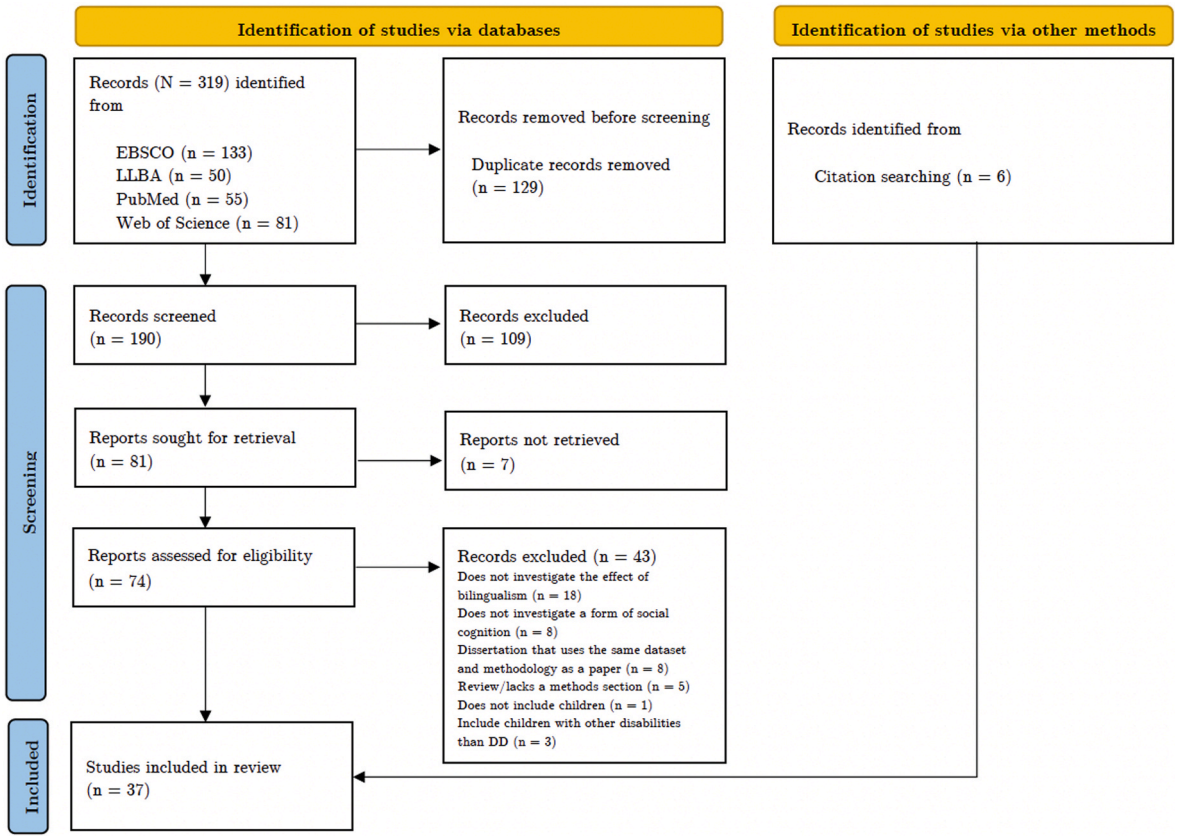

Fig. 2. PRISMA flowchart to identify studies to be included in the analysis.

Second-order False Belief tasks (11 %), six (16 %) used Appearance-Reality tasks, three (8 %) affective ToM tasks, such as emotion recognition, three (8 %) integrated a battery of tasks, and six (16 %) had measures of (visual) perspective taking.

Among the 37 studies included in the review, seven studies had a primary objective other than on ToM (Studies 16, 20, 23, 27, 28, 32, and 37 in Table 1).

Bilingualism hypothesis

Formulation of a bilingual hypothesis (RQ1)

To discuss the potential of the studies testing their claimed hypotheses about a direct or mediated effect of bilingualism on ToM, we first investigated the extent to which studies claimed a hypothesis. Only those studies (n = 30) including a primary investigation of the impact of bilingualism on ToM were considered for this analysis. Among the 30 studies, 28 (93 %) explicitly mentioned a hypothesis, while two (7 %) did not mention a hypothesis. Among those studies that claimed a hypothesis, 18 (60 %) claimed a direct effect, 26 (87 %) a mediating effect via EF, and 11 (37 %) a mediating effect via MLA. Overall, most studies claimed more than one potential way in which bilingualism may affect ToM, as shown in Fig. 3 (RQ1). Furthermore, studies investigating the effects of bilingualism on ToM in children with DD proposed the same hypotheses as those involving NT children. That is, studies including children with DD did not specifically address potential difficulties in line with the condition that may impact the effects of bilingualism on ToM, as discussed in Section 1.3.

Characterization of the bilingual experience (RQ2)

Among the 30 studies reviewed, 26 (87 %) applied a group comparison between monolingual and bilingual participants. Two studies (7 %) compared simultaneous bilinguals (exposed to two languages from birth) and sequential bilinguals (exposed to an L2 only after a certain age; Cheung et al., 2010; Listanti et al., 2023). Three studies (10 %) integrated three groups into their analyses: Fan and colleagues (2015) included a monolingual, a bilingual and a “bilingual exposure” group with participants having regular but limited exposure to a second language. Weimer and Gasquoine (2016) included bilinguals, English-dominant bilinguals and Spanish-dominant bilinguals; and Buac and Kaushanskaya (2020) included next to monolinguals and bilinguals also a group of sequential bilinguals. In two studies (7 %; Dicataldo & Roch, 2020; Yow & Li, 2024), only a bilingual group was included; in a similar way, Huang and colleagues (2023) conducted, besides a monolingual-bilingual group comparison, further analyses only on the bilingual group.

The explicit characterization of the bilingual participants varied widely across studies, as shown in Table 2.

Table 1
Study overview.

N°	Author(s), Year ToM main objective (YES/NO)	Population NT / DLD / ASD, *N*, Age range, Languages	Hypothesis about impact of bilingualism (RQ1) YES (type)/NO	Characterization and operationalization of the bilingual experience (RQ2) GC = Group comparison *VARIABLE(S) according to which bilinguals are characterized*	Inclusion of measure of potential mediators (RQ3) YES (type)/NO	ToM task used AR = Appearance-Reality FB = False Belief PT = Perspective taking	Effect found of bil on ToM (RQ5 and RQ6) Overall/individual tasks	Mediation analysis conducted (RQ4) YES (result)/NO
1	Goetz, 2003 YES	NT *N* = 104 3;2 – 4;11 English, Mandarin, (L3 dialects)	YES (Direct, EF, MLA)	GC: Mono vs. Bil *AOFE, EXPOSURE*	NO	AR, 2x First-order FB, Level 2PT	Overall: T1: Bil > Mono, T2: Bil = Mono Individual: 1x FB: Bil > Mono, AR, Level-2PT: Bil > Chinese Mono; rest =, 1x: Mono > Bil	(NO)
2	Berguno & Bowler, 2004 YES	NT *N* = 197 3;0 – 4;0 English & Other	YES (EF, MLA)	GC: Mono vs. Bil *USE, CONTEXTS*	NO	AR, First-order FB	Bil > Mono	(NO)
3	Bialystok & Senman, 2004 YES	NT *N* = 95 4;0 – 5;11 English & Other	YES (Direct, EF)	GC: Mono vs. Bil *CONTEXTS, USE*	YES (EF – STM)	AR	Bil = Mono (test questions)	(NO)
4	Chan, 2004 YES	NT *N* = 60 2;9 – 5;11 English & Chinese	YES (EF)	GC: Mono vs. Bil *CONTEXTS, PROFICIENCY*	YES (EF – Switching)	4x First-order FB	Bil > Mono	NO (only correlation ToM-DCCS 0.62)
5	Kovács, 2009 YES	NT *N* = 64 2;10 – 3;6 Romanian & Hungarian	YES (Direct, EF)	GC: Mono vs. Bil *AOFE, CONTEXTS, EXPOSURE*	NO	2x First-order FB	Bil > Mono overall and in each task	NO
6	Kyuchukov & Villiers, 2009 (Study 2) YES	NT *N* = 120 3;7 – 4;6 Bulgarian & Romani	YES (EF, MLA)	GC: Mono vs. Bil	NO	2x First-order FB	Bil = Mono	(NO)
7	Cheung et al., 2010 YES	NT *N* = 121 3;3 – 4;4 English & Cantonese	YES (Direct, EF)	GC: Second language learners vs. Bil *CONTEXTS, EXPOSURE, USE*	NO	2x First-order FB	Bil > Mono	(NO)
8	Farhadian et al., 2010 YES	NT *N* = 163 3;7 – 5;6 Persian & Kurdish	YES (EF, MLA)	GC: Mono vs. Bil	YES (MLA)	3x First-order FB	Bil > Mono overall	NO

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Table 1 (*continued*)

N°	Author(s), Year ToM main objective (YES/NO)	Population NT / DLD / ASD, *N*, Age range, Languages	Hypothesis about impact of bilingualism (RQ1) YES (type)/NO	Characterization and operationalization of the bilingual experience (RQ2) GC = Group comparison *VARIABLE(S) according to which bilinguals are characterized*	Inclusion of measure of potential mediators (RQ3) YES (type)/NO	ToM task used AR = Appearance-Reality FB = False Belief PT = Perspective taking	Effect found of bil on ToM (RQ5 and RQ6) Overall/individual tasks	Mediation analysis conducted (RQ4) YES (result)/NO
9	Greenberg et al., 2013 YES	NT *N* = 82 *M* = 8;45 English & Other (Spanish, Italian, Portuguese etc.)	YES (EF)	GC: Mono vs. Bil *CONTEXTS, PROFICIENCY, USE*	NO	Visual PT	Bil > Mono 180° and 270° condition, Bil = Mono 90° condition	NO
10	Han & Lee, 2013 YES	NT *N* = 133 3;2 – 6;10 English & Korean	YES (Direct, EF, MLA)	GC: Mono vs. Bil *CONTEXTS, PROFICIENCY*	NO	Cognitive and affective PT	Bil > Mono affective perspective taking, Bil = Mono cognitive perspective taking	(NO)
11	Pearson, 2013 (Study 4) YES	NT *N* = 68 2;8 – 4;5 English & Spanish	YES (Direct, EF, MLA)	GC: Mono vs. Bil *CONTEXTS*	YES (EF – Switching)	2x First-order FB	Bil = Mono Sally-Ann, Mono > Bil Puppet FB	NO
12	Kalashnikova & Mattock, 2014 YES	NT *N* = 66 3;3 – 5;7 English & Welsh	YES (Direct, EF, MLA)	GC: Mono vs. Bil *AOFE, CONTEXTS, EXPOSURE*	YES (EF – Switching, MLA)	AR	Bil = Mono	NO
13	Nguyen & Astington, 2014 YES	NT *N* = 72 3;0 – 5;0 English & French	YES (EF, SES)	GC: Mono vs. Bil *AOFE, EXPOSURE* (min. *30 %), PROFICIENCY*	YES (EF – Inhibitory control, WM)	2x First-order FB	Bil > Mono	YES (via verbal WM)
14	Fan et al., 2015 YES	NT *N* = 72 4;0 – 6;9 English & Other	YES (Direct, EF)	GC (3 groups): Mono vs. Bil vs. Bil exposure *CONTEXTS, EXPOSURE, PROFICIENCY*	YES (EF – Switching)	Director Task	Bil & Bil exposure > Mono	(NO; EF was not a predictor of performance on Director Task, so no mediation possible)
15	Yow & Markman, 2015 YES	NT *N* = 32 3;5 – 4;0 English & Other	YES (Direct, EF)	GC: Mono vs. Bil *CONTEXTS, EXPOSURE* (min. *30 %)*	YES (EF – Inhibitory control, STM)	Visual PT	Bil > Mono more "hidden" objects in "where" condition, Mono > Bil more "visible" objects in "where" condition	YES (no mediated effect via inhibitory control)
16	Göbel et al., 2016 NO	NT *N* = 135 7;0 – 10;0 German & Other	NO	GC: Mono vs. Bil *CONTEXTS*	(NO)	9x Emotion understanding	Bil > Mono	(NO)
17	Gordon, 2016 YES	NT *N* = 52 3;0 – 6;4 English & Spanish	YES (Direct)	GC: Mono vs. Bil *CONTEXTS, PROFICIENCY*	(NO)	ToM scale (Wellman & Liu, 2004), twice with different items	Bil > Mono Diverse Desires, Mono < Bil explicit FB, Bil = Mono rest & overall	(NO)

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Table 1 (*continued*)

N°	Author(s), Year ToM main objective (YES/NO)	Population NT / DLD / ASD, *N*, Age range, Languages	Hypothesis about impact of bilingualism (RQ1) YES (type)/NO	Characterization and operationalization of the bilingual experience (RQ2) GC = Group comparison *VARIABLE(S) according to which bilinguals are characterized*	Inclusion of measure of potential mediators (RQ3) YES (type)/NO	ToM task used AR = Appearance-Reality FB = False Belief PT = Perspective taking	Effect found of bil on ToM (RQ5 and RQ6) Overall/individual tasks	Mediation analysis conducted (RQ4) YES (result)/NO
18	Weimer & Gasquoine, 2016 YES	NT *N* = 102 3;7 – 7;6 English & Spanish	YES (Direct)	GC (3 groups): English-dominant Bil vs. Blanced Bil vs. Spanish-dominant Bil *CONTEXTS, PROFICIENCY*	(NO)	3x First-order FB, 4x Emotion understanding	Bil = ENG/SP-dominant bil in cognitive ToM tasks, SP-dom bil > Bil & ENG-dom in emotion understanding	YES
19	Dahlgren et al., 2017 YES	NT *N* = 28 2;11 – 5;5 Swedish & Slavonic languages	YES (EF)	GC: Mono vs. Bil *CONTEXTS*	YES (EF – Inhibitory control, Attention, WM)	5x First-order FB	Bil = Mono all tasks	(NO, only correlations between ToM and EF nonsignificant)
20	Tsimpli et al., 2017 NO	DLD/SLI *N* = 72 5;5 – 11;9 Greek & Albanian/ English/Romanian/ Bulgarian	NO	GC: Mono vs. Bil *AOFE, USE*	(YES – WM)	2x First-order FB, 2x Second-order FB	Bil = Mono First-order FB, Bil > Mono Second-order FB	NO
21	Díaz & Farrar, 2018 YES	NT *N* = 65 3;1 – 5;5 English & Spanish	YES (EF)	GC: Mono vs. Bil *EXPOSURE, PROFICIENCY (FLUENCY), USE*	YES (EF – Inhibitory control, Switching, STM)	3x First-order FB, 2x AR	Bil > Mono	NO (only correlation between Bear/ Dragon (EF) task and ToM in monolingual children)
22	Díaz & Farrar, 2018 YES	NT *N* = 78 2;11 – 5;6 English & Spanish	YES (Direct, EF, MLA)	GC: Mono vs. Bil *CONTEXTS, EXPOSURE, PROFICIENCY (FLUENCY), USE*	YES (EF (Inhibitory control, Switching, STM, MLA)	2x First-order FB, 1x AR	Bil > Mono	YES (MLA at Timepoint 1 predicted FB in bilinguals at Timepoint 2)
23	Meir & Novogrodsky, 2019 NO	NT *N* = 58 5;0 – 8;7 Hebrew & Russian ASD *N* = 27 4;6 – 9;2 Hebrew & Russian	NO	GC: Mono vs. Bil *CONTEXTS, EXPOSURE*	YES (EF – WM, Inhibitory control)	1x First-order FB, 1x Second-order FB	Bil = Mono (both NT and ASD)	NO
24	Andreou et al., 2020 YES	ASD *N* = 56 7;2 – 15;6 Greek & Albanian	YES (EF)	GC: Mono vs. Bil *AOFE, CONTEXTS, EXPOSURE*	YES (EF – WM)	2x Verbal First-order FB, 10x Non-verbal First-order FB	Bil > Mono	NO (only correlation for bilinguals between WM and ToM)
25	Buac & Kaushanskaya, 2020	NT *N* = 115	YES (EF)	GC (3 groups): Mono vs. Simultaneous bilinguals vs. Sequential bilinguals	YES (EF – Inhibitory	13x First-order FB, 10x Second-order FB	Sequential Bil = Simultaneous Bil = Mono	(NO, only WM as a sign. Predictor of ToM in mono, inhibition and shifting in simultaneous

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Table 1 (*continued*)

N°	Author(s), Year ToM main objective (YES/NO)	Population NT / DLD / ASD, *N*, Age range, Languages	Hypothesis about impact of bilingualism (RQ1) YES (type)/NO	Characterization and operationalization of the bilingual experience (RQ2) GC = Group comparison *VARIABLE(S) according to which bilinguals are characterized*	Inclusion of measure of potential mediators (RQ3) YES (type)/NO	ToM task used AR = Appearance-Reality FB = False Belief PT = Perspective taking	Effect found of bil on ToM (RQ5 and RQ6) Overall/individual tasks	Mediation analysis conducted (RQ4) YES (result)/NO
		5;0 – 9;11			control, WM, Switching)			bilinguals, no EF predictors in sequential bilinguals)
	YES	English & Spanish		*AOFE, EXPOSURE*				
26	Dicataldo & Roch, 2020	NT *N* = 111 3;8 – 6;2	NO	Continuous: characterized with differences in the length of exposure and daily exposure	YES (EF – WM, Inhibitory control, Switching)	1x First-order FB	No effect of exposure on ToM	NO (only correlation between WM corr and ToM)
	YES	Italian & Romanian/ Albanese/Turkish/ Arabic/Moldavian/ Russian		*AOFE, EXPOSURE*				
27	Peristeri et al., 2020	DLD *N* = 60 6;0 – 8;1	NO	GC: Mono vs. Bil *AOFE, EXPOSURE*	YES (EF – WM)	10x First-order FB	Bil > Mono in mentalistic items	(NO)
	NO	Greek & Albanian						
28	Dicataldo & Roch, 2021	NT *N* = 111 3;8 – 6;3	YES (Direct, EF)	Continuous: various language backgrounds (AOFE: between 0 and 3 years)	YES (EF – WM, Inhibitory control, Switching)	1x First-order FB	Correlation between length of exposure and ToM (but confounder with age)	NO (only correlation between WM and ToM)
	NO	Italian & Other						
29	Peristeri et al., 2021	ASD *N* = 103 6;9 – 15;6	YES (Direct, EF, MLA)	GC: Mono vs. Bil *AOFE, CONTEXTS*	YES (EF – WM, Attention, MLA)	10x First-order FB	Bil > Mono	YES (mediated by EF (Global-local))
	YES	Greek & Albanian/ Russian/Bulgarian						
30	Peristeri et al., 2021	NT *N* = 50 *M* = 10;2	NO	GC: Mono vs. Bil *AOFE*	(NO)	10x First-order FB	Bil > Mono (both NT and ASD)	(NO)
	YES	Greek & Albanian ASD *N* = 50 *M* = 10;7 Greek & Albanian						
31	Sudo & Matsui, 2021	NT *N* = 50 *M* = 5;4	YES (Direct, EF)	GC: Mono vs. Bil *CONTEXTS*	YES (EF –Inhibitory control)	1x Verbal First-order FB	Mono > Bil	NO
	YES	Portuguese & Japanese						
32	Gasiorek et al., 2022	NT *N* = 197 16;0 – 19;0	YES (Direct, EF)	GC: Mono vs. Bil *CONTEXTS, EXPOSURE*	NO	4x Situational PT	Bil > Mono	(NO)
	NO	Swedish & Finnish						

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Table 1 (*continued*)

N°	Author(s), Year ToM main objective (YES/NO)	Population NT / DLD / ASD, *N*, Age range, Languages	Hypothesis about impact of bilingualism (RQ1) YES (type)/NO	Characterization and operationalization of the bilingual experience (RQ2) GC = Group comparison *VARIABLE(S) according to which bilinguals are characterized*	Inclusion of measure of potential mediators (RQ3) YES (type)/NO	ToM task used AR = Appearance-Reality FB = False Belief PT = Perspective taking	Effect found of bil on ToM (RQ5 and RQ6) Overall/individual tasks	Mediation analysis conducted (RQ4) YES (result)/NO
33	Białecka et al., 2023 YES	NT *N* = 102 3;6 – 7;0 English & Polish	YES (Direct, EF, MLA)	GC: Mono vs. Bil *CONTEXTS*	NO	TRT (Białecka-Pikul et al., 2018)	L2 comprehension as a significant predictor in bilinguals, cumulative and current L2 exposure no significant predictors	(NO)
34	Huang et al., 2023 YES	NT *N* = 68 3;0 – 5;6 English & Spanish	YES (Direct, EF)	GC: Mono vs. Bil AND Continuous: Bilingual-status, amount of exposure *AOFE, EXPOSURE*	YES (EF – WM, Switching, Inhibitory control)	ToM battery (5 items, Wellman & Liu, 2004)	Bil > Mono overall, Balance of exposure predicted ToM in bilinguals	YES (mediated by WM and Switching in bilinguals)
35	Listanti et al., 2023 YES	NT *N* = 37, only bilinguals 8;2 – 11;8 Greek & Italian	YES (Direct, EF, MLA)	Continuous: home literacy (reading books etc. at home) *RICHNESS OF L2 EXPOSURE*	NO	4x First-order FB, 2x Second-order FB	Effect of home literacy on ToM	(NO)
36	Yow and Markman, 2015 YES	NT *N* = 140, only bilinguals 3;6 – 5;5 English/Mandarin/Tamil/Japanese & Other	YES (Direct, EF)	Only bilinguals *AOFE, EXPOSURE*	YES (EF – Inhibitory control, STM)	ToM task	Exposure entropy predicted PT	(NO, but EF no significant predictors)
37	Van Zwet & Unsworth, 2024 NO	NT *N* = 99 4;0 – 5;11 Dutch & Other	YES (Direct)	GC: Mono vs. Bil *AOFE, EXPOSURE*	(NO)	3x PT	Mono = Bil	(NO)

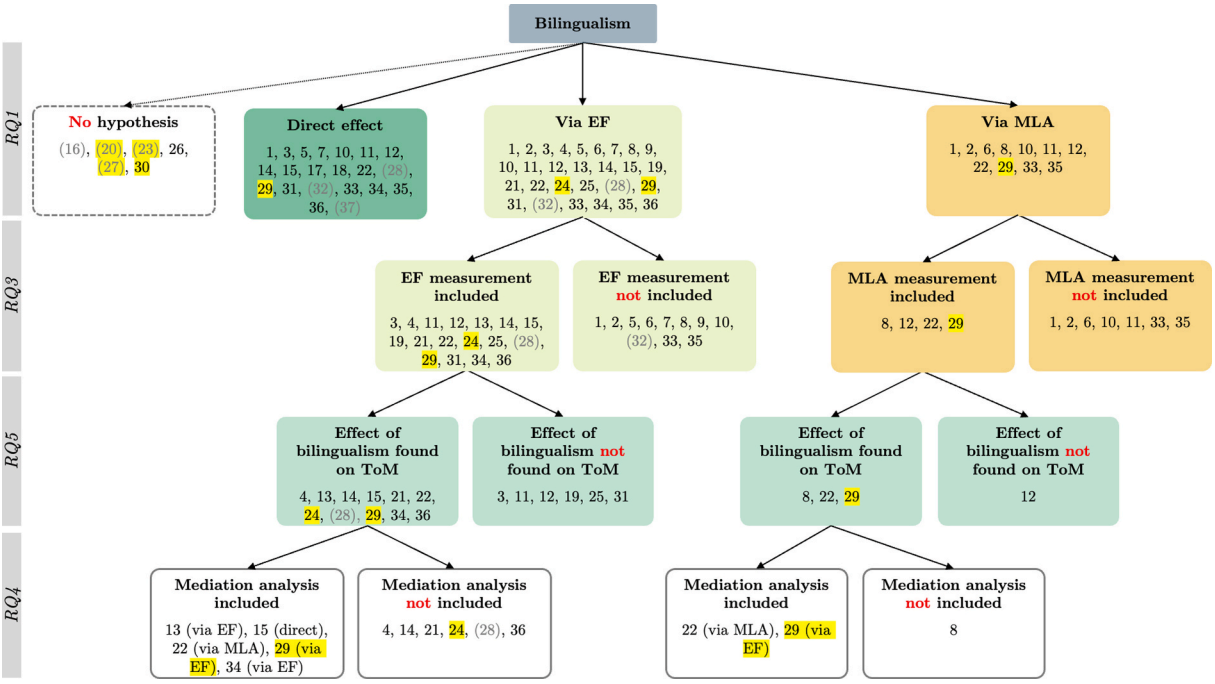

Fig. 3. Study characteristics based on RQs 1, 3, 4, 5. *Note.* Study numbers highlighted in yellow: studies including children with DD; study numbers in brackets: studies with a primary focus on another domain than ToM. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Table 2
Characterization of bilingual experiences in studies.

Characterization of the bilingual experience	Number of studies (%)
Age of first exposure to the L2 (AOFE-L2)	11 (37 %)
Contexts of language use/exposure (e.g., at home, in school, in the community)	19 (63 %)
Amount of L2 exposure	14 (47 %)
L2 proficiency	9 (30 %)
Amount of L2 use	7 (23 %)
Quality of L2 exposure	1 (3 %)

The age of first exposure to an L2 (AOFE-L2) was mentioned in 11 out of the 30 studies (37 %); in 19 studies (63 %), the contexts in which the different languages were used or heard are described (such as at home, in school, in the community); in 14 studies (47 %), an indication of the amount of exposure is provided; in nine (30 %) a verbal indication of the L2 proficiency is provided; in seven studies (23 %), the amount of use is described; and in one study (3 %), the richness of the L2 exposure is mentioned.

As shown in Table 3, of those 19 studies claiming a direct effect of bilingualism, to which the rationale of the amount of exposure fits (Díaz, 2021), eight (48 %) gave an explicit indication of the amount of exposure of their children, whereas two (11 %) did not provide any characteristics and nine studies (47 %) provided another piece of information about the participant's L2 proficiency, contexts of exposure or use, or AOFE-L2 that may indirectly (but not precisely) provide indications about the group-related amount of L2 exposure. Of those 29 studies claiming a mediated effect via EF, all except two studies (93 %) provided a characterization of the bilingual experience, using very different characterizations of the bilingual experience (based on AOFE-L2, exposure, use, proficiency or richness of L2 exposure or the contexts in which languages are heard or used). Of those 11 studies claiming a mediated effect via MLA, to which a rationale of the proficiency fits, two studies (18 %) characterized the bilingual participants according to proficiency, whereas seven (64 %) provided other characteristics and two (18 %) did not provide further information on the bilingual participants.

Test of potential mediators (RQ3)

Among the 26 studies that claimed a potential mediating effect of bilingualism via EF, 16 (62 %) included a measure of EF, whereas 10 (40 %) did not test any EF. Similarly, four (36 %) among the 11 studies that claimed an effect via MLA, included a measure of MLA into the study, whereas the remaining seven (64 %) did not integrate a test of MLA. Among the few studies including children with DD, all studies claiming a mediating effect via EF or MLA also included measures of those domains.

Table 3
Characterization of bilingual experiences according to claimed bilingualism hypothesis.

Bilingualism hypothesis claimed	Characterization of the bilingual experience	Number of studies (%)
Direct effect (19 studies)	Amount of L2 exposure	8 (47 %)
	No characteristics	2 (11 %)
	Other information (e.g., L2 proficiency, contexts of exposure, use, or AOFE-L2), which may indirectly suggest the group-related amount of L2 exposure	9 (47 %)
Via EF (29 studies)	Very different characterizations of the bilingual experience (based on AOFE-L2, exposure, use, proficiency or richness of L2 exposure or the contexts in which languages are heard or used)	27 (93 %)
Via MLA (11 studies)	L2 proficiency	2 (18 %)
	Other characteristics	7 (64 %)
	No characterization	2 (18 %)

Test of a potential mediating effect (RQ4)

As testing whether an effect of bilingualism on ToM is mediated via EF or MLA is only possible when an effect of bilingualism is found, we first verified whether the studies found an effect of bilingualism on ToM. Among those that had claimed an effect via EF and that had included a measure of EF (n = 16), ten (63 %) reported a positive effect of bilingualism, whereas six (38 %) did not find an effect. Among the ten studies that found an effect, five (50 %) included a mediation analysis, whereas five (50 %) did not or only included a correlation analysis between EF and ToM. Similarly, among the four studies that had claimed a mediation effect via MLA and that had included a measure of MLA, three studies (75 %) found an effect of bilingualism on ToM, whereas one (25 %) did not. Among the three studies that found an effect, two (67 %) included a mediation analysis, whereas one (33 %) did not. One study including children with DD (29) among the two that found a positive effect of bilingualism on ToM also included a mediation analysis.

Outcome of the mediation analysis (RQ5)

Among the five studies that had included a mediation analysis, one showed a direct effect of bilingualism on ToM, three via EF (one of which included children with DD) and one via MLA.

Study outcomes

Effects of bilingualism on ToM (RQ6)

In the 37 studies, 19 (51 %) reported only positive effects of bilingualism on ToM, including four studies with children with DD. Eight studies (22 %) showed only null results, one study (3 %) only a negative impact of bilingualism, and the remaining nine studies (24 %) showed mixed results with a combination of positive, negative and null results.

Bilingual characteristics of studies finding only positive effects of bilingualism (RQ7)

To investigate whether those studies finding only positive effects of bilingualism were those with a specific characterization of the bilingual experiences, we investigated the studies with positive effects of bilingualism further. Among the 19 studies that had shown a positive effect of bilingualism on all tasks, eight (42 %) had characterized the amount of exposure of the participants, five (26 %) had characterized their use, five (26 %) their proficiency, four (21 %) their AOFE-L2, one (5 %) their richness of L2 exposure, and eight (42 %) provided information in which contexts different languages were used or heard. Among the eight studies that had reported only null results, three (38 %) had provided information about the participants' exposure, two (25 %) about their L2 proficiency, four (50 %) about their AOFE-L2, and three (38 %) about their contexts. The only study that had reported negative effects had not provided any other information than about the participant's contexts. Among the seven studies that reported mixed results, one (14 %) had provided information about the participant's exposure, three (43 %) about their proficiency, and four (57 %) about their contexts.

Discussion

The overarching goal of this review was to identify actionable insights for future research and gain further insights into the characteristics of the bilingual experience (such as the amount of exposure or use, proficiency or AOFE) that can be taken into account when designing future studies on the effects of bilingualism on ToM in NT children and children with DD, in order to address the oversimplification of the bilingual experience stemming from the application of group comparisons between monolinguals and bilinguals as it is potentially the source of divergent findings (Grundy, 2020).

To reach this goal, this review took into account the potential pathways claimed for the effect of bilingualism on ToM (Objective 1). Furthermore, this review examined the extent to which studies operationalized the bilingual participants' characteristics in line with the claimed hypotheses (Objective 2). Finally, this review investigated whether studies not only hypothesized a relationship between bilingualism and ToM but also tested these hypotheses, by inclusion of tests of potential mediators, such as EF and MLA, and a mediation analysis (Objective 3).

The investigation of these three objectives allow together to identify those studies that claimed and consequently tested a hypothesis. Studies that identify specific mediation paths, as well as those reporting only a positive, null, or negative effect of bilingualism on ToM, highlight important bilingual characteristics. These characteristics can offer insights into which potential bilingual variables are relevant and should be measured and tested continuously.

Objective 1: Bilingualism hypotheses

To identify the bilingual characteristics that appear to be relevant regarding the impact of bilingualism on ToM in NT children and children with DD, the first objective (Objective 1) of this review was to explore why and how previous studies investigated the question of how bilingualism might enhance ToM, both in NT children and children with DD. While prior work, such as the narrative review by Yu and colleagues (2021), has touched upon these questions, a systematic approach has not yet been undertaken. Given the high number of bilingual children (Bialystok, 2018) and therefore the need for clinicians and caregivers working with children with DD to be informed about potential repercussions of the bilingual experience, the present scoping review also aimed to shed light on existing studies on the impact of bilingualism on ToM in children with and without DD. Although this was not the review's primary goal, the review revealed that, until the end of the search in May 2024, only six studies existed that included children with DD, of which there were four with children with ASD and two with children with DLD.

Importantly, this scoping review found that almost all studies investigating the impact of bilingualism on ToM proposed one or more hypotheses regarding how bilingualism might influence ToM. Interestingly, the few studies investigating the effects of bilingualism on ToM in children with DD did not take into account potential difficulties pertaining to social attention, language acquisition in general and EF difficulties as variables that could affect the influence of the bilingual experience on ToM in a different way than in NT children (RQ1).

Objective 2: Characterization of bilingualism

The operationalization of bilingualism, that is how bilingual groups are defined and characterized, varied widely across studies, and sometimes lacked information that is considered important for fully understanding the bilingual experience. As claimed, a characterization of the bilingual experience was expected to be in line with the hypothesized bilingual impact. That means, in case of a claimed direct effect, a characterization of the experience according to the participant's exposure to different languages would be expected, in case of a claimed mediated effect via EF, a description of the participant's L2 use, proficiency and switching habits would be anticipated, and in case of a claimed mediated effect through MLA, a description of the L2 proficiency would be expected. Although there is a substantial number of studies claiming a direct effect and describing the participants' amount of exposure to different languages, the picture is less obvious in the case of claimed mediated effects via EF and MLA (RQ2). Furthermore, the description of bilingual characteristics of participants included in studies with children with DD resembled those including NT children, and therefore did not present any specificities.

Objective 3: Test of mediators and inclusion of mediation analysis

Among studies hypothesizing a mediated effect of bilingualism on ToM through EF or MLA, the majority included tasks designed to measure these mediators. Among the few studies including children with DD and claiming a mediated effect through EF or MLA, all studies included a measure of those mediators. However, among studies including NT children, there was also a substantial number of studies not integrating a measure of EF or MLA (RQ3). Of those 17 studies integrating EF or MLA measures, only 11 found an effect of bilingualism on ToM, of which only five studies conducted formal mediation analyses to test whether these variables indeed mediated the relationship between bilingualism and ToM (RQ4). Of these, one study reported a direct effect of bilingualism on ToM, two found an effect mediated by EF, and one found an effect mediated by MLA.

In sum, aside from studies claiming a direct effect (which do not require further mediation analyses), only a few studies including both NT children and children with DD have actually tested the hypotheses on how and why bilingualism might impact ToM in depth.

Summary

Among the 18 studies that argued for a direct effect of bilingualism on ToM, nine studies found exclusively positive effects. Of these, five also provided information about the participants' amount of exposure to different languages. Díaz (2021) hypothesized that greater exposure to multiple languages may enhance children's ability to infer that speakers of different languages have different perspectives, which could foster perspective-taking skills in ToM. Although the bilingual profiles presented in studies that hypothesized and found a direct effect varied significantly, the majority (5 out of 9) of those that identified a direct positive effect characterized participants based on their language exposure, in line with Díaz's (2021) hypothesis. Even if the absolute number of five studies hypothesizing a direct effect while characterizing the bilingual participants according to their amount of exposure to different languages is small, this result could indicate that the amount of exposure to different languages is indeed a crucial predictor of ToM.

Of the five studies that conducted mediation analyses to test the potential mediating effect of EF or MLA, varying degrees of information were provided on participants' bilingual characteristics. In one study that demonstrated a direct effect of bilingualism, data were provided on both the participants' amount of language exposure and their L2 proficiency, thus this study is also in line with the aforementioned claim that the amount of exposure may be an important predictor of ToM. Among the three studies that reported a mediation effect via EF, the operationalization of bilingual characteristics also varied. One study provided information on the participants' amount of language exposure, another included details on the richness of L2 exposure, and two studies described the contexts in which the participants used their languages. The single study that found a mediating effect through MLA was more comprehensive in its operationalization, providing details on the participants' exposure to languages, frequency of language use, proficiency in the second language, and the contexts in which the languages were used. However, the overall pattern of characteristics across those

studies showing a mediated effect remains unclear, due to the wide range of bilingualism characteristics provided and the small number of studies.

This is also true for recent research evidence that emerged by the time this scoping review was completed, which investigated the impact of bilingualism on ToM in children with DD (Peristeri et al., 2024a; 2024b). In one of the two new studies, bilingual children with DLD, bilingual autistic children and bilingual NT children were compared to their monolingual peers in a ToM task (Peristeri et al., 2024a). The authors claimed a potential pathway of bilingualism effects on ToM via EF or MLA, but did not further specify any specificities for the DD populations, which is in line with the observations made for Objective 1 in the studies included in this scoping review. Furthermore, the authors provided a detailed description of the bilingual participants being simultaneous bilinguals with exposure to both languages from birth, however being dominant in one of the languages (Objective 2). In line with the claimed hypothesis on bilingualism's effects on ToM via EF, a measure of inhibition was included; however, no task measuring MLA was part of the protocol. No mediation analysis was conducted (Objective 3). The study found a significantly better performance in bilingual autistic children compared to their monolingual peers, but did not find any differences in NT children and children with DLD. To sum up, this study is in line with previous research investigating the effects of bilingualism on ToM in NT children and children with DD regarding their reasoning frameworks. The other newly published study (Peristeri et al., 2024b) compared bilingual autistic to monolingual autistic children in First- and Second-order False-Belief tasks over a course of three testing points. The study indirectly hypothesized a potential benefit in bilinguals through enriched expressive vocabulary, as this has been suggested to help in fostering understanding complex language structures required for Second-order False-Belief understanding, but no links were hypothesized via EF or MLA (Objective 1). The characteristics of bilingual participants allowed some insights into the potential amount of exposure to two languages, and their language proficiency (Objective 2). A measure of EF was included, but no mediation was hypothesized nor was a mediation analysis run (Objective 3).

Conclusion

The goal of this scoping review was to examine the existing literature on the impact of bilingualism on ToM in NT children and children with DD to inform future research that aims to move from group comparisons to continuous assessments of the bilingual experience. To achieve this, we identified the bilingual characteristics of those studies that follow a reasoning pathway (including the specification of a hypothesis why and how bilingualism should impact ToM, and a test of potential mediators and running mediation analysis). A systematic search of multiple databases related to psychology, linguistics, and clinical research was conducted in line with the PRISMA-ScR guidelines. Despite the importance of this topic for families and practitioners working with children with DD in bilingual environments, only six studies focusing on children with DD were published until May 2024, while most of the research focused on NT children. This thus highlights a gap in the literature. This scoping review has the limitation that the choice of databases may have led to the omission of relevant studies. This limitation was underscored by the inclusion of six additional studies through reference list verification after the initial screening process.

The main objective of this review was to examine the bilingual characteristics of the participants based on hypothesized pathways and study outcomes. The results showed that only three studies to date have used continuous measurements of bilingual experience, with the remaining studies relying on group comparisons. In studies employing group comparisons, bilingual characteristics were classified into categories such as amount of language exposure, frequency of language use, second language proficiency, age of first exposure to the L2, and the contexts in which the languages are used or heard. Analyses of the description of the bilingual characteristics of participants based on the claimed hypotheses and the overall study outcomes showed that the majority of studies claiming a direct effect and providing information about the amount of exposure to different languages also showed uniquely positive effects. Similarly, without taking into account the claimed pathways, the majority of studies showing overall positive effects included characteristics of the exposure to different languages. However, no clear patterns emerged from studies claiming and investigating a mediated effect via EF and MLA, which were moreover largely categorical.

Given that the overall study characteristics and 'reasoning frameworks' were similar between studies including children with DD and those with NT children at various steps, we suggest that the most suitable predictor to consider when designing studies with a continuous approach is the amount of exposure to different languages. This aligns with a potential direct effect of bilingualism and applies to both NT children and children with DD, as no differing patterns were observed between the two groups. Furthermore, this review's findings highlight the need for studying the effect of bilingualism on ToM in children with DD, but also in NT children, taking an explicit, step-by-step investigation. This includes (a) formulating clear hypotheses, pertaining to the specific difficulties children with DD may have regarding ToM, (b) operationalizing the bilingual experience in a continuous manner by adhering to the claimed hypothesis (that is for example by measuring the amount of exposure to different languages), (c) incorporating measurements of potential mediators, such as EF or MLA tasks, and (d) conducting mediation analyses when an effect of bilingualism on ToM is found.

Such a fine-grained, continuous approach would allow to disentangle the questions arising on different findings (positive, negative and null results) in bilingualism effects on ToM in children with DD and NT children.

Data availability statement

The original contributions presented in the study are included in the article and the Appendix, further inquiries can be directed to the corresponding author.

Author contributions

FB and SD conceptualized this scoping review. FB conducted the search; FB, DB and LR screened the papers in two phases and extracted the data from the papers. FB organized the data management and coding consensus. FB wrote the manuscript, while DB and LR provided feedback. SD provided feedback and reviewed and edited the manuscript. SD conducted the funding acquisition. All authors approved the submitted version.

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Declaration of competing interest

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

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Appendix 1. PRISMA-ScR Checklist

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	Abstract
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	1–4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	5
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	5-6
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	6
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	6
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	6
RESULTS			

(*continued on next page*)

(*continued*)

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	6
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	6
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	6
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	6-7
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	7-15
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	15-17
Limitations	20	Discuss the limitations of the scoping review process.	17
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	17
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	17

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 16 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

Appendix 2. Search strings in databases

PubMed

(bilingual*[Title/Abstract] OR multilingual*[Title/Abstract] OR trilingual*[Title/Abstract] OR "dual language*"[Title/Abstract] OR "two languages" [Title/Abstract] OR "second language" [Title/Abstract] OR "heritage language*"[Title/Abstract] OR "home language*"[Title/Abstract] OR "societal language*"[Title/Abstract] OR "minority language*"[Title/Abstract] OR "majority language*"[Title/Abstract] OR "dominant language*"[Title/Abstract] OR "weak language*"[Title/Abstract] OR "foreign language*"[Title/Abstract] OR BFLA[Title/Abstract] OR "English as an additional language" [Title/Abstract] OR EAL OR "English language learner" [Title/Abstract] OR ELL[Title/Abstract] OR L1[Title/Abstract] OR L2[Title/Abstract] OR L3[Title/Abstract] OR "language dualism"[tiab:~0] OR bimodal*[Title/Abstract] OR "sequential* bilingual*"[Title/Abstract] OR "simultaneous* bilingual*"[Title/Abstract] OR diglot*[Title/Abstract] OR polyglot*[Title/Abstract] OR multi-tongued[Title/Abstract]) AND.

("social cognit*"[Title/Abstract] OR "theory of mind"[Title/Abstract] OR ToM[Title/Abstract] OR TOM[Title/Abstract] OR "diverse desire*"[Title/Abstract] OR "diverse-desire*"[Title/Abstract] OR "diverse belief*"[Title/Abstract] OR "diverse-belief*"[Title/Abstract] OR "false belief*"[Title/Abstract] OR "false-belief*"[Title/Abstract] OR FB[Title/Abstract] OR "Sally-Ann*"[Title/Abstract] OR mindreading*[Title/Abstract] OR mentalizing*[Title/Abstract] OR mentalising*[Title/Abstract] OR "perspective taking*"[Title/Abstract] OR perspective-taking*[Title/Abstract] OR mental-state*[Title/Abstract] OR "understanding of emotion*"[Title/Abstract]) AND (child*[Title/Abstract] OR kid*[Title/Abstract] OR "school-age*"[Title/Abstract] OR preschooler*[Title/Abstract]).

Web of Science

(AB=(bilingual*) OR AB=(multilingual*) OR AB=(trilingual) OR AB=(dual language*") OR AB=("two languages") OR AB=("second language") OR AB=("heritage language*) OR AB=("home language*") OR AB=("societal language*") OR AB=("minority language*") OR AB=("majority language*") OR AB=("dominant language*") OR AB=("weak language*") OR AB=("foreign language*") OR AB=(BFLA) OR AB=("English as an additional language") OR AB=(EAL) OR AB=("English language learner") OR (AB = ELL) OR AB=(L1) OR AB=(L2) OR AB=(L3) OR AB=("language dualism") OR AB=(bimodal) OR AB=(sequential* bilingual*) OR AB=(simultaneous* bilingual*) OR AB=(diglot*) OR AB=(polyglot*) OR AB=(multi-tongued)) AND (AB=("social cognit*") OR AB=

("theory of mind") OR AB=(ToM) OR AB=(TOM) OR AB=("diverse desire*") OR AB=("diverse-desire*") OR AB=("diverse belief*") OR AB=("diverse-belief*") OR AB=("false belief*") OR AB=("false-belief*") OR AB=(FB) OR AB=("Sally-Ann*") OR AB=(mind-reading*) OR AB=(mentalizing*) OR AB=(mentalising*) OR AB=("perspective taking*") OR AB=(perspective-taking*) OR AB=(mental-state*) OR AB=("understanding of emotion*")) AND (AB=(child*) OR AB=(kid*) OR AB=("school-age*") OR AB=(preschooler*)).

PsycINFO + ERIC + child development & Adolescent studies

AB (bilingual* OR multilingual* OR trilingual OR "dual language*" OR "two languages" OR "second language" OR "heritage language* OR "home language*" OR "societal language*" OR "minority language*" OR "majority language*" OR "dominant language*" OR "weak language*" OR "foreign language*" OR BFLA OR "English as an additional language" OR EAL OR "English language learner" OR ELL OR L1 OR L2 OR L3 OR "language dualism" OR bimodal OR "sequential* bilingual*" OR "simultaneous* bilingual*" OR diglot* OR polyglot* OR multi-tongued) AND.

AB ("social cognit*" OR "theory of mind" OR ToM OR TOM OR "diverse desire*" OR "diverse-desire*" OR "diverse belief* OR "diverse-belief*" OR "false belief* OR "false-belief* OR FB OR "Sally-Ann*" OR mindreading* OR mentalizing* OR mentalising* OR"perspective taking*" OR perspective-taking* OR mental-state* OR "understanding of emotion*") AND AB (child* OR kid* OR "school-age*" OR preschooler*).

Linguistics and language behavior abstracts (LLBA)

(TITLE,ABSTRACT(bilingual*) OR TITLE,ABSTRACT(multilingual*) OR TITLE,ABSTRACT(trilingual*) OR TITLE,ABSTRACT(dual language*) OR TITLE,ABSTRACT(two languages) OR TITLE,ABSTRACT(second language) OR TITLE,ABSTRACT(heritage language*) OR TITLE,ABSTRACT(home language*) OR TITLE,ABSTRACT(societal language*) OR TITLE,ABSTRACT(minority language*) OR TITLE,ABSTRACT(majority language*) OR TITLE,ABSTRACT(dominant language*) OR TITLE,ABSTRACT(weak language*) OR TITLE,ABSTRACT(foreign language*) or TITLE,ABSTRACT(BFLA) or TITLE,ABSTRACT(English as an additional language) OR TITLE,ABSTRACT(EAL) OR TITLE,ABSTRACT(English language learner) OR TITLE,ABSTRACT(ELL) OR TITLE,ABSTRACT(L1) OR TITLE,ABSTRACT(L2) OR TITLE,ABSTRACT(L3) OR TITLE,ABSTRACT(language dualism) OR TITLE,ABSTRACT(bimodal) OR TITLE,ABSTRACT(sequential* bilingual*) OR TITLE,ABSTRACT(simultaneous* bilingual*) OR TITLE,ABSTRACT(diglot*) OR TITLE,ABSTRACT(polyglot*) OR TITLE,ABSTRACT(multi-tongued)) AND (TITLE,ABSTRACT(social cognit*) OR TITLE,ABSTRACT(theory of mind) OR TITLE,ABSTRACT(ToM) OR (TOM) OR TITLE,ABSTRACT(diverse desire*) OR TITLE,ABSTRACT(diverse-desire*) OR TITLE,ABSTRACT(diverse belief*) OR TITLE,ABSTRACT(diverse-belief*) OR TITLE,ABSTRACT(false belief*) OR TITLE,ABSTRACT(false-belief*) OR TITLE,ABSTRACT(FB) OR TITLE,ABSTRACT(Sally-Ann*) OR TITLE,ABSTRACT(mindreading*) OR TITLE,ABSTRACT(mentalizing*) OR TITLE,ABSTRACT(mentalising*) OR TITLE,ABSTRACT(perspective taking*) OR TITLE,ABSTRACT(perspective-taking*) OR TITLE,ABSTRACT(mental-state*) OR TITLE,ABSTRACT(understanding of emotion*)) AND (TITLE,ABSTRACT(child*) OR TITLE,ABSTRACT(kid*) OR TITLE,ABSTRACT(school-age*) OR TITLE,ABSTRACT(preschooler*)).

Data availability

No data was used for the research described in the article.

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