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Defining Bilingualism in Infancy and Toddlerhood: A Scoping Review

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Author Note

We have no known conflict of interest to disclose.

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Abstract

Aims and Objectives

The aim of this manuscript is to provide an overview of the population and languages studied and the methods and practices surrounding the definition of bilingualism in children below age three.

Methodology

A quantitative descriptive scoping review

Data and Analysis

From 530 articles, we identified 127 papers (167 studies) that met our predefined criteria, of which 144 studies defined their bilingual population.

Findings/Conclusions

The samples investigated were predominantly western in geographical origin and languages. Percent exposure was the most common method to measure bilingualism among infants and young children, with 20% and 25% the most used cutoffs as the minimum requirement for children's second language. We also analyzed the predictive value of these cutoffs on the likelihood that studies reported a significant difference between monolinguals and bilinguals. The stricter the inclusion requirement for bilinguals was, the higher the odds of a study to report a difference between monolingual and bilingual children. We conclude that a lack of uniformity of definition in the field may be one factor that predicts whether or not significant differences are reported.

Originality

This scoping review provides developmental researchers with a unique overview of the different practices used in the field to characterize bilingual and monolingual infants/toddlers.

The reported results can be used as preliminary evidence for the field to report and carefully formulate how to categorize monolinguals and bilingual infants.

Significance/Implications

As globalization continues to foster migration and intercultural exchange, it is essential for developmental researchers to diversify their samples and language groups. We highly encourage researchers to carefully document the definitions and rationale for all their language groups and to consider analyzing the impact of bilingualism both from a categorical and continuous approach.

Keywords: bilingualism, infancy, toddlerhood, scoping review, measures, definition

Defining Bilingualism in Infancy and Toddlerhood: A Scoping Review

Who is Included in Studies of Bilingualism?

Researchers have estimated that at least half of the people in the world speak more than one language (Ansaldi et al., 2008; Ellajosyula et al., 2020; Giovannoli et al., 2020; Grosjean, 2010; Grosjean, 2013). For example, some nations (approx. 200) officially recognize two or more languages (e.g., Bolivia, India, Nigeria, etc.). And even though the United States does not have an official language, it counts with a diverse bi/multilingual population with at least 1 out of 5 people reporting speaking more than one language at home (Ryan, 2013). Considering that globalization has facilitated the migration of millions of people per year, it is very likely that the number of multilingual speakers around the globe will continue to increase over time.

The majority of psychological and developmental literature has focused on participants coming from or living in Western, Educated, Industrial, Rich, and Democratic (WEIRD) nations (Arnett, 2016; Henrich et al., 2010; Moriguchi, 2021, Nielsen et al., 2017). Researchers have urged the scientific field to expand their research beyond a western-centric focus (Arnett, 2016, Cole, 2006; Hendriks et al., 2019; Jahoda, 2016; Pollet & Saxton, 2019). Considering that the bilingual population is more diverse and lives in more than half of the nations of the world, it would be expected that research would also reflect such diversity in location and participants. The current study aims to empirically review the diversity of the sample populations across the ages zero to three in the bilingual developmental literature.

Along with sample diversity, it is important to direct a spotlight on which languages the field is focusing on. Societies or governments consider some languages to be "more prestigious" or carry higher value or priority. Such arbitrary consideration can influence the way policies and intervention programs are developed and the populations that are served. For example, a report

by Unicef and FILAC pointed out that the more recent COVID-19 pandemic has exacerbated the exclusion of native languages in the education systems of most Latin American countries. Out of 12 nations in this region, only a small percentage have been able to create remote learning programs or materials for all their indigenous groups, all their languages, or even all their school grades (UNICEF, 2021). The lack of appropriate remote educational materials has left thousands of children without access to an intercultural or bilingual education. The current scoping review will document which bilinguals are researched and where.

Defining Bilingualism

The Linguistic Society of America defines an individual as bilingual as "someone who speaks two languages" (Birner, n.d.). In the Merriam-Webster online dictionary (n.d.), bilingualism is defined as "the ability to speak two languages or the frequent use (as by a community) of two languages" (see Byers-Heinlein, & Lew-Williams, 2013 for a similar definition). For adults, bilingualism is defined as a dynamic and multidimensional construct that includes both individual and contextual variability (Kaushanskaya, & Prior, 2015, Luk & Bialystok, 2013). Such variability may explain the absence of a common standard to define adult individuals as bilinguals (Surrain & Luk, 2019).

But how is bilingualism defined for young infants who are still preverbal or are barely able to produce any words? Even though the definition of bilingualism for very young children does not need to account for language production, different research groups have applied different criteria (e.g., Birules et al., 2018 or Morin et al., 2019 for 25%; Polka et al., 2017 or Singh, 2018 for 30%) and used various methodological approaches to classify infants as monolinguals and bilinguals (e.g., Language Exposure Questionnaire by Bosch & Sebastián-Gallés, 2001; or LENA by Orena et al., 2019). Such variation makes it difficult for researchers to compare their findings across research groups and populations, increasing the probability of mixed results in the field. In some instances, such definitions are not even included in the published documents.

An additional challenge of creating a standard definition of bilingualism in the developmental field is the increased weight of contextual variables on infants' bilingual experience. Contextual variables include family language practices and beliefs, family language policies (Crawford, 1991; King et al., 2008), speakers' language proficiency, and even the language combinations exposed to at home and in the surrounding community. For example, while some caregivers may both choose to speak multiple languages, other families may choose to have each primary caregiver as the sole source of each language the child is learning (e.g., Parent A only speaks language A while Parent B only speaks language B). In some instances, families may choose to code-switch or use a language other than the ones spoken in the community.

Currently, there is no empirical evidence documenting the variability in the definition of bilingualism in infant populations. And even when the definition is based on the same construct (language exposure), researchers may not use the same threshold or cutoff to define what amount of language exposure makes an infant monolingual or bilingual. The current study aims to fill that gap in the literature and provide the field with a compilation of questionnaires utilized for such definitions.

Does the Way that Researchers Define Bilinguals Matter?

Despite a considerable increase in bilingualism research during infancy and toddlerhood over the last 20 years (Byers-Heinlein, 2015), several findings remain inconsistent. For example, a study by Kovács and Mehler (2009) using an anticipatory eye movement paradigm to measure 7-month-olds' cognitive skills reported a monolingual-bilingual difference, with the latter being more likely to update their prediction during the test trials. As one of the earliest studies to show such an advantage even before the language producing stage, several researchers have attempted to replicate such findings with no success (D'souza et al., 2020; Ibáñez-Lillo et al., 2010; Kalashnikova et al., 2020; Molnar et al. 2014; Tsui & Fennell, 2019; but see Iliaei et al., 2020's updated analysis). Some researchers focused on other cognitive skills such as memory flexibility have found bilingual infants to outperform their monolingual peers (Barr, Rusnak, Brito, & Nugent, 2020; Brito et al., 2020; Brito & Barr, 2012; Brito & Barr, 2014; Brito et al., 2014; Brito et al., 2015) but not all published studies have found a significant difference in cognitive

skills. For example, in a review by Williams et al. (2021), out of 26 studies focusing on infants' executive function and memory skills, only 10 of them reported a significant difference between monolinguals and bilinguals--with bilinguals outperforming their monolingual peers. Some people have attributed the contradictory findings to the variability of tasks utilized (Hilchey & Klein, 2011; Valian, 2014), the analytical approaches (Iliaei et al., 2020), and even the definitions used to classify infants into various language groups (Luk & Bialystok, 2013; Marian, 2018). To help answer this question, the present scoping review will analyze whether the differences in definitions (using language exposure cutoff as a proxy) could impact the likelihood of the study reporting a significant difference between monolingual and bilingual infants.

The Present Study

This is a scoping review of the definition of bilingualism in studies with samples of children younger than three years of age. This quantitative descriptive review aims to provide an overview of the different methods and practices used in the empirical field to categorize infants and toddlers as "bilinguals." And whether the different cutoffs used to define bilinguals have any predictive value on the likelihood of them reporting a significant difference between monolinguals and bilinguals.

There are three main research questions we aim to answer:

1. Who is included in studies of bilingual infants?
 - a) Where do bilingual populations come from?
 - b) What languages are included in the bilingual developmental literature?
2. How are bilingual (and monolingual) infants defined in the developmental literature?
 - a) What are the most common measures used to define bilinguals?
 - b) How often do researchers provide an operational definition of their language group?
 - c) For studies where researchers have estimated language exposure, how much exposure is enough to meet monolingual/bilingual inclusion?
 - d) Do the various cutoffs utilized vary across time?
 - e) Are there gaps in the cutoffs? How much is too little L2 to be categorized?

3. Can we predict the likelihood of a study to report differences between monolingual and bilingual infants using the L2 cutoffs?

Methods

Search Strategy & Selection Criteria

Three searches were performed using the PsycINFO database with the keywords 'biling*' OR 'dual language learner' AND one of the following three: 'infan,' 'toddl,' and 'babies.' The searches were performed to include all articles published by April 9th, 2020. After removing duplicates ($n = 453$), there were 530 unique papers. All 530 abstracts were reviewed using predetermined criteria (see Table 1).

Inter-Rater Reliability

A second independent coder reviewed 86 abstracts and classified them as being eligible or not for review utilizing the aforementioned criteria. Inter-coder agreement was high, Cohen's Kappa = .84, $p < .001$, with any disagreement resolved via discussions.

The same coder was also trained on a set of studies to extract information pertaining to the following variables: monolingual sample size, bilingual sample size, monolingual and bilingual definition present (binary: yes/no), monolingual cutoff, and bilingual cutoff. A test set of 17 studies (~10% of total eligible studies) was used to calculate inter-reliability for the sample and article characteristic variables. All kappas were acceptable, range = .77-.93. Any discrepancies were resolved through discussion between the coders.

Results

The flow chart in Figure 1 details the selection process used for the review. Of 983 references found in the database for all three searches (oldest from 1933), 453 were excluded as being duplicates. Abstracts from a total of 530 unique records were screened using the predetermined criteria. Four hundred and three records did not meet the predetermined criteria and were excluded from further review, leaving a sample of 127 records eligible for review (or 167 studies). Records were excluded for the following reasons: papers were not being empirical ($n = 190$), papers were not focused on bilinguals or their cognitive/linguistic outcomes ($n = 97$), papers were meta-analysis/monographs/dissertations ($n = 33$),

papers focused on children older than three years old ($n = 55$), papers focused on children who were not typically developing ($n = 22$), papers focused on multimodal bilinguals ($n = 6$). The oldest study was published in 1993, and the newest study in 2020. The complete table for all eligible studies ($n = 167$) included in the review is posted in *Supplement A*, including information about language categorization and measures utilized for each study. The complete dataset and scripts used in this review can be found in this OSF repository: https://osf.io/5fhrb/?view_only=62555867466a42eb85b00bed984ac6ba.

Q1. Who Is Included in Studies of Bilingual Infants?

Q1a. Where Do Bilingual Populations Come from?

The study's geographic location was described either explicitly or in the acknowledgments/notes of the manuscript. A significant proportion (38 studies) did not report where the study was conducted. The majority of researchers recruited participants for their studies solely from Canada (27), the United States (27), or Spain (23). Eight studies included samples from multiple countries. For example, Cote and Bornstein (2014) recruited bilingual samples in the United States but monolingual samples from the United States, South Korea, and Argentina. Two others (Legacy et al., 2016; Legacy et al., 2018) recruited monolinguals from Geneva, Switzerland, while the bilingual groups were recruited from Montreal, Canada (for more details, see *Supplement A*). Figure 2 shows a map of the locations and languages provided by the articles, including those who recruited samples from multiple countries.

Q1b. What Languages Are Included in the Developmental Bilingual Literature?

Only four studies did not include information about their bilinguals' language pairs. Since the majority of the participants were recruited in countries where English, French, or Spanish is the community language (United States, Canada, and Spain, respectively), the majority of the bilingual groups had English as one of the languages of interest (110 studies), followed by Spanish (60 studies) and French (31 studies).

While 116 studies restricted their bilingual sample to one type of language pair (e.g., English-Spanish, Spanish-Catalan), 51 studies focused on more diverse bilinguals (Table 2). This approach would

allow for one primary language among the children in the sample while their second language (L2) could have been any other language (e.g., English-Other, Spanish-Other).

Q2. How Are Bilingual (and Monolingual) Infants Defined in the Developmental Literature?

Q2a. What Are the Most Common Measures Used to Define Bilinguals?

Measures of bilingualism vary from single questions such as "Consider your baby's whole life, up till the time that he/she was 24 months. When you, your spouse, and everybody else in your baby's life talked to him/her, what percentage of each language was spoken to him/her?" (Goh et al., 2017) to more complex measures. For example, some studies took advantage of long detailed questionnaires asking caregivers for the time all individuals spend with the child, their languages, and the amount of time they speak to the child. This number was later converted into proportions/percentages for overall exposure (e.g., Bosch & Sebastián-Gallés, 2001; DeAnda et al., 2016).

Some researchers (n=36 studies) reported using their questionnaires, while the remainder reported using a specific published measure (either with a source or not). Among the measurements provided, the Language Exposure Questionnaire by Bosch & Sebastián-Gallés, 2001 (37 studies) and 1997 (29 studies) were the most common measures cited. Despite authors citing either one of these sources, Bosch and Sebastián-Gallés' questionnaires from 1997 and 2001 had the same questions making this questionnaire the most used measure to assess children's language exposure (39.53% of 167 studies, see Table 3). How the language exposure measures are reported and used differs across studies, as seen in the follow-up questions.

Q2b. How Often Do Researchers Provide an Operational Definition of their Language Groups?

Monolinguals

Of the 167 eligible studies, 111 included a monolingual group for comparison. However, only 64.86% of studies (n = 72) offered some definition for their monolingual group, and the remaining 26.24% (n = 39) did not. Of the 72 studies that included a definition, $\frac{3}{4}$ (n = 55) focused on time or percent exposure. In contrast, $\frac{1}{4}$ (n = 17) used the caregiver or home status as a proxy for monolingualism (e.g., "child growing up in a monolingual household" or "parents only speaking one language"; see Table

4). For example, some studies included explicit definitions of monolinguals, such as "to be included in a monolingual group, participants had at least 75% of regular exposure to either Catalan or Spanish..." (Bosch et al., 2013). Others used vaguer definitions, such as the one in Kalashnikova et al., 2018 that reported their monolingual infants to be acquiring English with no exposure to any other languages. For the 39 studies that did not report an operational definition for their monolingual group, ¼ of them (n = 10) reported descriptive information for their monolingual language exposure suggesting that the authors may have used *exposure* for their measure of monolingualism but did not provide a specific definition. No definitions or additional information were provided for the remaining studies (n = 29).

Bilinguals

The majority of the studies (86.23%, n = 144 studies) offered some sort of definition for their bilingual group (see Table 4). If the document provided enough information about its measures, we could deduce the researcher's method to classify children as bilingual. The "Percent exposure to a second language" was the most common method employed (123 studies), followed by "Caregiver/Home status" (19 studies; i.e., defined as bilinguals if caregivers or home were bilingual). The vagueness of one of the definitions did not allow us to determine whether they were interested in the parent/home status or the amount of exposure (i.e., "exposed to both languages regularly"). One study utilized the children's receptive vocabulary as a marker for bilingualism (i.e., defined as bilinguals if the number of words they reported to know in English fell between 20% and 80% of the total words known in both languages; Vihman et al., 2007)

Q2c. How Much Exposure is Enough to Meet Monolingual/Bilingual Inclusion?

Considering that most of the studies utilized measures focused on a child's language exposure, it was important to analyze how consistent studies have been at stating cutoffs or minimum requirements that would guide the experimenters on their definition of monolinguals and bilinguals.

Monolinguals

Twenty studies out of 72 that included a definition for their monolingual group did not state a minimum requirement or cutoff for their monolingual sample. Twenty-seven studies (37.5%) stated a

cutoff of "90%" for their first language (L1), while ten studies reported having a cutoff of 80% (see Figure 3).

Bilinguals

Of the 123 studies that reported exposure as their proxy for bilingualism, 23 (18.70%) studies did not provide a minimum exposure requirement for the bilingual group. Four studies (3.25%) used "number of hours of exposure" (range 8 to 20 hours) for their bilingual categorization. However, the majority of studies used a percent exposure cutoff to categorize infants as monolingual or bilingual. Researchers opted for two percentage cutoffs most frequently, 26 studies used "25%" as their minimum requirement for the child's second language (L2), and 25 studies used "20%" as their cutoff (See Figure 4).

Q2d. Do the Various Cut-offs Utilized Vary across Time?

To observe whether the use of cutoffs varied over time, a Pearson correlation was performed to determine the relationship between the study's publication year and Percent L2 exposure cutoff (Figure 5). A statistically significant negative correlation ($r = -.41, p = <.001$) revealed that the most recently published studies were more likely to use lower cutoffs. Figure 5 also illustrates an increase in the number of studies using cutoffs to categorize bilingual infants in the past ten years. A similar analysis was performed for the monolingual cutoffs, but this was not statistically significant, likely due to more inconsistent reports of monolingual definitions ($r = .24, p = .089$; see Figure 6).

Q2e. Are There Gaps in the Cut-Offs? How Much Is Too Little L2 to Be Categorized?

Some researchers exclude participants whose L2 is too high to be considered monolingual or too low to be considered bilingual. For example, if the participant's L2 exposure is 20%, but the L2 cutoff of the bilingual group is 25%, and the monolingual group cutoff is 10%, this participant would be excluded from analyses for not meeting language criteria. To investigate the frequency of this practice, only studies that included cutoffs for both a monolingual and bilingual sample were included ($n = 45$). For the 11 studies with a zero-gap, individuals would be categorized into either of the language groups (e.g., Children with $\geq 20\%$ L2 exposure are classified as bilinguals, but if $<20\%$ categorized as monolinguals;

see Figure 7). On the other hand, for the rest of the studies ($n = 34$), if a participant's L2 percentage falls in these gaps, they would be excluded from the analysis or not included in the study in the first place.

Q3. Can We Predict the Likelihood of a Study to Report Differences Between Monolingual and Bilingual Infants Using the L2 Cutoffs?

Overall, 57 studies did not include a monolingual comparison group. For the remaining studies, 69 studies reported significant differences between both language groups, and 41 studies did not. Studies were included in the following analyses if they included a monolingual sample and information about the exposure cutoffs for both languages (Figure 8). A logistic regression was performed to assess whether we could predict the likelihood of studies to report a significant difference between monolinguals and bilinguals. The following variables were included in the model: year of publication, bilingual cutoff, and L2 gap size. The overall model was significant, $\chi^2(3) = 8.26, p = .041$. The L2 gap size and publication year did not predict the likelihood that studies reported differences between monolingual and bilingual infants. In contrast, the cutoff for the bilingual group was significantly associated with the likelihood of studies reporting a significant difference. Studies were 15% more likely to report a significant difference between monolinguals and bilinguals for every 5-point increase in their L2 cutoffs (see Table 5). Meaning that the more L2 % exposure was required to be considered bilingual, the more likely the study was to report a significant difference between the two language groups.

Discussion

Overall, the scoping review demonstrated that the field of early bilingual development is limited to industrialized countries and non-indigenous languages. It also revealed the vast variability in the definition of monolinguals and bilinguals. This variability is associated with when the articles were published (as a proxy for data collection) and the assessment method. Furthermore, the definition may be one factor that predicts whether or not significant differences are reported. The discussion will expand upon the implications of each of these findings.

Like most developmental science literature, research on bilingual exposure is limited to a narrow geographical range. As reflected in Figure 2, most of the studies eligible for this review focus on

northwestern populations with few exceptions. There is little to no representation of samples residing in the continents of Africa, South America, or Asia (see Figure 2). Furthermore, it was surprising that geographic location could not be determined for 38/127 studies despite the predefined protocol to extract this information from the entirety of the manuscript rather than solely from the main text. A more transparent reporting of the context (e.g., geographic location), the target population, and the methods utilized (including a rationale for their bilingual definition) would facilitate replication and increase the validity of findings. For the bilingual field specifically, the context such as the geographic locations could explain the possibility of contradictory findings. Research with bilingual populations in geographic regions with no support at a policy level may not reflect the same patterns as those in cultural contexts where bilingualism is not only accepted but encouraged.

It is also important to mention that even though both the United States and Canada were the most common sample recruitment locations, none of the studies conducted in the U.S. or Canada included language groups from indigenous communities. Once again, this finding highlights a focus on WEIRD nations (i.e., Western, Educated, Industrialized, Rich and Democratic; Henrich et al., 2010) and how the field has overlooked families from indigenous communities. The lack of inclusion of indigenous or non-European languages reduces our understanding of bilingualism. More research is needed that includes a broader range of languages and representation across geography, race, and ethnicity. The field is moving to expand to other nations through large scale collaborations such as ManyBabies ("ManyBabies - Multi-lab replications of classic developmental psychology experiments," n.d.), ManyNumbers ("OSF ManyNumbers," n.d.), and Quantifying Bilingual Experience ("Quantifying bilingual experience," n. d.) but more intentional work to reach these goals is needed (see Byers Heinlein et al., 2021 for an example).

Considering the different measures of bilingualism chosen by researchers, almost 40% of the studies utilized either the original or adapted version of the questionnaire published by Bosch and Sebastián-Gallés in 2001 and 1997 (see a version in *Supplement B*). The questionnaire (which happens to be the same questionnaire in both publications) asks the primary caregiver questions about the family's language background and the amount of time they spend with the child. Caregivers then estimate the

child's daily and overall exposure to each of the languages provided earlier. This questionnaire does not necessarily require a structured interview to complete it, limiting how much information the caregivers could provide about the length and quality of exposure. Another limitation of this questionnaire is that it does not consider the fluency or nativeness of the speakers. It is possible that a child with a "significant" language exposure (as defined by the researchers) could be exposed to a low-quality second language, which may modulate how bilingual exposure relates to a specific outcome. The majority of the studies that provided a definition for their bilingual groups (124 studies out of 140) focused on the quantity of language exposure, discounting the possible effects of its quality (but see Bree et al., 2016 for an exception). More studies are needed to understand how the quality of language in a bilingual environment is associated with outcomes.

Even though this scoping review focuses on the definition of bilingualism, authors need to include information on all groups being compared. Most of the studies reviewed here provided some definition for their bilingual group, but surprisingly, only 64.86% offered a definition for their monolingual sample(s). Given that many studies (34 out of 45 in this review) excluded some participants based on exposure thresholds (e.g., $<10\%$ L2 = monolinguals, $> 25\%$ L2 = bilinguals), researchers can no longer assume that monolinguals are simply the inverse of the bilingual group (e.g., $<20\%$ L2 = monolinguals, $\geq 20\%$ L2 = bilinguals). Thus, reporting the definitions of monolingual and bilingual groups is necessary to facilitate replication and extension of prior research (see Byers-Heinlein et al., 2019 for some guidelines).

In addition, based on our review, more recently published studies were more likely to use lower cutoffs to classify bilinguals (Figure 4). It is unclear why this pattern has emerged, and a more in-depth analysis is required. It might be that the recent increase of articles published in the past decade originate from only a handful of laboratories that have lower cutoffs or that the field is moving towards a less stringent definition of bilingual exposure. Alternatively, the metrics for collecting exposure data have also changed across time from single questions to more structured interviews meaning that estimates may also have been affected. It is important to note that our review revealed an association between the cutoff used

to classify bilinguals and the likelihood of the studies reporting a language difference. In other words, the greater the L2 minimum requirement, the greater the likelihood of studies reporting a significant difference between monolinguals and bilinguals. It is also likely that other factors, including the study outcome (linguistic or cognitive outcomes), may have been associated with the likelihood of a significant difference between monolinguals and bilinguals. We would caution researchers not to overinterpret this finding because more stringent inclusion requirements could make data collection more complex and less inclusive. Future research is needed to examine how bilingual measurement and other experimental factors are associated with differences in outcomes. This finding raises the possibility that differences in bilingual measurement in and of itself account for some of the mixed findings in the literature.

Limitations and Future Directions

The scoping review presents mainly descriptive results. Regarding the search for records, it is possible that some studies have not been included due to our criterion for the records to be peer-reviewed articles, as well as restricting the search to one database (PsycINFO). Even though the search terms were meant to encompass a broad array of studies with the bilingual infant/toddler population, we decided to focus the search on early bilinguals and did not explicitly include other terms such as "multilingual." No statistical findings were extracted for each record; therefore, no major quantitative analyses were included. Besides, while we provide an array of measures utilized by researchers to measure bilingualism (see *Supplement B*), their quality or characteristics were not evaluated. Furthermore, the review did not include an evaluation of the quality of the definitions provided.

Despite these limitations, the present scoping review provides developmental researchers with a unique overview of the different practices used in the field to characterize bilingual and monolingual infants/toddlers. The reported results can be used as preliminary evidence for the need of the field to report and carefully formulate how to categorize monolinguals and bilingual infants. Further work is needed to more accurately operationalize early bilingual exposure taking into account its complexity and factors such as language quality and family policies. To interpret and compare findings across studies, developmental researchers need to include operational definitions of monolinguals and bilinguals and

details of the relevant measures/questionnaires used to make such classifications (see Table 6 for more recommendations). New open-source databases such as OSF (<https://osf.io/>), Databrary (<https://nyu.databrary.org/>), or Github (<https://github.com/>) can be used to share measures and questionnaires to facilitate reproducibility.

There are pros and cons of a standardized definition. The pros are that it would be much easier to compare across studies if a standardized measure and cutoff were used for each study. However, we do not advocate for a standardized bilingual categorization method because it would not fully characterize the variability within different bilingual populations and could limit the inclusion of different bilingual samples and the breadth of questions asked. One solution to using a standardized binary categorization would be to use continuous measures of bilingual exposure. In our review, only a handful of studies included exploratory analyses treating bilingual exposure as a continuous variable (see Carbajal & Peperkamp, 2020; Tsang et al., 2018).

A second possibility suggested by Kremin and Byers-Heinlein, (2021) is that researchers could combine both a binary categorization and a continuous approach when reporting their results (see following examples: Rocha-Hidalgo et al., 2020; Kalashnikova et al., 2021). Categorization approaches could also be improved. Another option could be to use a more sophisticated method to categorize participants into different language groups that better reflects the heterogeneity of growing up in a bilingual household. For example, researchers could take advantage of latent profile analyses to identify latent subgroups in their samples based on the language information provided (e.g., percent exposure, speakers' nativeness to the languages, language profile of the location, speakers proficiency, etc.). This holistic approach would take into consideration more than one factor (e.g., exposure) and provide a much richer picture of the experience of growing up in a bilingual household.

However, it is important for researchers to carefully decide a priori which approach(es) is(are) appropriate for their population and research questions. Practices such as pre-registered reports can facilitate the exchange of peer-reviewed feedback before the study is performed, increasing the likelihood of more careful decision-making. This pre-registration step can also function as a method to keep

researchers accountable with the predetermined approach (categorization vs. continuous vs. both) and therefore reduce the likelihood of subsequent manipulation of the criteria to find significant results.

General Conclusion

This scoping review has evaluated a body of available empirical research on bilingual infants and toddlers to examine how bilingualism is being defined to research the implications of growing up in a bilingual environment. From the initial studies conducted in the early 90s and 2000s, the field has advanced considerably, moving away from defining bilingualism based on one "yes/no" question to more detailed interviews (see Cattani et al., 2014; DeAnda et al., 2016), taking into account other caregivers and members of the family (e.g., grandparents and siblings), and even more complex ones that take into account the speaker's fluency (see Bree et al., 2016; *Supplemental Material B*). Despite this improvement, there is no consensus on the definition of bilingual exposure during infancy and early childhood. In addition, we now have another challenge with the existence of various methods and measures used to classify children and their environment as monolingual or bilingual (for a review, see Kaščelan et al., 2020). As the bilingual population continues to grow in the United States and the world, it is essential for developmental researchers to examine more diverse groups of young children and to carefully document definitions of what it means to grow up in bilingual and multilingual contexts.

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Table 1*Selection Criteria*

Sample Characteristics
There was a clear monolingual and a clear bilingual group or solely a bilingual group.
The study included participants below the age of 36 months. If a study focused on both age groups below and after 36 months, only information about the younger group was reported.
The study tested spoken language users rather than sign language users (studies focused on bimodal bilinguals were omitted).
Article Characteristics
Was published in a peer-reviewed journal.
Included at least one empirical study (case studies and observational studies were excluded).
Was not a review, metanalysis, book, chapter, opinion, or dissertation.
Compared cognitive or linguistic outcomes (studies focused on intervention programs were excluded).
Was published in English, Spanish, or French.
Was published as of April 9th, 2020.

Table 2*Frequency of Language Pairs Reported in Studies*

Language Pairs	N	Language Pairs	N
English-Other	31	Catalan-Spanish & Catalan-Other	1
Catalan-Spanish	26	English or French-Other	1
English-Spanish	25	English-German	1
French-English	22	English-Maltese	1
English-Mandarin	16	English, Mandarin, Malay, or Tamil/Hindi	1
Dutch-Other	8	Finish-Russian	1
Basque-Spanish	5	French-Créole	1
English-Welsh	4	French-English & English-Mandarin or Cantonese	1
French-Other	4	French-English & English-Spanish	1
Italian-Other	4	French-German	1
Catalan-Spanish-English	2	Mandarin-Other	1
English-Mandarin or Cantonese	2	Swiss German- or Std German-Other	1
English-Tagalog	2	Unreported	4

Note. N refers to the number of studies that reported having these language pairs.

Table 3*Summary of Measures Utilized to Classify Bilinguals*

Measure	N	Percent
*Language Exposure Questionnaire (Bosch & Sebastián-Gallés, 1997; 2001)	66	39.53
*Own Questionnaire	36	21.56
Not-Specified	16	9.58
*Language Background questionnaire (source not specified)	10	5.99
Single Question	7	4.19
Multilingual Infant Language Questionnaire (Liu & Kager 2016)	6	3.59
*The Language Exposure Assessment Tool (LEAT; DeAnda, Bosch, Poulin-Dubois, Zesiger, & Friend, 2016)	6	3.59
Bilingual Questionnaire (Conboy, 2002)	3	1.80
*Language Background Questionnaire (Sabourin, Leclerc, Lapierre, Burkholder, & Brien, 2016)	2	1.20
*Language Social Background Questionnaire (LSBQ; adapted from Anderson Mak, Chahi, & Bialystok, 2018)	2	1.20
*Multilingual Approach to Parent Language Estimates (MAPLE; Byers-Heinlein et al., 2019)	3	1.80
Bilingual Language Background and Use Questionnaire (BLBUQ; Holowka, Brosseau-Lapré, & Petitto, 2002)	1	0.60

Communicative Development Inventory (CDI) adapted for British English by Hamilton, Plunkett, and Schafer (2001) and for Welsh by Margaret Bell.	1	0.60
English/Spanish Bilingual Background Questionnaire (Garcia-Sierra et al., 2009; Garcia-Sierra et al., 2012)	1	0.60
Home Language Environment Questionnaire (HLEQ; Marchman et al., 2004)	1	0.60
Language environment interview (Following Marchman et al. (2004) and others)	1	0.60
*Language Environment Questionnaire (Carbajal & Peperkamp, 2019)	1	0.60
Questionnaire by Marchman & Martínez-Sussmann, 2002	1	0.60
*Questionnaire for Parents of Bilingual Children: Infants and Toddlers Version (PaBiQ-IT)	1	0.60
The Rosetti Infant-Toddler-Language Scale (Rosetti, 1990)	1	0.60
**Utrecht Bilingual Language Exposure Calculator (UBiLEC; Unsworth, 2013)	1	0.60

Note. *Permission by author to share questionnaire. ** Has a creative commons license. See a copy of this measure in *Supplement B*.

Table 4*Frequency of Method Used to Classify Monolinguals and Bilinguals*

Language Group	Method	Exposure	Caregiver/Home Status	No clear method	Vocabulary*
Monolingual	N	55	17	0	0
	%	76.39%	23.61%	0%	0%
Bilingual	N	123	19	1	1
	%	73.65%	11.38	0.60	0.60

Note. N refers to the number of studies that reported enough information about the method employed.

*Defined bilingual if the number of words they reported to know in English fell between 20 and 80% of the total words known in both languages (Vihman et al., 2007).

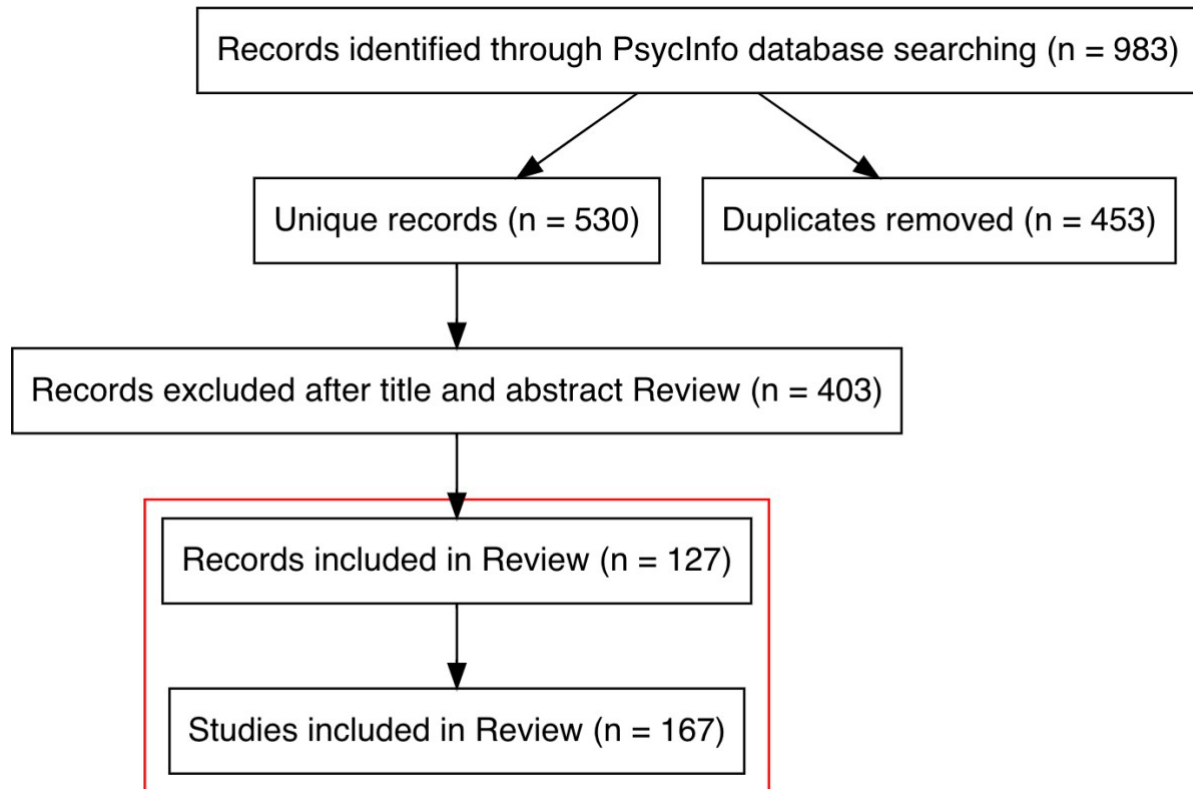
Table 5*Logistic Regression Model for Reporting Differences between Groups (Yes/No)*

Variable	Odds Ratio	Z	Sig.
Intercept	8.24e-15	-.21	.831
Bilingual L2 cutoffs	1.15	2.08	.037 *
Gap L2 cut-offs	.98	-.39	.696
Year of publication	1.02	.20	.844

Note. Total of 47 studies were included in the regression model (LR $\chi^2(3) = 8.26$, $p = .041$).

Table 6*Recommendations and Suggestions from the Present Scoping Review*

Topic	Recommendation & Suggestions
Defining Bilingualism	Be deliberate and transparent about what is being measured and the predetermined definition. Provide definitions for all language groups in the sample. If utilizing a cutoff approach for language exposure, report the predetermined cutoff for all language groups (monolingual and bilingual). Be explicit in reporting whether the bilingual measure is assessing the current (i.e., time of visit) or the cumulative (i.e., from birth to visit time) language status of the child. Provide detailed information about the tool or approach utilized to assess bilingualism. If possible, make it available.
Bilingual samples	Diversify the participant pool. Reduce the bias in the developmental field to focus mainly on WEIRD populations. Diversify the languages the field is focused on. Encourage and build collaborations across different laboratories and geographic locations (e.g., ManyBabies). Measure and report different aspects of the bilingual experience such as language exposure, language use, language quality, geographical location, languages, etc. (See Byers-Heinlein et al., 2019 for some helpful guidelines).
I say 20, you say 30: definitions could explain mixed results	Provide a rationale for predetermined definitions of bilingualism. Walk away from the binary Monolingual vs. Bilingual categorization by either using a continuous approach or using more sophisticated methods such as latent profile analyses to categorize participants. Consider analyzing data using both categorical and continuous measures of bilingual exposure. Pre-register reports to reduce the likelihood of p-hacking and strengthen the validity of findings. Transparency is key for replicability.

Figure 1*Study Selection Process' Flow Diagram*

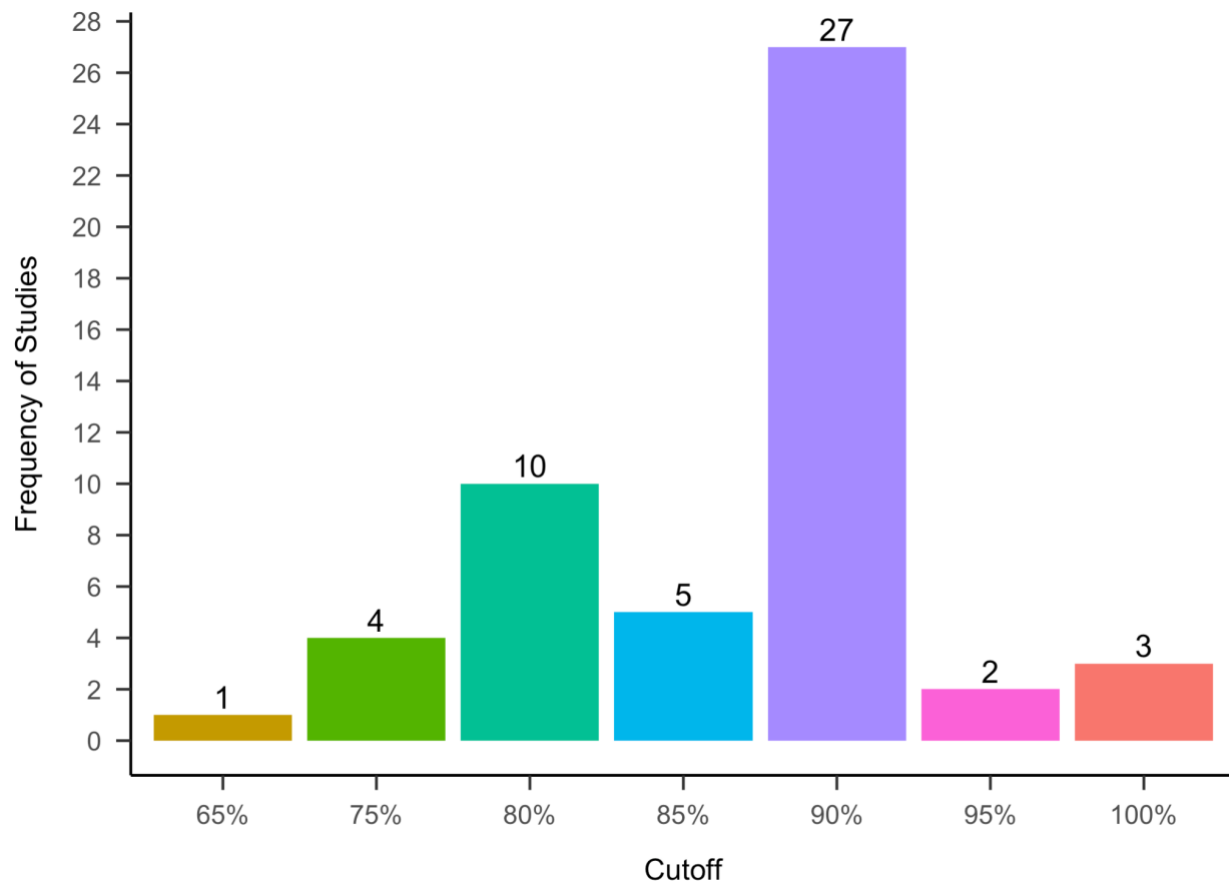
Note. Since some records could include multiple studies, the number of total studies included in the review (n= 167) surpasses the number of records (n = 127) that met the criteria.

Figure 2*Frequency of Studies by Geographic Location and Language(s) Reported*

Note. The frequency of studies is represented by the dots' size and their colors. Only studies that reported a recruitment location were included.

Figure 3

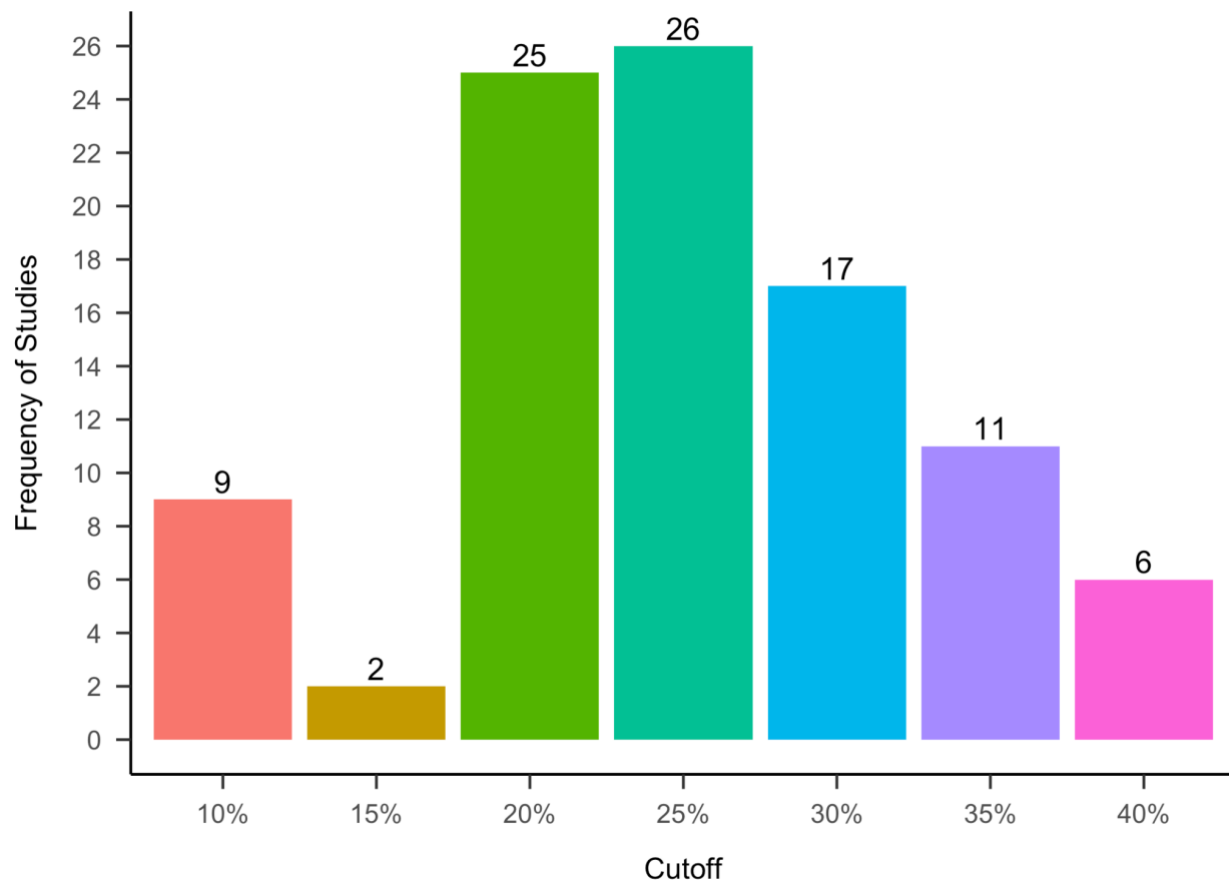
Frequency of Studies by the Reported Cutoff for Children's L1



Note. Cutoff refers to the minimum amount of exposure to L1 utilized to classify a child or environment as monolingual.

Figure 4

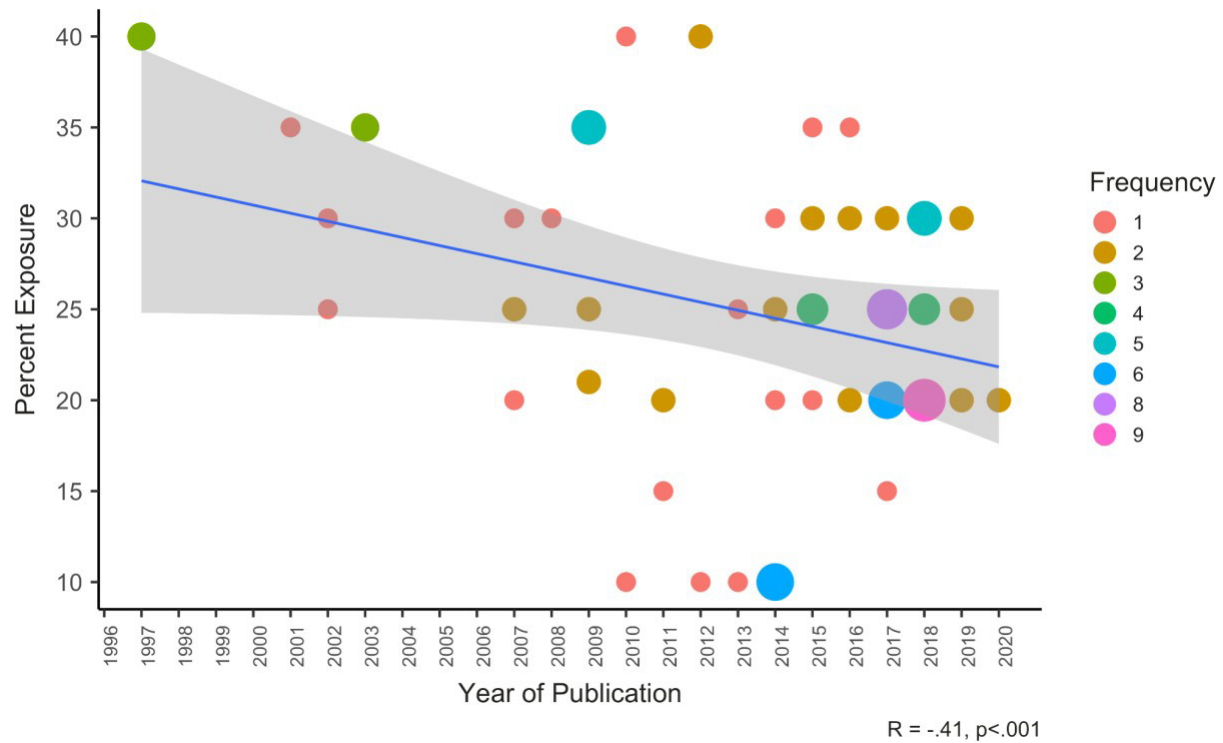
Frequency of Studies by the Reported Cutoff for Children's L2



Note. Cutoff refers to the minimum amount of exposure to L2 used to classify children or the environment as bilingual.

Figure 5

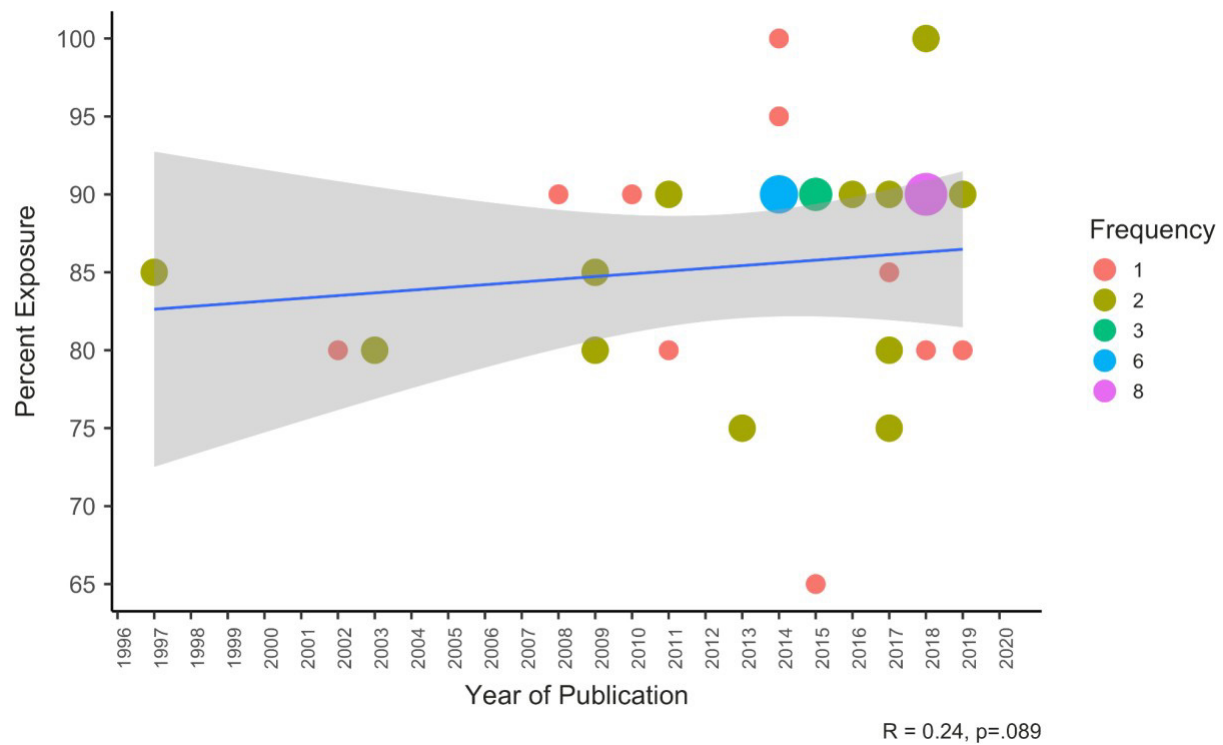
Association between the Study's year of Publication and their reported L2 Cutoff



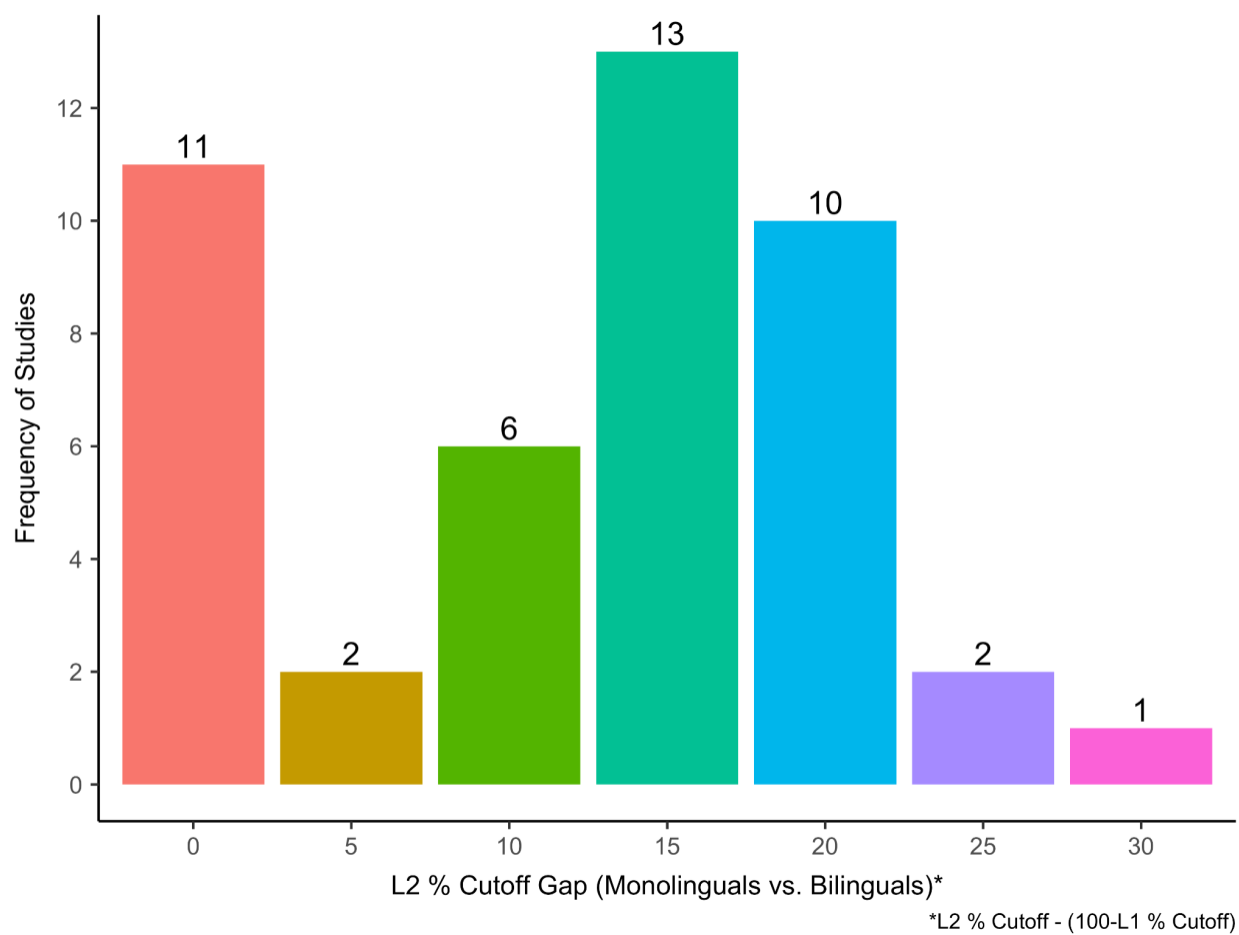
Note. The dots' sizes and colors represent the frequency of studies that share the same year of publication and reported L2 cutoff. The bigger the dot, the more studies share these characteristics. Overall, the studies most recently published presented lower L2 cutoffs.

Figure 6

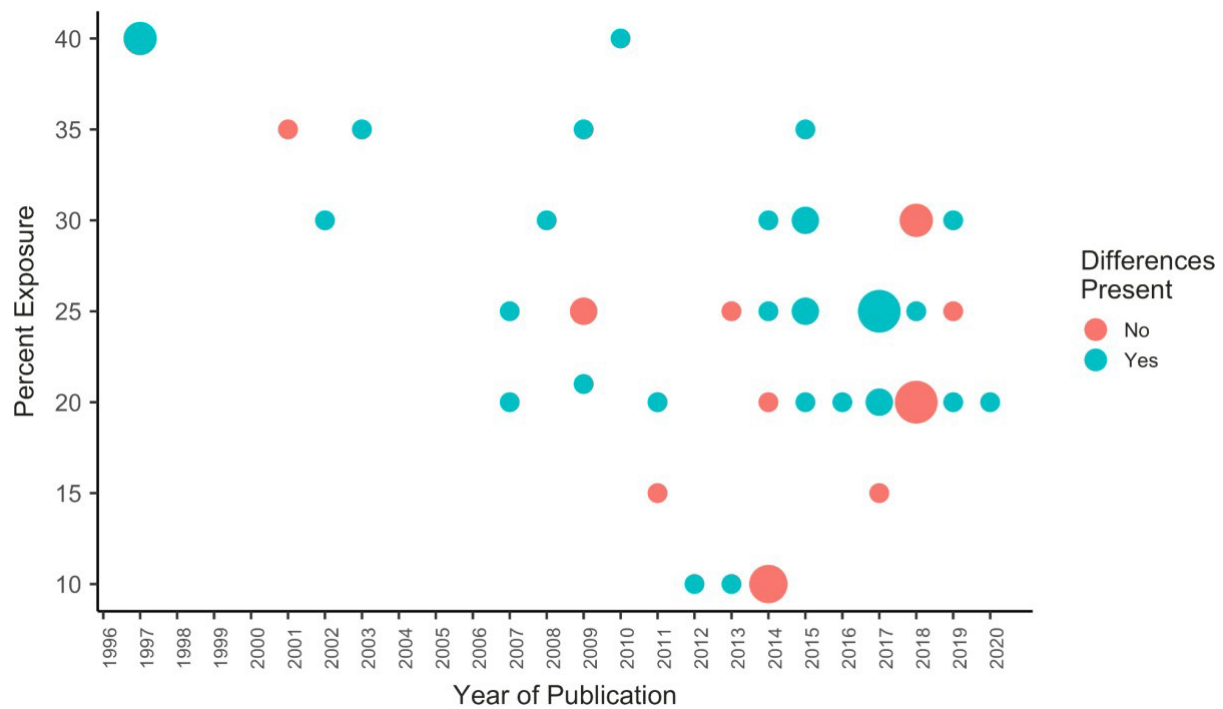
Association between the Study's year of Publication and their reported L1 Cutoff



Note. The dots' sizes and colors represent the frequency of studies that share the same year of publication and reported L1 cutoff. The bigger the dot the more studies share these characteristics. There was no significant correlation between % Exposure Cutoff and Year of Publication.

Figure 7*Frequency of Studies by the Gap between L2 Cut-offs*

Note. Distribution of studies that reported cutoffs for both language groups (monolinguals and bilinguals).

Figure 8*Scatterplot of Studies by Year of Publication and Reported L2 Cutoff*

*Only includes studies that had both monolingual and bilingual groups

Note. The dots' sizes represent the frequency of studies that share the same year of publication and reported L2 cutoff. Orange = No significant differences were reported between monolinguals and bilinguals. Blue = At least one significant difference was reported.