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Language input to infants of different socioeconomic statuses: A quantitative meta-analysis

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Abstract

For the past 25 years, researchers have investigated language input to children from high- and low-socioeconomic status (SES) families. Hart and Risley first reported a "30 Million Word Gap" between high-SES and low-SES children. More recent studies have challenged the size or even existence of this gap. The present study is a quantitative meta-analysis on socioeconomic differences in language input to young children, which aims to systematically integrate decades of research on this topic. We analyzed 19 studies and found a significant effect of SES on language input quantity. However, this effect was moderated by the type of language included in language quantity measures: studies that include only child-directed speech in their language measures find a large SES difference, while studies that include all speech in a child's environment find no effect of SES. These results support recent work suggesting that methodological decisions can affect researchers' estimates of the "word gap." Overall, we find that young children from low-SES homes heard less child-directed speech than children from mid- to high-SES homes, though this difference was much smaller than Hart & Risley's "30 Million Word Gap." Finally, we underscore the need for more cross-cultural work on language development and the forces that may contribute to it, highlighting the opportunity for better integration of observational, experimental, and intervention-based approaches.

KEYWORDS
infancy, language development, language input, meta-analysis, socioeconomic status, word gap

1 | Introduction

When children enter their school classrooms for the first time, they are not starting out as blank slates. Some of the children are well-rested, well-nourished, and well-prepared to start their schooling, while others have already faced a host of disadvantages in their early years of life.

Socioeconomic status (SES) is a broad, complex construct that captures the social and economic standing of a family and consists of three main factors: income, education, and occupation (Duncan & Magnuson, 2001). These three factors, independently or in combination, have been clearly demonstrated to have wide-ranging effects in children's early lives, from parenting behaviors (Hoff and Laursen, 2002) to cognitive and behavioral development and health outcomes (Halle et al., 2009). Children from low-SES families enter school less "ready" for school than their more affluent peers (Coley, 2002; Telegdy, 1974): on average, they have smaller vocabularies (Arriaga et al., 1998; Huttenlocher et al., 2010), less phonological awareness (Bowey, 1995; Hecht et al., 2000), and lower "reading readiness" (e.g., letter recognition; Hanson and Robinson (1967), West et al. (2000)), putting them at a disadvantage when learning to read.

However, this language difference begins well before children start school. A gap in language abilities between children from low-SES and higher-SES families is evident by 2 years of age (Arriaga et al., 1998; Betancourt et al., 2015; Fernald et al., 2013) and may widen through

RESEARCH HIGHLIGHTS

- We conducted a quantitative meta-analysis on language input to young children of different socioeconomic statuses (SES) and analyzed data from 19 studies (nearly 2000 children).
- The overall effect of SES was statistically significant (g=0.41), but much smaller than the often-cited "30 Million Word Gap."
- Studies that included only child-directed speech in their language measures found a larger SES difference than those that included all speech in children's environments.

the first few years of life, with high-SES children showing faster rates of language growth (Hoff, 2006; Hurtado et al., 2008; Huttenlocher et al., 2010; Scaff and Cristia, n.d.). These findings clearly demonstrate that children from low-SES homes have different language trajectories than children from high-SES homes. While children from low-SES homes may have unique language strengths (e.g., Vernon-Feagans et al., 2001), SES-based differences in language abilities at school entry (around 5 years old) predict later academic outcomes (Durham et al., 2007; Lee & Burkam, 2002; Walker et al., 1994). Low-SES children's language abilities differ from high-SES children's in ways that are important for school success (Callanan & Waxman, 2013; Hoff, 2013).

One hypothesized reason for the socioeconomic-based language disparity focuses on children's early language input. Language input is vital to language development: children who hear more words in their environment have larger vocabularies (Huttenlocher et al., 1991, 2010; Rowe, 2012; Weisleder & Fernald, 2013). If low-SES families talk to their children less, the difference in children's language experience could be driving the observed difference in language abilities.

Research on this input difference often aims to understand and address the "30 Million Word Gap," first reported by Hart and Risley (1995). Hart & Risley's landmark study was the first to document the language experience of children across socioeconomic groups, with the aim of explicating why children from economically disadvantaged homes perform worse on language assessments than their affluent peers. They investigated the quantity and quality of language heard by children from across the socioeconomic range and estimated that children from high-SES families heard 45 million words by their third birthday, while low-SES children heard only 13 million words – a gap of over 30 million words. Hart and Risley's striking finding has been incredibly influential, sparking a massive amount of research into the purported word gap, its effect on vocabulary differences, and interventions aimed at closing it. Their book has been cited nearly 9000 times and has inspired articles in popular media (e.g., Talbot et al., 2015), public awareness campaigns (e.g., Clinton Foundation, 2013), and public early intervention policies (e.g., Providence Talks, 2015).

However, the Hart and Risley (1995) study has since been criticized on theoretical and methodological grounds. First, Hart and Risley (1995) have been criticized for their focus on the language *deficiencies* of the low-SES group (e.g., Dudley-Marling & Lucas, 2009). This "deficit model" holds mid- to high-SES American families as the baseline for correct behavior and labels discrepancies between this baseline and low-SES participants as language deficiencies in the low-SES group. However, these studies show how nondominant groups in society differ from more mainstream groups, without consideration of varying language practices, which are "culturally organized, sociolinguistically patterned, and exquisitely sensitive to context" (p. 994, Sperry et al., 2019). Operating under a deficit model may underplay evidence of wide within-group variability (cf. Hurtado et al., 2008; Sperry et al., 2019; Weisleder & Fernald, 2013) and ignore other aspects of children's language environments that may also influence language abilities, such as personal storytelling (Miller et al., 2005).

Hart and Risley also had a relatively small sample of participants (N = 42) and a restricted range of home language environments over which they ran their extrapolation. Their participants were monolingual English-speaking American families in Kansas City who varied in SES (defined by parental occupation). Trained researchers visited participants' homes for 1 h per month, starting when infants were 7–9 months old and continuing for 2.5 years. The researchers took notes on what the child was doing and audio-recorded parent–child interactions; the audio recordings were later transcribed. This work was unprecedented and time-consuming, and aimed to address disparities in language growth trajectories. However, the well-known "30 Million" word difference is an extreme extrapolation based on a comparison of language input between 13 high-SES and six low-SES children in this study. The "word gap" estimate includes only speech from one parent directed to the target child, and excludes speech directed to the child from other speakers as well as other conversations in the children's environment. Furthermore, despite the fact that low-SES families in the United States are racially and ethnically diverse (Simms et al., 2009), the socioeconomic groups in Hart & Risley's study are confounded with race: six of six families in the lowest-SES group were Black, while only one of 13 families in the highest-SES group were.

Recent studies with larger and more diverse samples have found evidence that the word gap may be much smaller than 30 million words (Gilkerson et al., 2017) or may not exist at all (Sperry et al., 2019).

Studies may find varying estimates of the "word gap" due to variable methods of collecting language samples (see Purpura, 2019 for a review). There are many approaches to quantifying language input; language samples are collected through researcher observations or audio-/video-recordings, either in a laboratory or in participants' homes, during a specified task or during everyday interactions, with researchers present or absent. The language measures may include only language addressed to the target child, or may include overheard speech (such as talk between two adults in the room). Researchers must decide between these many options when collecting language samples, and their methodological decisions – such as the method of recording, the context of parent–child interactions, and what type of environmental language to include – can dramatically change group difference estimates.

Observer bias and participant reactivity are two major threats to validity in observational studies (Johnson & Bolstad, 1972). The

presence of researchers alone can influence participant behavior, and researcher-observed measures may be biased due to non-blinded raters making judgments about parental behaviors (Johnson & Bolstad, 1972). These two issues can be attenuated by collecting audio or video recordings in the family's home, without a researcher present, which are later annotated or transcribed by researchers unaware of study hypotheses. Even still, adults often demonstrate a "Hawthorne effect," changing their behavior when they know they are being observed (McCambridge et al., 2014). This could influence parents to be on their best behavior and talk to their children more when they know they are being recorded (Suskind et al., 2013; Zegiob et al., 1975). Perhaps because of this, short video recordings and long audio recordings – even if both captured in families' homes without researchers present – give different pictures of infants' language input, with short video recordings potentially leading to overestimations of the amount of language infants hear (Bergelson et al., 2019).

Many studies of children's language environments include only child-directed speech in their measures (e.g., Hart & Risley, 1995; Rowe, 2012; Weisleder & Fernald, 2013). However, children hear speech from a variety of speakers and directed to a variety of listeners (i.e., speech directed both at them and at others). While many studies highlight the importance of child-directed speech (Shneidman & Goldin-Meadow, 2012; Weisleder & Fernald, 2013), others find that children can also learn from overheard speech in laboratory settings (Akhtar et al., 2001; Floor & Akhtar, 2006) and adult-directed speech makes up a considerable portion of children's language input (Bergelson et al., 2019). Sperry et al. (2019) found evidence that only including speech from the primary caregiver and directed to the target child underestimates the amount of language heard by children in low-SES families. When considering all audible speech, instead of only speech from the primary caregiver directed at the child, the SES difference may disappear (Sperry et al., 2019).

Despite concerns about the validity of the "30 Million Word Gap," addressing SES differences in early language experience and abilities remains incredibly important. Researchers – who may disagree about the magnitude or existence of the word gap – all aim to help children succeed, and it remains clear that children growing up in poverty enter formal schooling at a disadvantage. Boosting the language skills of disadvantaged children remains a valuable endeavor, and determining the true presence and size of this SES-based difference in language input is critical to aiding children at risk for language delays. By better understanding child language environments, we will be better poised to intervene early and effectively, helping low-SES children build the skills they need to succeed in school, without disparaging cultural differences or labeling differences from higher-SES children as deficits (Callanan & Waxman, 2013; Hoff, 2013).

The present study serves to take stock of the wide literature on differences in early language experience by children across SES groups by analyzing a broad literature that spans communities, countries, and language groups. Specifically, this meta-analysis assesses socioeconomic differences in the quantity of language input to young children, with two main research questions:

(1) Do young children from higher-socioeconomic groups hear more language than children from low-socioeconomic groups?
(2) How do methodological differences between studies affect researchers' estimates of the "word gap?"

We hypothesize that there are significant differences in children's early language environments between socioeconomic groups; however, we expect to find wide variability within groups (Schwab & Lew-Williams, 2016; Sperry et al., 2019) and a smaller between-group difference than Hart and Risley suggested (Gilkerson et al., 2017). We also expect to find effects of study methods on estimates of the word gap, as proposed by Purpura (2019) commentary. Specifically, we hypothesize that the group differences in language input will be moderated by methodological variables: In line with Sperry et al. (2019), we expect that studies measuring only child-directed speech will find a greater SES difference than studies measuring all the language in a child's environment.

2 | METHOD

This meta-analysis was preregistered and reviewed before the data were collected; the Stage 1 manuscript can be found at https://osf.io/vc5fu. This meta-analysis is reported according to PRISMA guidelines (Moher et al., 2009).

2.1 | Eligibility criteria

2.1.1 | Inclusion criteria

To be included in this analysis, studies must have analyzed the quantity of language input to infants of multiple socioeconomic groups (see "SES variables"). Observational studies of children under 3 years of age learning any language(s) were included. We included studies of naturalistic, unstructured interactions, regardless of which caretaker(s) were included in the observation. Studies were included if they were written in English and were written/published in 1990 or later. Unpublished studies (i.e., preprints and dissertations) were included if no publications based on them were available. Finally, studies must have reported an effect size, or there must have been sufficient information to calculate an effect size. If necessary information was not included in a publication, the authors were contacted and the study's data were included if they were received by the time analyses were conducted.

2.1.2 | Exclusion criteria

Multilingual samples were excluded if they only measured one of the languages that occurred in the children's language samples (e.g., only counting English in a Spanish-English bilingual family). Studies reporting on out-of-home childcare language environments (e.g., language in daycare classrooms) were excluded because the "word gap" focuses

on children's home language environments. Studies on interventions, investigating specific types of parent–child interactions (e.g., reading), or which specifically recruited samples of parents with mental health issues or children with atypical development (e.g., children with known hearing issues) were also excluded, as these factors are assumed to affect parental speech (Montag et al., 2015; Murray et al., 1993; Suskind et al., 2016). Last, studies were excluded if their data overlapped with another study included in this analysis. If more than one study used the same data, we used the following criteria to select which study to include, in order: (1) most thoroughly reported relevant data, (2) larger sample size, and (3) more recent publication[1].

2.1.3 | SES variables

As described above, SES is a highly complex, abstract construct that can be operationalized in numerous ways. Here, studies using absolute or relative measures of education, income, and/or occupation as their measure of SES were included. This includes both family-level and community-level operationalizations (e.g., household income and Census tract median income), as well as composite measures of SES (e.g., Hollingshead Index). Comparisons of low-, mid-, and/or high-SES groups were included in this dataset. We converted all reported SES measurements onto one common scale of "low-," "middle-," and "high'-SES groups, with the aim of increasing comparability across studies that used different definitions of SES[2]. In the analyses described below, we analyzed comparisons of low-SES groups to mid- and high-SES groups[3].

2.1.4 | Input variables

Infant language input was operationalized as the quantity of language heard by infants in a given time span. In an effort to include as many data-points as possible, word type, token, and utterance counts were included, as well as both actual and estimated measures. If a study reported results from more than one quantity metric, the more common metric in the current dataset was used.

2.2 | Search strategy

A database search, forward search, backwards search, author search, and listserv query were implemented in an attempt to gather data from all relevant studies. Data collection took place between March 19 and April 4, 2020. PsycInfo was queried using the following search terms: (infan* or baby or toddler or child) and (language or speech or linguistic or word or verbal) and (socioeconomic or SES or income or maternal education or parental education or social class or poverty or welfare), using PsycInfo's filters for year of publication (1990 – present) and language of publication (English); we screened the first 5000 records. The same search was conducted in Google Scholar, with titles and/or abstracts screened for the first 500 results. A second PsycInfo search using the search term "word gap" and the same filters, and a second Google Scholar search with these search terms (screening the first 500 results) were implemented. Additionally, a forward search on Hart and Risley (1995) (screening the first 300 results) and a backwards search using the reference lists of included articles were conducted. Last, a request for relevant data was posted on the listservs of the Cognitive Development Society, International Congress of Infant Studies, and CHILDES, as well as on the Society for Research in Child Development Commons. The final sample size was determined by the number of papers found by the above search method that meet the inclusion criteria. Data collection was ended upon exhausting the above search methods. Detailed literature search documentation, including full results lists, are publicly available via our OSF project (https://osf.io/veyxu/).

TABLE 1 List of variables extracted from all included studies

Category	Variables coded
Paper characteristics	Author, year of publication
Study characteristics	Total *N*, number of subgroups, n per subgroup, location and language of study
Method characteristics	Type of language observation, observation setting, number of observations per participant, observation length, type of input quantity metric, type of language included (i.e. child-directed speech only or all speech)
Participant characteristics	Age, gender, race, ethnicity, SES groups/comparisons included, type of SES measure
Study results	Input quantity measures for each subgroup, raw input quantities (if reported), effect sizes, type of test used, moderators included

2.3 | Data extraction

For all included studies, we extracted a number of details about the publication, sample, methods, and findings; see Table 1.

2.4 | Deviations from registered protocol

Four deviations from the original registered protocol were made: two involving the number of search results screened and two involving the

[1] For example, three papers reported overlapping datasets: Huttenlocher et al. (2007), Cartmill et al. (2013), and Rowe (2012). Huttenlocher et al. (2007) reports the most thorough relevant data (input quantity measures for each SES group for multiple timepoints), so we chose to include this paper over the more recent Cartmill et al. (2013) and Rowe (2012).

[2] We direct the interested reader to our OSF project for further details on this SES scale, including our full conversion spreadsheet: https://osf.io/tfdgc/

[3] Our SES comparisons were conducted as established in our Stage 1 preregistration. Our effect size measure, Hedge's g, is a standardized difference between two means. Papers measuring SES-based differences in language skills and input generally focus on comparisons between low- and higher-SES groups, with few mid- versus high-SES comparisons. Given the nature of this measure and the literature, our analysis compares low- versus mid-/high-SES groups. If a study had three groups, we included both low- versus mid- and low- versus high- in our analyses and accounted for this statistically with our random effects structure.

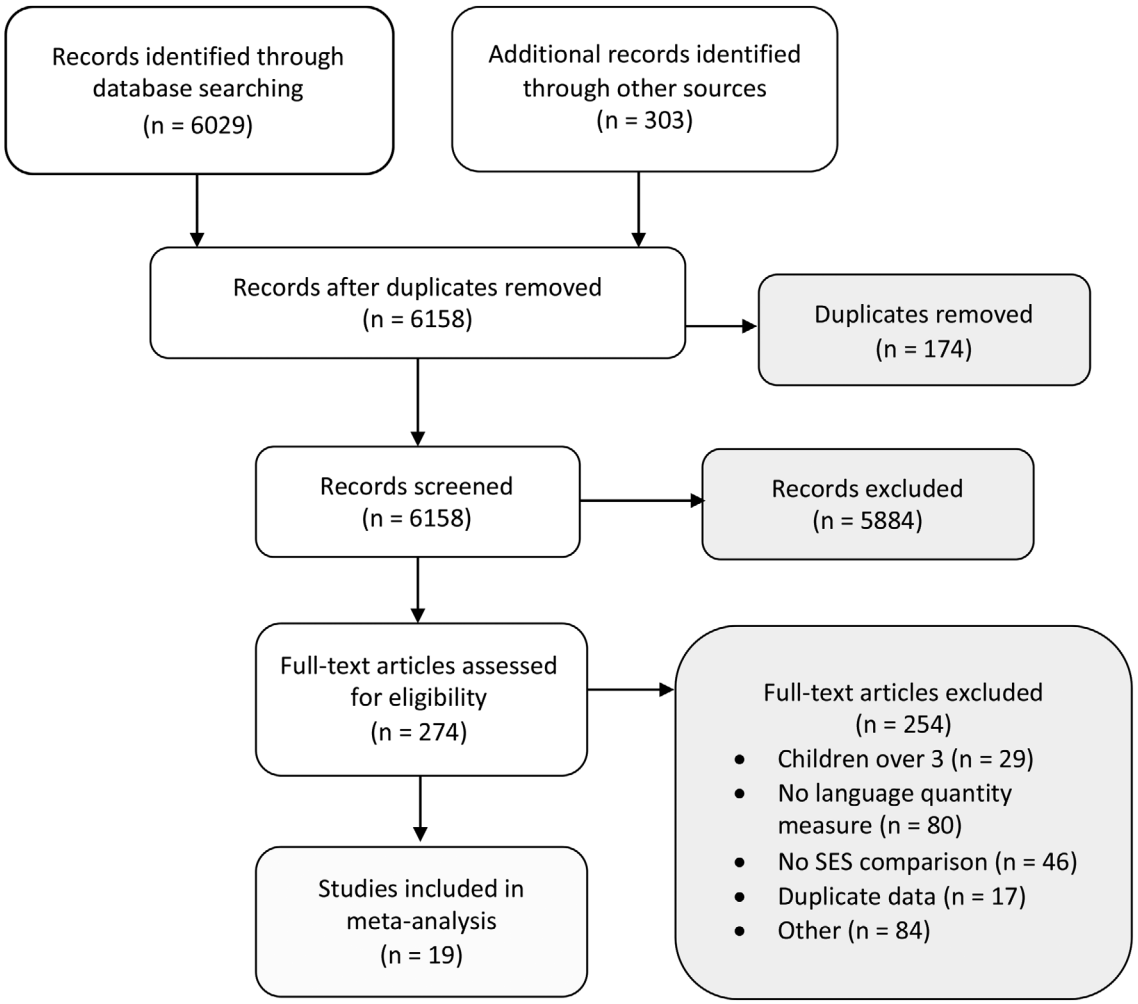

FIGURE 1 Flowchart indicating the number of articles identified, included and excluded throughout the literature search process (adapted from the PRISMA flow diagram; Moher, et al., 2009). All literature search documentation, including full results lists, are publicly available via our OSF project.

listserv requests. We planned to screen all results from our PsycInfo searches and our forward search, but we did not anticipate the large numbers of records that these search methods found (9640 and 8619, respectively). We instead screened the first 5000 results from PsycInfo and the first 300 results from the forward search on Hart and Risley (1995)[4]. We chose these numbers of records to screen without consideration of the results, and do not believe this deviation has affected our analysis. Additionally, our data collection plan included requests for data to the listservs of the International Society for the Study of Behavioural Development and the Society for Research in Child Development, but neither organization has a member listserv. Instead, we were able to post a request for data on the Society for Research in Child Development Commons, an online forum.

3 | RESULTS

This manuscript was generated using papaja (Version 0.1.0.9942, Aust and Barth, 2020), and all analyses were conducted in R (Version 4.1.1; R Core Team, 2019). The meta-analysis was conducted using the metafor package (Version 2.1-0, Viechtbauer, 2010). All data and scripts are available via Open Science Framework at https://osf.io/veyxu/.

Nineteen studies (described in 19 articles) were identified via the literature search to be included in the present meta-analysis; see Figure 1 for details of the literature search and see Appendix, Table A1 for details of the included studies. These studies include a total of 1991 participants in five countries, spanning four languages (including both monolingual and bilingual environments). Participants range in age from 1 to 48 months old[5] ($M = 16.82$ months). From these 19 studies, we were able to calculate a total of 34 effect sizes, as many stud-

[4] Full search results from our main PsycInfo search, including records that were not screened, are available on our OSF project. All search results that were screened (n=300) for our forward search on Hart and Risley (1995) are available on our OSF (though unscreened results are not available through Google Scholar). See spreadsheets and more literature search documentation on our OSF project (https://osf.io/veyxu/).

[5] Studies were included if the mean age of participants in the sample was 3 years (i.e., 36 months) or less (see "inclusion criteria"), but individual children within those samples ranged up to 48 months.

ies reported multiple comparisons or data from multiple timepoints. The nested structure of these data was accounted for using hierarchical models.

3.1 | Analysis plan

We first converted raw data into standardized mean differences (Hedges' g[6]) using raw input quantity metrics and their variance, if reported. For manuscripts that reported an effect size but not the raw data ($n = 5$), we converted the reported effect size to Hedges' g. We also calculated words per hour for each study where possible ($n = 16$). Next, we calculated three weighted mean effect sizes: (1) overall effect size of language quantity across SES groups; (2) effect size across studies that included only child-directed speech (CDS); and (3) non-standardized effect size of words per hour. For each effect size calculation, we used a hierarchical model to account for the nested structure of data from multiple timepoints within studies. Additionally, we conducted a series of moderator analyses and a test for publication bias.

3.2 | Effect sizes

First, we examined our full dataset, merging studies that examined all speech and studies that included CDS-only. We computed a weighted mean effect size to assess the overall difference between low-SES and mid- to high-SES groups on measures of infant language input. The effect size was significantly above zero (Hedges' $g = 0.41$ [0.19, 0.63], $SE = 0.11$, $p < 0.001$), indicating a significant effect of SES group on language input quantity. See Figure 2.

Second, we calculated an effect size for the subset of studies that measured only child-directed speech in their language samples (21 effect sizes from ten studies), in order to have direct comparability with Hart and Risley (1995) and others, who only included child-directed speech in their language quantity measures. This effect size was statistically significant and large in magnitude (Hedges' $g = 0.69$ [0.40, 0.98], $SE = 0.15$, $p < 0.001$).

Third, we calculated a weighted mean effect size using nonstandardized mean differences (D, words per hour). Ten studies provided sufficient information to calculate words per hour, from which 16 effect sizes could be calculated.[7] Across these studies, low-SES children heard 1439 words per hour on average (range: 275–2916), compared to 1829 words per hour for mid-SES children (range: 997–2519) and 1956 words per hour for high-SES children (range: 674–3021). The weighted mean effect size was 350.71 words per hour, meaning that low-SES infants hear an estimated 350.71 fewer words per hour than mid-/high-SES infants. While this difference is not significantly different from zero ([−16.90, 718.31], $SE = 187.56$, $p = 0.062$), our small sample of studies means this analysis is likely underpowered. While not statistically significant, a difference of 350.71 words per hour between SES groups is notable.

All three of these models had significant heterogeneity remaining (all ps < 0.05 by Cochran's Q-test), indicating a large amount of unexplained variance in effect sizes, so next we turn to moderator analyses.

3.3 | Moderators

Our moderator analyses were conducted over the full sample of 19 studies. Other than type of language included, no methodological variables (e.g., measure of SES, type of recording, setting of observation) were significant moderators of the SES difference (all ps > 0.1; see Table 2 for a list of all moderators tested). This is contrary to our hypothesis and may be due to the number of included studies being lower than anticipated ($n = 19$), limiting variability across these methodological variables. Additionally, study country was not a significant moderator ($Q(4) = 5.52$, $p = 0.238$); this may again be due to limited variability across included studies. Nearly two-thirds (12 of 19) of the studies were conducted in the United States, and nearly all (16 of 19) were conducted in North America or Europe.

In contrast to these other variables, type of language was a significant moderator of SES differences ($Q(1) = 6.96$, $p = 0.008$). This confirms our hypothesis that studies measuring only child-directed speech would find a greater SES difference than studies measuring all speech in the environment ($\beta_{cds} = 0.51$, $p < 0.008$; $g_{all-lang} = 0.17$; $g_{cds} = 0.69$). Indeed, when considering only the subset of studies that included all speech in their measures, there was no significant difference between SES groups (Hedges' $g = 0.17$ [−0.07, 0.42], $SE = 0.13$, $p = 0.170$). See Figure 2.

3.4 | Comparison with Hart and Risley (1995)

Hart and Risley (1995)'s effect of SES on language input was by far the largest in the current sample, with an effect size over 2 (Hedge's $g = 2.46$). This is much higher than the overall weighted mean effect size for this meta-analysis ($g_{overall} = 0.41$). Since Hart and Risley (1995) included only speech from the primary caregiver directed to the child, the effect size in child-directed speech samples serves as a better comparison, although this effect size is also markedly smaller than Hart and Risley's ($g_{cds} = 0.69$).

Unsurprisingly, Hart and Risley also stood out in our words per hour measure as well. As reported above, descriptively, we found a roughly 500 word-per-hour difference between low- and high-SES groups overall (which includes Hart and Risley), and a (nonsignificant) weighted mean effect size of 350.71 words per hour in our low versus mid-to-high SES planned analysis. In comparison, children from the six low-SES families in Hart and Risley (1995) heard 634.92 fewer words per hour than the 23 mid-SES children, and 1536.60 fewer words per hour than the 13 high-SES children in that study. In fact, Hart

[6] Hedges' g is a corrected effect size that performs better than Cohen's d for small or unequal samples (Cooper, 2016). It can be interpreted using the same guidelines as Cohen's d.

[7] While our planned analyses compare low versus mid-to-high SES groups, we provide per-group words per hour here as a descriptive summary.

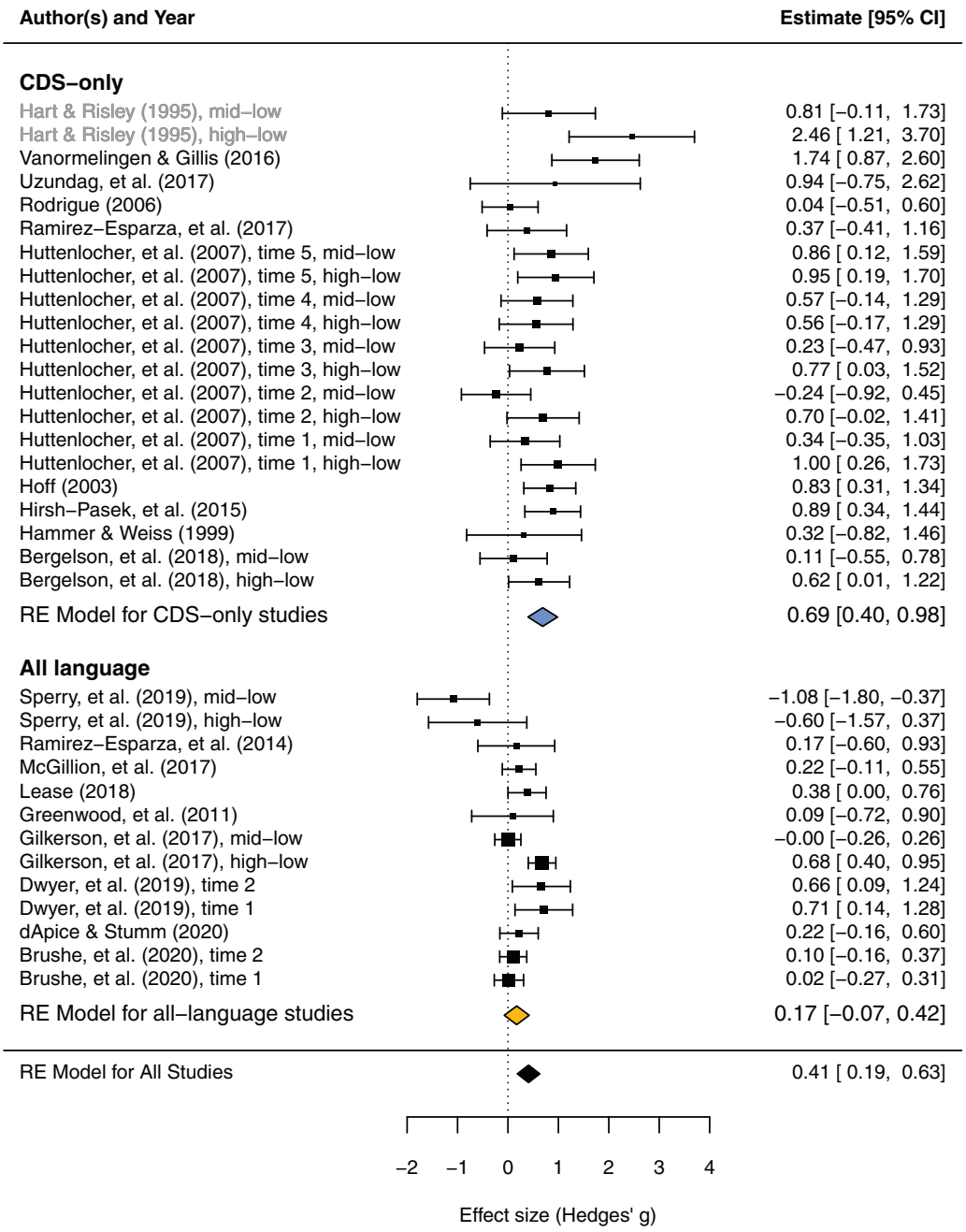

FIGURE 2 Forest plot depicting all effect sizes in the current meta-analysis, grouped by the type of language included (child-directed speech only (CDS-only) vs. all speech in the child's environment). Some studies provided multiple effect sizes (due to multiple timepoints or comparisons); this nested structure was accounted for in our models. Hart & Risley (1995) is in gray for visualization purposes only.

and Risley (1995) had the largest SES difference in words per hour out of all studies in this analysis. That said, although Hart and Risley's data is an extreme within our sample of studies, model diagnostics showed no evidence of cases with undue influence in our effect size analyses (all Cook's Distances < 1, all DFBETAs < 1, and no extreme hat values), though the relatively low study *N* may play a role here.[8]

[8] Removing Hart and Risley's data, our overall effect size decreases from Hedges' g = 0.41 to 0.36 but remains statistically significant (p<0.001). Our CDS-only model without Hart and Risley's data fails to converge, likely due to only including nine studies.

3.5 | Publication bias

A rank correlation test shows no evidence of funnel plot asymmetry (Kendall's $\tau = 0.17$, $p = 0.156$; see Figure 3), suggesting no publication bias.

4 | DISCUSSION

In this meta-analysis, we combined data from 19 studies that analyzed the language environments of 1991 individual children and found

TABLE 2 Summary of all moderator tests. Only type of speech included is a significant moderator; all other tests of moderation are nonsignificant

Moderator	Levels (count)	Cochran's Q-test
SES measure	Parental education (23), composite (7), other (4)	Q = 0.78, df = 2, p = 0.68
Recording type	Video (18), audio (16)	Q = 0.2, df = 1, p = 0.66
Recording setting	Home (31), lab (3)	Q = 0.007, df = 1, p = 0.93
Measure of language quantity	Word tokens (19), LENA adult word count (9), mins per hour (2), utterance count (2), other (2)	Q = 0.87, df = 4, p = 0.93
Type of speech included	Child-directed speech only (21), all ambient language (13)	Q = 6.96, df = 1, p = 0.008
Country	US (24), Australia (4), UK (2), Belgium (1), Turkey (1)	Q = 5.52, df = 4, p = 0.24

Abbreviation: SES, socioeconomic status

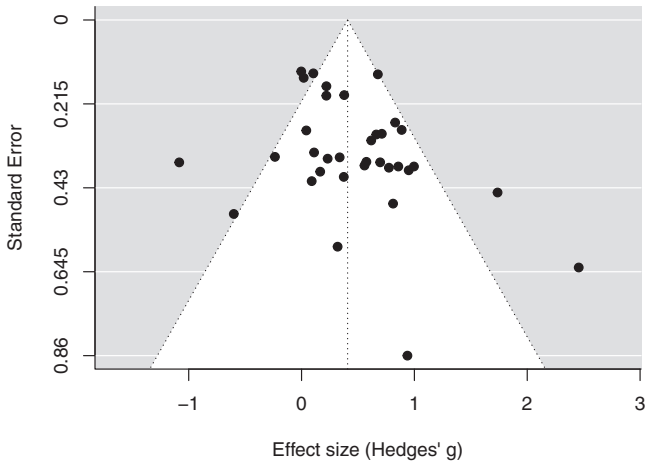

FIGURE 3 Funnel plot, showing standard error as a function of effect size (Hedges' g).

that overall, children from mid- and high-SES homes heard more language in their home environments than infants from low-SES homes. However, when separating studies by the type of speech they included, this SES difference was only present in studies analyzing child-directed speech (n=10 studies) and not in studies analyzing all speech (n=9 studies). Children from different SES groups did *not* hear different language quantities when considering all speech in their environments, although children from lower-SES homes heard fewer words *directed to them* than children from higher-SES homes did. Therefore, a researcher's decision to include only child-directed speech versus all speech in a child's environment has a drastic impact on what they conclude about the existence of a "word gap."

We did not, however, find evidence that other methodological variables moderated the SES effect. As stated above, our meta-analysis included 19 studies, which is a smaller number of studies than we anticipated. This limits our statistical power, particularly for our planned moderator analyses, and therefore, we are hesitant to definitively conclude that other methodological variables do not moderate SES effects based on these null effects. We hope that future studies will expand this literature, allowing for more informative moderator analyses.

4.1 | Measuring language input

Our results suggest that children from low-SES homes hear less *child-directed speech* on average than children from high-SES homes, but not less speech overall. While studies have found that young children can learn from overheard speech in laboratory settings (Akhtar et al., 2001; Floor & Akhtar, 2006; Gampe et al., 2012; Shneidman et al., 2009), child-directed speech may be particularly valuable to early child language development (Shneidman & Goldin-Meadow, 2012; Weisleder & Fernald, 2013). However, understanding the roles of different types of speech is difficult when "child-directed," "overheard," and "ambient" speech, and even "language input," are defined differently across studies.

For example, Hart and Risley (1995) included only speech from one primary caregiver directed to the target child in their quantity metrics. Using this stringent definition of language input, speech from other family members directed to the target child and speech from a primary caregiver directed to a nearby sibling were not counted towards the child's language input. On the other hand, many studies (such as Brushe et al., 2020) use Language Environment Analysis software (LENA, Greenwood et al., 2011), which uses LENA's proprietary algorithm to automatically estimate the number of words spoken by all adults near (but not necessarily directly to) the target child. These dramatically different definitions demonstrate that there is no clear consensus on what "counts" as language input.

Similarly, while some language in a child's environment may be irrelevant or uninteresting to young children (e.g., adults on the phone discussing mortgage options), speech to nearby children or speech from various caretakers is likely to have some of the same attention-grabbing properties as speech directed to the child by their primary caretaker. Investigations of different types of language input and how children attend to and learn from them are needed, alongside a concerted effort to harmonize terminology across interrelated strands of work.

4.2 | Measuring SES

We have analyzed SES as a single broad construct, but the educational, occupational, and economic components of SES likely impact parental speech and child development in different ways (Duncan & Magnuson, 2001; Rowe, 2008). We planned to examine the effect of these different SES measures in our analysis, but unfortunately, the low variability in our sample limited the utility of our moderation analysis. Across the 19 studies included in our meta-analysis, seven used composite measures of SES and one used community-level factors, so these results cannot speak to the various components of SES. Of the remaining 11 studies, ten used parental education as their SES measure, one used parental occupation, and none used family income. We are therefore unable to disentangle these components in our meta-analysis.

When measuring SES, researchers must also contend with the ways that SES varies across countries and communities. Levels of family income, household wealth, and parental education vary by population. Thus, an income that is high-SES in one country, culture, or context may be low-SES in another. Additionally, social structures (e.g., social safety nets) vary by country. For example, the United States and Belgium are both high-income countries, yet they have drastically different social safety net programs. Belgium, similar to other continental European countries, spends 18.5% of their GDP on social safety net programs and has a poverty rate of 8.2%. The United States, on the other hand, spends 8% of their GDP on social safety net programs and has a poverty rate of 17.8% (OECD, 2021; Tesliuc, 2006). These two socioeconomic contexts create vastly different experiences for people living in poverty.

While standardizing SES measures appropriately across countries and cultural contexts is a complicated question, we encourage future work to collect and report multiple measures of SES when possible. Research is needed to deepen our understanding of SES as a construct and investigate how its different components may affect parents' language to their children in different contexts.

4.3 | Cultural differences

The studies included in the current meta-analysis are largely based in the United States, reflecting a clear limitation of the current literature. Indeed, research on language development in infancy (and developmental science in general) is overwhelmingly conducted in Western societies, and even within those societies, in "convenience samples" (Bornstein et al., 2013; Fernald, 2010). While there is a growing body of research on children's early language experience in understudied communities around the world (e.g., Casillas et al., 2019, 2021; Ma et al., 2021; Vogt et al., 2015), all but one of the included studies were conducted in Western countries (with the exception being conducted in Turkey). Research on children's early language experience in "Majority World," low- and middle-income, or non-Western countries is lacking, leaving open important questions about universality and generalizability. More research on parental language to children in socioeconomically, culturally, and linguistically diverse communities around the world is needed.

Even within the United States, ethnographic and qualitative research has highlighted linguistic practices that vary between communities (Avineri et al., 2015). Attitudes about (and styles of) speaking with young children vary cross-culturally (Avineri et al., 2015). Some evidence also suggests that lifestyles and daily activities lead to differences in children's language experience, above and beyond caregivers' attitudes about child-directed speech (Casillas et al., 2021). Accordingly, child-directed speech is not common in all cultural contexts (Casillas et al., 2019, 2021; Cristia et al., 2019; Lieven, 1994; Shneidman & Goldin-Meadow, 2012). However, children in cultures where CDS is not common learn language at roughly the same pace as their peers who frequently hear CDS (e.g., Casillas et al., 2021; Crago et al., 1997; Cychosz et al., 2021). This raises important questions about the mechanisms underlying language development and the interplay of child-directed and overheard speech, which await further research.

4.4 | Potential mechanisms of SES effects

When considering possible mechanisms of differences in language experience between low- and high-SES children, we find it necessary to consider the broader context of SES effects on children and their families. SES is a complex construct which may affect children's lives in myriad ways, including their neighborhood, housing stability, food security, and more (Jyoti et al., 2005; Mayberry et al., 2014; Ziol-Guest and McKenna, 2014). Research has found that family income is associated with parents' stress levels and mental health, as well as their ability to invest time and material resources into child development (Linver et al., 2002; Yeung et al., 2002).

With this in mind, we consider how family SES affects parent–child interactions and parents' speech to their children. Parents facing economic distress have increased stress and are at a higher risk for mental health problems, which can directly influence parent–child interactions (Conger & Conger, 2002; Newland et al., 2013). In a recent experiment, Ellwood-Lowe et al. (2021) found that caregivers who were prompted to think about their financial scarcity said fewer words to their 3-year-old children in an in-lab play session than those in a control group. Parents' recollection of financial distress directly affected their child-directed speech (Ellwood-Lowe et al., 2021). This work provides initial evidence that links between language input and financial stress may be implicated in larger-scale differences across SES groups, like those analyzed here. In addition, parental mental health could affect parents' language. Low-SES mothers are at a higher risk for depression (Moore et al., 2006; Stein et al., 2008; Zuckerman and Beardslee, 1987), which affects mother–infant interactions (Cohn et al., 1990) and maternal child-directed speech (Bettes, 1988). Taken together, these findings suggest that the "word gap" could be driven, at least in part, by external, structural factors associated with SES that impact parents (Hoff and Laursen, 2002).

Hart and Risley (1995) (whose work was conducted at a different time in our field's evolving understanding of the forces underlying poverty and SES) inspired many researchers to design "word gap" interventions that aim to increase low-SES parents' speech to their

young children (e.g., Suskind et al., 2016). However, these interventions often fail to significantly change parental speech in the long term (e.g., McGillion et al., 2017; Suskind et al., 2016). These failures are unsurprising when considering the broader context of SES on families: interventions that aim to encourage low-SES parents to speak to their children more, without addressing the underlying and complex mechanisms of SES-based differences, are likely to be ineffective over time.

The current meta-analysis cannot speak to causal mechanisms underlying links between SES and language input, nor can it speak to intervention efficacy. Large-scale poverty relief efforts that measure parent–child interactions and child language development, such as the ongoing Baby's First Years study Noble et al. (2021); https://www.babysfirstyears.com), stand to elucidate mediators of SES-based differences in children's language environments and development. If parental stress and mental health are found to mediate the effect of SES on language input, boosting parents' mental health would be a valuable target for intervention, as this could have cascading effects on parent–child interactions and child outcomes (Yeung et al., 2002).

Our interpretation of the literature leads us to believe that efforts to provide families with a package of services, including resources to support parental well-being and to promote access to quality childcare (Yeung et al., 2002) hold great promise as potential mitigators of SES-based disparities. Additionally, ensuring access to social services (Finkel et al., 2020) and high-quality childcare for all children and families (Chaudry et al., 2011; Laurin et al., 2015; National Institute of Child Health, 2000) may be effective in addressing socioeconomic disparities in children's development. This too is an important area where comparative work across diverse communities is sorely needed for both a broader and deeper understanding of these complex social variables. Lastly, we note that much remains to be done to better understand potential multifactorial links between SES and any metrics of language input or skills, given the large role that systematic disadvantages play in this process.

5 | CONCLUSION

Twenty-five years have passed since Hart and Risley's landmark study was published in 1995. Since Hart & Risley (1995) first calculated the "30 Million Word Gap," based on data from six low- and 13 high-SES children in the early 1990s, this finding has been incredibly influential, both in scientific circles and in broader society, especially within the United States. Our meta-analysis examines the legacy of this work, combining data from nearly 2000 children collected over the past 30 years. Collectively, our results confirm the initial finding that children from higher-SES homes do hear more language input on average than their low-SES counterparts, particularly when child-directed input is the focus of analysis. Notably, the differences we find are far smaller than Hart and Risley (1995) suggested, likely due to limitations in their sampling and methodology. Additionally, the literature on SES and language input thus far has a notable lack of socio-cultural and geographic diversity, calling for more research to understand this relationship.

The intervening decades since Hart and Risley's work have seen great strides in our understanding of the complex construct of SES and its effects on children and families. How best to address differences in child development between SES groups in order to help all children reach their potential remains an important open question.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

All data and scripts for this study are openly available on Open Science Framework at https://osf.io/veyxu/.

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APPENDIX A

TABLE A1 Details of all studies included in meta-analysis

Authors	Year	*N*	Study location	Language	Age in months	SES groups
Bergelson et al.	2018	61	North America	English	3 – 20	high-mid-low
Brushe, Lynch, Reilly, Melhuish, and Brinkman	2020	245	Australia	English	6, 12	high-low
d'Apice and von Stumm	2019	107	London, UK	English	24 – 48	high-low
Dwyer, Jones, Davis, Kitamura, and Ching	2018	50	Sydney, Australia	English	6 – 9, 12 – 15	high-low
Gilkerson et al.	2017	329	Denver, CO	English	2 – 48	high-mid-low
Greenwood et al.	2011	30	Kansas City	English	12 – 21	high-low
Hammer and Weiss	1999	12	Southern US	English	12 – 18	mid-low
Hart and Risley	1995	42	Kansas City, KN	English	7 – 36	high-mid-low
Hirsh-Pasek et al.	2015	60	US	English	24 – 29	mid-low
Hoff	2003	63	Wisconsin, US	English	16 – 31	high-low
Huttenlocher, Vasilyeva, Waterfall, Vevea, and Hedges	2007	50	Chicago, IL	English	14 – 30	high-mid-low
Lease	2019	11	Minneapolis, MN	English, Spanish, and Spanish-English bilinguals	1 – 44	high-low
McGillion, Pine, Herbert, and Matthews	2017	140	UK	English	11	high-low
Ramirez-Esparza, Garcia-Sierra, and Kuhl	2017	25	Seattle, WA	Spanish-English bilinguals	11, 14	high-low
Ramirez-Esparza, Garcia-Sierra, and Kuhl	2014	26	Seattle, WA	English	11, 14	high-low
Rodrigue	2006	50	San Diego, CA	English	12	high-low
Sperry, Sperry, and Miller	2019	42	US	English	18 – 48	high-mid-low
Uzundag, Tasci, Kuntay, and Aksu-Koc	2018	6	Istanbul, Turkey	Turkish	8 – 36	mid-low
Vanormelingen and Gillis	2016	34	Flanders, Belgium	Dutch	6 – 24	high-low