JSLHR

Research Note

# Prevalence of Publication Bias Tests in Speech, Language, and Hearing Research

Jason C. Chow[a]

**Purpose:** The purpose of this research note is to systematically document the extent that researchers who publish in American Speech-Language-Hearing Association (ASHA) journals search for and include unpublished literature in their meta-analyses and test for publication bias.
**Method:** This research note searched all ASHA peer-reviewed journals for published meta-analyses and reviewed all qualifying articles for characteristics related to the acknowledgment and assessment of publication bias.
**Results:** Of meta-analyses published in ASHA journals, 75% discuss publication in some form; however, less than 50% test for publication bias. Further, only 38% ($n$ = 11) interpreted the findings of these tests.
**Conclusion:** Findings reveal that more attention is needed to the presence and impact of publication bias. This research note concludes with 5 recommendations for addressing publication bias.
**Supplemental Material:** https://doi.org/10.23641/asha.7268648

Meta-analysis is an analytical method for quantitative synthesis of research literature. Although this quantitative synthesis method has advanced the ability to conduct and interpret reviews of the literature, meta-analysis is not without its flaws. Like all research methods, there are several important factors to take into account to be able to provide an accurate interpretation of the included data. One of these factors is the publication bias. Publication bias is the phenomenon that refers to likelihood that the publication process may bias the findings of systematic review. That is, the publication process may systematically exclude studies from entering the literature and, thus, potentially eliminating unpublished work from review and synthesis inclusion. In meta-analysis, there are common procedures for testing for and addressing the risk of this bias.

Because of the proliferation of meta-analytic reviews in nearly all areas of research, an understanding of the strengths and weaknesses of every method used is necessary. The purpose of this research note is to (a) provide a brief overview of publication bias; (b) examine the extent that meta-analyses in speech, language, and hearing research acknowledge and attend to this important form of potential bias; and (c) provide recommendations for future meta-analyses.

[a]Virginia Commonwealth University, Richmond
Correspondence to Jason C. Chow: jcchow@vcu.edu
Editor-in-Chief: Sean Redmond
Editor: Geralyn Timler
Received March 20, 2018
Revision received April 21, 2018
Accepted June 11, 2018
https://doi.org/10.1044/2018_JSLHR-L-18-0098

## *Publication Bias*

Publication bias describes the condition in which the published literature in a given field is unrepresentative of all of the research that has been conducted (Rothstein, Borenstein, & Sutton, 2006). It most commonly refers to a bias against the publication of studies with null effects (e.g., Ferguson & Brannick, 2012; Ferguson & Heene, 2012; Rosenthal, 1979) or a level of bias present in meta-analytic and systematic reviews that is a function of the publication process (Chow & Ekholm, 2018). It is widely recognized that studies with positive findings or larger effects are more likely to be published than studies with negative results (see Ferguson & Heene, 2012; Hopewell, Loudon, Clarke, Oxman, & Dickersin, 2009; Ioannidis, 2005).

However, even though this phenomenon has been concerning researchers for over a century, publication bias, or the "file-drawer problem," has remained a significant concern. However, a series of recent studies have examined specific issues related to the prevalence and impact of publication bias. Ioannidis, Munafo, Fusar-Poli, Nosek, and David (2014) report on publication bias over a wide range of fields, including medicine, neuroimaging, and psychology. Similarly, Rothstein et al. (2006) estimate that the impact of publication bias is modest or severe in approximately half of the meta-analyses across all research domains.

Because the general conclusions researchers, practitioners, and consumers draw from meta-analyses often pertain to what practice, program, intervention, or treatment works, it is essential that these conclusions are drawn from

***Disclosure:*** *The author has declared that no competing interests existed at the time of publication.*

an unbiased set of research studies. Meta-analysts aggregate data across studies to inform important decision making. What is particularly problematic is when important information is systematically excluded from this process—potentially biasing the results and subsequent conclusions of a meta-analysis. Failure to identify all the relevant research in a particular area might lead researchers and practitioners to make decisions based on only part of the science conducted on a topic. If the publication process is systematically excluding studies from synthesis, then publication bias is a problem.

In an attempt to address the problem of publication bias (i.e., the results of a meta-analysis being innately biased due to some facet of the publication process), researchers have developed several methods to test for the likelihood of bias. These tests estimate the association between the effect size metric of interest and precision (e.g., Duval & Tweedie, 2000; Egger, Smith, Schneider, & Minder, 1997). While these methods are more commonly used, there are other factors, such as small study effects, that influence the results of publication bias tests (Ferguson & Heene, 2012). Thus, publication bias tests (tests for the likelihood that the publication process biased the meta-analytic sample), more appropriately, provide researchers quantitative information in order to make sample-appropriate inferences about the degree to which bias is likely and the severity of the potential bias. Most importantly, however, publication bias tests provide more precise information about the sample of studies included in a meta-analysis that allows the researcher to contextualize appropriate inferences and conclusions (Chow & Ekholm, 2018). Tests that result in little or no bias may provide more confidence in the meta-analysis primary findings, whereas tests that result in biased outcomes may lead to more cautious conclusions and provide direction and guidance for important discussions of future directions.

It is also important to recognize that there are other reasons why studies may not be published that are not a function of the publication process. There may be reasons why researchers do not submit certain data for publication, such as scope of study, null findings, inadequate monitoring of intervention, and missing data. Other data may be a part of program requirements, such as master's theses, or individuals who pursue clinical or research doctoral degrees may secure professional positions that are not conducive to writing and publication, and thus, the publication of studies and corresponding data may not be pursued. These reasons notwithstanding, these potential problems may hide their presence by providing researchers skeptical about publication bias with alternative explanations for why studies are not published. For instance, researchers have noted that there was not enough evidence to conclude that unpublished studies were lower in methodological quality than published studies, yet published studies still yielded larger effect sizes than unpublished studies (Hopewell et al., 2009). This suggests that study quality may not reliably differentiate effect size magnitude between published and unpublished studies.

In meta-analysis, a well-established method to guard against publication bias in meta-analyses includes both published and unpublished literature, which is referred to as *gray literature*. Although some report reservations about the utility of including gray literature in protecting against publication bias (e.g., Cook et al., 1993; Ferguson & Brannick, 2012), the Campbell Collaboration (Kugley et al., 2017) and the Cochrane Collaboration (Higgins & Green, 2011) both recommend that authors of systematic reviews include unpublished studies as a way to minimize bias. This recommendation is supported by meta-reviews that estimate statistically and substantively significant differences between published and unpublished literature; on average, the difference between effect sizes favored published studies over unpublished studies in psychology, education, and special education (Chow & Ekholm, 2018; Polanin, Tanner-Smith, & Hennessey, 2016). Thus, researchers should attempt to guard against publication bias by searching for gray literature. Additionally, they can test for publication bias by estimating and comparing the overall effect sizes reported in published literature to those reported in gray literature.

### *Brief Overview of Publication Bias Tests*

There are several methods that have been developed to test for publication bias. Common tests include visual analysis of funnel plots (Sterne, Becker, & Egger, 2005), variants of fail-safe *N* tests (Orwin, 1983; Rosenthal, 1979), trim and fill analysis (Duval & Tweedie, 2000), and Egger's regression test (Egger et al., 1997). These methods are widely used in meta-analysis across many fields of research (see Ferguson & Brannick, 2012, for more details). In addition to these common methods, newer or less common tests include selection models (Copas & Shi, 2001; Vevea & Woods, 2005), an application of cumulative meta-analysis for publication bias (Kepes, Banks, & Oh, 2014), *p*-curve (Simonsohn, Nelson, & Simmons, 2014), *p*-uniform (van Assen, van Aert, & Wicherts, 2015), and the precision-effect test and precision-effect estimate with standard errors method (Stanley & Doucouliagos, 2014). Although often referred to under the umbrella term of *publication bias tests*, these tests can differ considerably in their complexity, Type I error rates, power, and the levels of inferences that can be drawn from tests results.

Because recently more advanced statistical techniques have been developed to assess the likelihood that publication bias exists within a sample of studies in a meta-analysis, older methods have important limitations to acknowledge. For example, the fail-safe *N* analysis (Orwin, 1983; Rosenthal, 1979) has several shortcomings, including the inability to incorporate information about study characteristics into the analysis. Further, fail-safe *N* methods result in variable estimates of the number of additional studies needed to nullify an effect, which naturally leads to variable conclusions (Becker, 2005). Descriptions of common publication bias tests can be found in Supplemental Material S1.

### *Purpose*

Broadly, researchers who report meta-analytic findings can attend to the phenomenon of publication bias by acknowledging the potential impacts of publication bias, conducting and interpreting publication bias tests, reporting effect sizes of published and unpublished studies separately, and contextualize findings within the overall purpose of the meta-analysis. Thus, the purposes of the present review are to

1. determine the extent that meta-analyses in the American Speech-Language-Hearing Association (ASHA) journals acknowledge and address publication bias;
2. determine the methods authors use to address or test for the likelihood for publication bias;
3. determine the extent that efforts to address publication bias are discussed, both the results of tests and the results of the tests in context of the overall study findings; and
4. provide recommendations for future meta-analyses related to publication bias.

## Method

To determine the extent of meta-analyses that address publication bias in journals published by the ASHA, I searched their four scientific, peer-reviewed journals for published meta-analyses: *American Journal of Audiology*; *American Journal of Speech-Language Pathology* (AJSLP); *Journal of Speech, Language, and Hearing Research* (JSLHR); and *Language, Speech, and Hearing Services in Schools*. This search was conducted for all published meta-analyses through February 1, 2018, and had no other limits on search parameters.

### *Search Strategy*

We entered the key word *meta-analysis* in search fields for all journals, yielding 722 reports. From this list, I screened all the titles and abstracts to retrieve the full sample of published meta-analyses. This process resulted in 691 that were excluded because they were not meta-analyses, which resulted in 31 published meta-analyses for further analysis. From this sample, two were excluded because they were, in fact, not meta-analyses; this resulted in a final sample of 29 meta-analyses. See Figure 1 for frequency of retrieved meta-analyses by year.

### *Eligibility Criteria*

Eligible reports were meta-analyses published prior to February 1, 2018, in any of the four journals searched. No other restrictions were applied for this review.

### *Coding of Meta-Analytic Reviews*

We coded retrieved meta-analyses for four descriptive and seven substantive variables. Descriptive variables included author(s), title, year of publication, and journal of publication. Substantive variables included whether or not the meta-analysis (a) discussed publication bias in any fashion, (b) attempted to include gray literature, (c) included gray literature, (d) tested for publication bias, (e) estimated differences between published and unpublished studies within the meta-analysis, (f) interpreted the results of publication bias tests or analyses, and (g) interpreted the results of the meta-analysis in lieu of potential publication bias. First, all substantive variables were coded dichotomously (*yes* = 1, *no* = 0). Next, substantive variables that were coded "1" were coded for related details. For example, if a study conducted publication bias tests, I recorded the type of publication bias tests used.

## Results

Of the 29 meta-analyses retrieved from a search of four journals, nine were published in the AJSLP, and the rest ($n$ = 20) were published in the JSLHR. None were published in the *American Journal of Audiology* or *Language, Speech, and Hearing Services in Schools*. Meta-analyses publication dates ranged from 2001 to 2018 with the majority (86%) being published since 2010. All but one meta-analysis used traditional synthesis methods for the meta-analysis of group design studies; Bailey, Eatchel, and Wambaugh (2015) synthesized single-case design studies and was published as a supplement. See Table 1 for included studies.

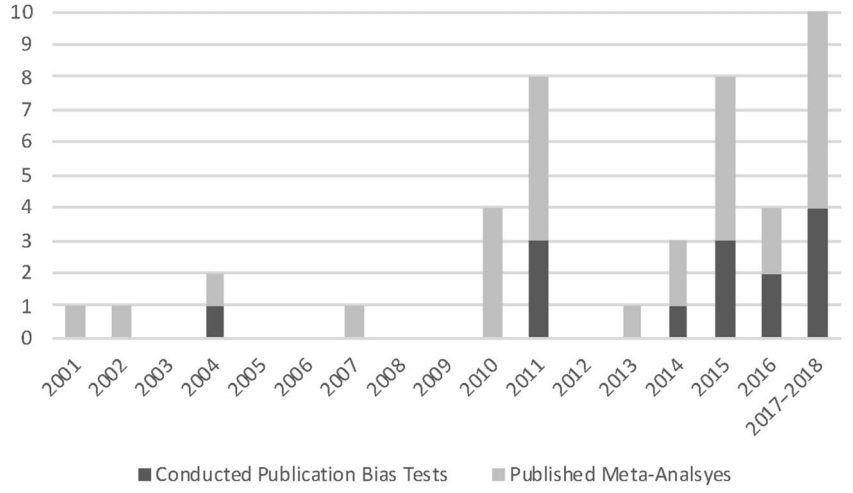
### *Acknowledgment of Publication Bias*

In the full sample of meta-analyses, 75% ($n$ = 22) mentioned publication bias in some form. This includes studies that mention the issue or the threat but did not make efforts to address the issue. For example, Whitehouse (2010) mentioned that publication bias is an issue in meta-analysis but decided not to address the issue because the variables of interest were not a part of the primary research aims. Nye et al. (2013) acknowledge the issue of publication bias but do not conduct any tests nor couch their findings in the context of possible bias. The most common mention of publication bias, whether addressed or not, was related to the exclusion of studies due to the publication process. Seven meta-analyses did not mention publication bias in any form (e.g., "file-drawer problem").

### *Gray Literature*

One of the primary ways meta-analysts can attempt to address publication bias is through searching the gray literature in an effort to include unpublished reports in the analyses. For example, the authors included a dissertations and theses database in their electronic search. In this sample, over half (55%) attempted to include gray literature in some form (e.g., searching dissertations, conference presentations, author contact), whereas just under half (48%) successfully located unpublished reports to include in their meta-analysis. That is, there were some studies that

**Figure 1.** Prevalence of publication bias test in published meta-analyses. Each light gray bar represents the frequency of published meta-analyses in the American Speech-Language-Hearing Association journals by year. The dark gray bar represents the proportion of the meta-analyses published per year that tested for publication bias.




attempted to include gray literature but were unsuccessful in locating any. These results suggest that the general efforts to locate unpublished reports were successful, with only two efforts to locate deemed unsuccessful (Latoszek, Maryn, Gerrits, & De Bodt, 2018; Nye et al., 2013).

### *Testing for Publication Bias*

Fourteen (48%) of the meta-analyses conducted at least one test for publication bias. Across studies, four tests were conducted: visual examination of a funnel plot, fail-safe *N*, trim and fill analysis (Duval & Tweedie, 2000), and Egger's regression (Egger et al., 1997). Of the studies that tested for publication bias ($n$ = 14), 64% ($n$ = 9) visually analyzed a funnel plot, 43% ($n$ = 6) used a trim and fill analysis, 35% ($n$ = 5) used Egger's regression, and 21% ($n$ = 3) used a version of fail-safe *N*.

### *Estimating the Difference Between Published and Unpublished Studies*

Because overall mean effect size estimates favor published studies (Chow & Ekholm, 2018; Polanin et al., 2016), this review coded for studies that estimated this difference in any fashion. No studies provided any estimation of effect differences between published and unpublished studies, nor descriptive statistics from which this difference could be extracted.

### *Interpretation of Publication Bias Tests*

Of studies that tested for publication bias, 11 interpreted the results of the tests conducted, whereas three studies conducted tests without providing substantive interpretation of test results. That is, the authors conducted the tests absent from explaining the results or discussing the information the tests provided. Further, only five studies that tested for publication bias interpreted the results of publication bias tests in the context of their results. For example, these five studies tested for publication bias in the methods section but did not return to discuss the implications of the publication bias results in the context of the overall results, context, or discussion.

## Discussion

The purpose of this review was to determine the state of publication bias tests conducted within four journals in the field of speech, language, and hearing sciences. Although three quarters of meta-analyses mentioned publication bias, only half of the authors included some examination or test for publication bias within their meta-analysis. Although the American Psychological Association requires the reporting authors to explain the article sampling rationale (published only vs. including unpublished), address publication bias, and report results of publication bias tests (Albarracin, 2015; American Psychological Association, 2008; Appelbaum et al., 2018), findings from the present review suggest that there is a general lack of consistency for this process in the current sample of journals. Although 75% of studies include discussion at some level of this topic, higher rates of conducting and interpreting publication bias tests are needed. Over 50% of studies did not conduct any publication bias tests.

Specific to publication bias tests conducted in these studies, it is promising that more authors are electing to conduct regression-based tests (i.e., trim and fill, Egger's) in place of more subjective and often misleading tests (fail-safe *N*). Of the meta-analyses that conducted publication bias tests, only three studies conducted multiple tests (Fisher, 2017; Roberts & Kaiser, 2011; Sandbank & Yoder, 2016). Researchers have called for the specific selection and interpretation of multiple publication bias tests

**Table 1.** Included studies.

| First author (year) | Title | Journal | Discuss | Gray search | Gray include | PB test | Difference | Interpret test | Interpret results |
|---|---|---|---|---|---|---|---|---|---|
| Bailey et al. (2015) | Sound Production Treatment: Synthesis and Quantification of Outcomes | AJSLP | Yes | Yes | Yes | No | No | No | No |
| Boutsen et al. (2002) | Botox Treatment in Adductor Spasmodic Dysphonia: A Meta-Analysis | JSLHR | No | No | No | No | No | No | No |
| Casby (2001) | Otitis Media and Language Development: A Meta-Analysis | AJSLP | Yes | No | No | No | No | No | No |
| Cleave et al. (2015) | The Efficacy of Recasts in Language Intervention: A Systematic Review and Meta-Analysis | AJSLP | No | No | No | No | No | No | No |
| Dollaghan & Horner (2011) | Bilingual Language Assessment: A Meta-Analysis of Diagnostic Accuracy | JSLHR | No | No | No | No | No | No | No |
| Ebert & Kohnert (2011) | Sustained Attention in Children With Primary Language Impairment: A Meta-Analysis | JSLHR | Yes | Yes | Yes | No | No | No | Yes |
| Estes et al. (2007) | Differences in the Nonword Repetition Performance of Children With and Without Specific Language Impairment: A Meta-Analysis | JSLHR | Yes | Yes | Yes | No | No | No | No |
| Fisher (2017) | A Systematic Review and Meta-Analysis of Predictors of Expressive-Language Outcomes Among Late Talkers | JSLHR | Yes | Yes | Yes | Yes | No | No | No |
| Flippin et al. (2010) | Effectiveness of the Picture Exchange Communication System (PECS) on Communication and Speech for Children With Autism Spectrum Disorder: A Meta-Analysis | AJSLP | No | No | No | No | No | No | No |
| Gallinat & Spaulding (2014) | Differences in the Performance of Children With Specific Language Impairment and Their Typically Developing Peers on Nonverbal Cognitive Tests: A Meta-Analysis | JSLHR | Yes | Yes | Yes | Yes | No | No | No |
| Gatlin & Wanzek (2015) | Relations Among Children's Use of Dialect and Literacy Skills: A Meta-Analysis | JSLHR | Yes | No | No | Yes | No | Yes | Yes |
| Kan & Windsor (2010) | Word Learning in Children With Primary Language Impairment: A Meta-Analysis | JSLHR | Yes | No | No | No | No | No | No |
| Krok & Leonard (2015) | Past Tense Production in Children With and Without Specific Language Impairment Across Germanic Languages: A Meta-Analysis | JSLHR | Yes | No | No | Yes | No | Yes | No |
| Lammertink et al. (2017) | Statistical Learning in Specific Language Impairment: A Meta-Analysis | JSLHR | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Latoszek et al. (2018) | A Meta-Analysis: Acoustic Measurement of Roughness and Breathing | JSLHR | No | Yes | No | No | No | No | No |
| Law et al. (2004) | The Efficacy of Treatment for Children With Developmental Speech and Language Delay/ Disorder: A Meta-Analysis | JSLHR | Yes | Yes | Yes | Yes | No | Yes | Yes |

(*table continues*)

**Table 1.** *(Continued).*

| First author (year) | Title | Journal | Discuss | Gray search | Gray include | PB test | Difference | Interpret test | Interpret results |
|---|---|---|---|---|---|---|---|---|---|
| Leung et al. (2018) | Voice, Articulation, and Prosody Contribute to Listener Perceptions of Speaker Gender: A Systematic Review and Meta-Analysis | JSLHR | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Lum et al. (2015) | A Meta-Analysis of Cross-Sectional Studies Investigating Language in Maltreated Children | JSLHR | Yes | No | No | Yes | No | Yes | No |
| Ntourou et al. (2011) | Language Abilities of Children Who Stutter: A Meta-Analytic Review | AJSLP | Yes | Yes | Yes | Yes | No | No | No |
| Nye et al. (2013) | Behavioral Stuttering Interventions for Children and Adolescents: A Systematic Review and Meta-Analysis | JSLHR | Yes | Yes | No | No | No | No | No |
| Pauls & Archibald (2016) | Executive Functions in Children With Specific Language Impairment: A Meta-Analysis | JSLHR | Yes | Yes | Yes | Yes | No | Yes | No |
| Pawłowska (2014) | Evaluation of Three Proposed Markers for Language Impairment in English: A Meta-Analysis of Diagnostic Accuracy Studies | JSLHR | Yes | No | No | No | No | No | No |
| Roberts & Kaiser (2011) | The Effectiveness of Parent-Implemented Language Interventions: A Meta-Analysis | AJSLP | Yes | Yes | Yes | Yes | No | Yes | No |
| Rudolph (2017) | Case History Risk Factors of Specific Language Impairment: A Systematic Review and Meta-Analysis | AJSLP | Yes | No | No | Yes | No | Yes | No |
| Sandbank & Yoder (2016) | The Association Between Parental Mean Length of Utterance and Language Outcomes in Children with Disabilities: A Correlational Meta-Analysis | AJSLP | Yes | Yes | Yes | Yes | No | Yes | Yes |
| Scott et al. (2011) | How Well Do Children Who Are Internationally Adopted Acquire Language? A Meta-Analysis | JSLHR | Yes | Yes | Yes | Yes | No | Yes | No |
| van Kleek et al. (2010) | Should We Use Telegraphic or Grammatical Input in the Early Stages of Language Development With Children Who Have Language Impairments? A Meta-Analysis of the Research and Expert Opinion | AJSLP | No | Yes | Yes | No | No | No | No |
| Whitehouse (2010) | Is There a Sex Ratio Difference in the Familial Aggregation of Specific Language Impairment? A Meta-Analysis | JSLHR | Yes | No | No | No | No | No | No |
| Zimmerman (2018) | Do Infants Born Very Premature and Who Have Very Low Birth Weight Catch Up With Their Full Term Peers in Their Language Abilities by Early School Age? | JSLHR | No | No | No | No | No | No | No |

*Note.* AJSLP = *American Journal of Speech-Language Pathology*; JSLHR = *Journal of Speech, Language, and Hearing Research*; PB = publication bias.

(Ferguson & Brannick, 2012). Because different tests of publication bias provide substantively different information about the risk of bias in a sample of studies, authors should conduct multiple tests and provide a summative interpretation of the findings of these tests taken together.

Another noteworthy result of this review is that there were no published meta-analyses retrieved from the *American Journal of Audiology* nor the *Language, Speech, and Hearing Services in Schools*. It may be that meta-analyses in these fields are published in other journals (e.g., AJSLP, JSLHR). However, although this finding may not necessarily be problematic, given the proliferation of meta-analytic reviews in the social sciences, it is possible that the field of speech, language, and hearing sciences would ultimately benefit from more systematic reviews that leverage meta-analytic techniques to synthesize study findings. Not attending to these important issues may result in the selection and adoption of practices or interventions based on a corpus of studies that does not represent the full body of literature but a biased sample of published literature. Because meta-analyses often drive practitioner and policy decision making, being conscious of this potential bias is essential when interpreting the findings from systematic reviews and meta-analyses. However, it is possible that the readership of ASHA and other journals in the field overlaps to a degree where the syntheses published reach their intended audiences. Regardless, rigorous meta-analyses of interventions that inform decisions related to what works and for whom are needed, particularly for children and adults who are predisposed to poorer outcomes.

### *Concluding Recommendations*

Less than half of the meta-analyses published in ASHA journals attempted to address publication bias. This overview of the overall state of publication bias efforts within a selected sample of meta-analyses inform the following recommendations:

Recommendation 1: Meta-analysts should include published and unpublished literature in their primary search strategy. Doing so will allow for the possible identification and retrieval of gray literature but does not require the inclusion of unpublished data if the search strategy specific to the researcher's goals does not identify unpublished data.

Recommendation 2: If gray literature is successfully identified and included in a meta-analysis, researchers should conduct multiple tests for publication bias. These include visual (e.g., funnel plot) and statistical tests (e.g., trim and fill, Egger's), which provide important but different types of information about publication bias, and thus, should both be included when summarizing the likelihood of publication bias within a sample of synthesized studies. For more detail on publication bias test types, purposes, and recommendations, see Ekholm and Chow (under review) and Ferguson and Brannick (2012).

Recommendation 3: Discontinue the use of the fail-safe *N* test. Although user friendly and relatively easy to calculate, there are several issues with fail-safe *N* that make it problematic (e.g., Becker, 2005). Perhaps, most notably, the fail-safe *N* does not allow for a statistical test of bias, and the computation uses statistical significance of the meta-analytic summary effect as the criterion against which publication bias is based. Further, fail-safe *N* methods do not allow for the inclusion of study characteristics in the analysis, nor do they provide consistent estimates of the number of studies required to nullify an effect. Making judgments about or coming to overall conclusions in the context of publication bias based on this test likely leads researchers to underestimate publication bias.

Recommendation 4: Findings from this review lead to the recommendation that authors should report data for published and unpublished studies separately, regardless of the effect size metric. This recommendation is supported by recent studies that compare the effects of published and unpublished studies that estimate larger effects for published studies when compared with unpublished studies ($d$ = .18 to .64; Chow & Ekholm, 2018; Polanin et al., 2016). It is important to note that this recommendation encourages authors to report data separately but not in place of an overall average effect. This additional step of reporting will allow for more transparency when interpreting effects of the included literature.

Recommendation 5: Studies need to (a) interpret the findings of publication bias tests accurately and (b) discuss the results of publication bias tests in context: both in the context of the literature reviewed and the overall meta-analytic findings. Just as in primary results of research studies and the main effects of meta-analyses, it is the researcher's responsibility to translate the results and implications of all analyses of a study to the reader. Tests for publication bias speak directly to the interpretability of meta-analytic data and should be discussed to contextualize review findings.

## References


*References marked with an asterisk indicate articles included in the present review.*

**Albarracin, D.** (2015). Editorial. *Psychological Bulletin, 141*(1), 1–5.

**American Psychological Association.** (2008). Reporting standards for research in psychology: Why do we need them? What might they be? *American Psychologist, 63,* 839–851.

**Appelbaum, M., Cooper, H., Kline, R. B., Mayo-Wilson, E., Nezu, A. M., & Rao, S. M.** (2018). Journal article reporting standards for quantitative research in psychology: The APA Publications and Communications Board task force report. *The American Psychologist, 73*(1), 3–25.

***Bailey, D. J., Eatchel, K., & Wambaugh, J.** (2015). Sound production treatment: Synthesis and quantification of outcomes. *American Journal of Speech-Language Pathology, 24*(4), S798–S814.

**Becker, B.** (2005). Failsafe *N* or file-drawer number. In H. R. Rothstein, A. J. Sutton, & M. Bornstein (Eds.), *Publication bias in meta-analysis: Prevention, assessment and adjustments* (pp. 35–48). Chichester, England: Wiley.

***Boutsen, F., Cannito, M. P., Taylor, M., & Bender, B.** (2002). Botox treatment in adductor spasmodic dysphonia: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 45*(3), 469–481.

*Casby, M. W. (2001). Otitis media and language development: A meta-analysis. *American Journal of Speech-Language Pathology, 10*(1), 65–80.

Chow, J. C., & Ekholm, E. (2018). Do published studies yield larger effect sizes than unpublished studies in education and special education? A meta-review. *Educational Psychology Review, 30*(3), 727–744. https://doi.org/10.1007/s10648-018-9437-7

*Cleave, P. L., Becker, S. D., Curran, M. K., Van Horne, A. J. O., & Fey, M. E. (2015). The efficacy of recasts in language intervention: A systematic review and meta-analysis. *American Journal of Speech-Language Pathology, 24*(2), 237–255.

Cook, D. J., Guyatt, G. H., Ryan, G., Clifton, J., Buckingham, L., Willan, A., . . . Oxman, A. D. (1993). Should unpublished data be included in meta-analyses? Current convictions and controversies. *JAMA, 269*(21), 2749–2753.

Copas, J. B., & Shi, J. Q. (2001). A sensitivity analysis for publication bias in systematic reviews. *Statistical Methods in Medical Research, 10*(4), 251–265.

*Dollaghan, C. A., & Horner, E. A. (2011). Bilingual language assessment: A meta-analysis of diagnostic accuracy. *Journal of Speech, Language, and Hearing Research, 54*(4), 1077–1088.

Duval, S., & Tweedie, R. (2000). Trim and fill: A simple funnel-plot-based method of testing and adjusting for publication bias in meta-analysis. *Biometrics, 56,* 455–463. https://doi.org/10.1111/j.0006-341x.2000.00455.x

*Ebert, K. D., & Kohnert, K. (2011). Sustained attention in children with primary language impairment: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 54*(5), 1372–1384.

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *British Medical Journal, 315,* 629–634. https://doi.org/10.1136/bmj.315.7109.629

*Estes, K. G., Evans, J. L., & Else-Quest, N. M. (2007). Differences in the nonword repetition performance of children with and without specific language impairment: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 50*(1), 177–195.

Ferguson, C. J., & Brannick, M. T. (2012). Publication bias in psychological science: Prevalence, methods for identifying and controlling, and implications for the use of meta-analyses. *Psychological Methods, 17,* 120–128. https://doi.org/10.1037/a0024445

Ferguson, C. J., & Heene, M. (2012). A vast graveyard of undead theories: Publication bias and psychological science's aversion to the null. *Perspectives on Psychological Science, 7*(6), 555–561. https://doi.org/10.1177/1745691612459059

*Fisher, E. L. (2017). A systematic review and meta-analysis of predictors of expressive-language outcomes among late talkers. *Journal of Speech, Language, and Hearing Research, 60*(10), 2935–2948.

*Flippin, M., Reszka, S., & Watson, L. R. (2010). Effectiveness of the Picture Exchange Communication System (PECS) on communication and speech for children with autism spectrum disorders: A meta-analysis. *American Journal of Speech-Language Pathology, 19*(2), 178–195.

*Gallinat, E., & Spaulding, T. J. (2014). Differences in the performance of children with specific language impairment and their typically developing peers on nonverbal cognitive tests: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 57*(4), 1363–1382.

*Gatlin, B., & Wanzek, J. (2015). Relations among children's use of dialect and literacy skills: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 58*(4), 1306–1318.

Higgins, J., & Green, S. (Eds.). (2011). *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0* [updated March 2011]. The Cochrane Collaboration, 2011. Retrieved from http://handbook.cochrane.org

Hopewell, S., Loudon, K., Clarke, M. J., Oxman, A. D., & Dickersin, K. (2009). Publication bias in clinical trials due to statistical significance or direction of trial results. *The Cochrane Database of Systematic Reviews,* (1), MR000006. https://doi.org/10.1002/14651858.MR000006.pub3

Ioannidis, J. P. (2005). Why most published research findings are false. *PLoS Medicine, 2*(8), e124. https://doi.org/10.1371/journal.pmed.0020124

Ioannidis, J. P., Munafo, M. R., Fusar-Poli, P., Nosek, B. A., & David, S. P. (2014). Publication and other reporting biases in cognitive sciences: Detection, prevalence, and prevention. *Trends in Cognitive Sciences, 18*(5), 235–241.

*Kan, P. F., & Windsor, J. (2010). Word learning in children with primary language impairment: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 53*(3), 739–756.

Kepes, S., Banks, G. C., & Oh, I. S. (2014). Avoiding bias in publication bias research: The value of "null" findings. *Journal of Business and Psychology, 29*(2), 183–203.

*Krok, W. C., & Leonard, L. B. (2015). Past tense production in children with and without specific language impairment across Germanic languages: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 58*(4), 1326–1340.

Kugley, S., Wade, A., Thomas, J., Mahood, Q., Jørgensen, A., Hammerstrøm, K., & Sathe, N. (2017). *Searching for studies: A guide to information retrieval for Campbell systematic reviews.* Oslo, Norway: The Campbell Collaboration. https://doi.org/10.4073/cmg.2016.1

*Lammertink, I., Boersma, P., Wijnen, F., & Rispens, J. (2017). Statistical learning in specific language impairment: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 60*(12), 3474–3486.

*Latoszek, B. B. V., Maryn, Y., Gerrits, E., & De Bodt, M. (2018). A meta-analysis: Acoustic measurement of roughness and breathiness. *Journal of Speech, Language, and Hearing Research, 61*(2), 298–323.

*Law, J., Garrett, Z., & Nye, C. (2004). The efficacy of treatment for children with developmental speech and language delay/disorder: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 47*(4), 924–943.

*Leung, Y., Oates, J., & Chan, S. P. (2018). Voice, articulation, and prosody contribute to listener perceptions of speaker gender: A systematic review and meta-analysis. *Journal of Speech, Language, and Hearing Research, 61*(2), 266–297.

*Lum, J. A., Powell, M., Timms, L., & Snow, P. (2015). A meta-analysis of cross sectional studies investigating language in maltreated children. *Journal of Speech, Language, and Hearing Research, 58*(3), 961–976.

*Ntourou, K., Conture, E. G., & Lipsey, M. W. (2011). Language abilities of children who stutter: A meta-analytical review. *American Journal of Speech-Language Pathology, 20*(3), 163–179.

*Nye, C., Vanryckeghem, M., Schwartz, J. B., Herder, C., Turner, H. M., & Howard, C. (2013). Behavioral stuttering interventions for children and adolescents: A systematic review and meta-analysis. *Journal of Speech, Language, and Hearing Research, 56*(3), 921–932.

Orwin, R. G. (1983). A fail-safe *N* for effect size in meta-analysis. *Journal of Educational Statistics, 8*(2), 157–159.

*Pauls, L. J., & Archibald, L. M. (2016). Executive functions in children with specific language impairment: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 59*(5), 1074–1086.

*Pawłowska, M. (2014). Evaluation of three proposed markers for language impairment in English: A meta-analysis of diagnostic accuracy studies. *Journal of Speech, Language, and Hearing Research, 57*(6), 2261–2273.

Polanin, J. R., Tanner-Smith, E. E., & Hennessy, E. A. (2016). Estimating the difference between published and unpublished effect sizes: A meta-review. *Review of Educational Research, 86*(1), 207–236. https://doi.org/10.3102/0034654315582067

*Roberts, M. Y., & Kaiser, A. P. (2011). The effectiveness of parent-implemented language interventions: A meta-analysis. *American Journal of Speech-Language Pathology, 20*(3), 180–199.

Rosenthal, R. (1979). The file drawer problem and tolerance for null result. *Psychological Bulletin, 86,* 638–641. https://doi.org/10.1037/0033-2909.86.3.638

Rothstein, H. R., Borenstein, M., & Sutton, A. J. (2006). *Publication bias in meta-analysis: Prevention, assessment, and adjustments*. Chichester, England: Wiley.

*Rudolph, J. M. (2017). Case history risk factors for specific language impairment: A systematic review and meta-analysis. *American Journal of Speech-Language Pathology, 26*(3), 991–1010.

*Sandbank, M., & Yoder, P. (2016). The association between parental mean length of utterance and language outcomes in children with disabilities: A correlational meta-analysis. *American Journal of Speech-Language Pathology, 25*(2), 240–251.

*Scott, K. A., Roberts, J. A., & Glennen, S. (2011). How well do children who are internationally adopted acquire language? A meta-analysis. *Journal of Speech, Language, and Hearing Research, 54*(4), 1153–1169.

Simonsohn, U., Nelson, L. D., & Simmons, J. P. (2014). P-curve: A key to the file-drawer. *Journal of Experimental Psychology: General, 143*(2), 534–547.

Stanley, T. D., & Doucouliagos, H. (2014). Meta-regression approximations to reduce publication selection bias. *Research Synthesis Methods, 5*(1), 60–78.

Sterne, J. A. C., Becker, B. J., & Egger, M. (2005). The funnel plot. In H. R. Rothstein, M. Bornstein, & A. J. Sutton (Eds.), *Publication bias in meta-analysis: Prevention, assessment, and adjustments* (pp. 145–174). Chichester, England: Wiley.

van Assen, M. A., van Aert, R., & Wicherts, J. M. (2015). Meta-analysis using effect size distributions of only statistically significant studies. *Psychological Methods, 20*(3), 293–309.

*van Kleek, A., Schwarz, A. L., Fey, M., Kaiser, A., Miller, J., & Weitzman, E. (2010). Should we use telegraphic or grammatical input in the early stages of language development with children who have language impairments? A meta-analysis of the research and expert opinion. *American Journal of Speech-Language Pathology, 19*(1), 3–21.

Vevea, J. L., & Woods, C. M. (2005). Publication bias in research synthesis: Sensitivity analysis using a priori weight functions. *Psychological Methods, 10*(4), 428–443.

*Whitehouse, A. J. (2010). Is there a sex ratio difference in the familial aggregation of specific language impairment? A meta-analysis. *Journal of Speech, Language, and Hearing Research, 53*(4), 1015–1025.

*Zimmerman, E. (2018). Do infants born very premature and who have very low birth weight catch up with their full term peers in their language abilities by early school age? *Journal of Speech, Language, and Hearing Research, 61*(1), 53–65.