



Do Bilinguals Have an Advantage in Theory of Mind? A Meta-Analysis

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Bilingualism might help children develop Theory of Mind, but the evidence is mixed. To address the disagreement in the literature, a meta-analysis was conducted on studies that compared bilingual and monolingual children on false belief and other Theory of Mind tests. The meta-analysis of 16 studies and 1,283 children revealed a small bilingual advantage (Cohen's $d = 0.22$, $p = 0.050$). A secondary analysis was conducted on studies ($k = 8$) that statistically adjusted the Theory of Mind scores to correct for a bilingual disadvantage in language proficiency. This secondary analysis indicated a medium-size bilingual advantage (Cohen's $d = 0.58$, $p < 0.001$). There was no evidence for publication bias in either analysis. Taken together, the results provide support for a beneficial effect of acquiring two languages on mental state reasoning. Explanations for this bilingual advantage, which include bilingual-monolingual differences in executive functioning, metalinguistic awareness, and socio-pragmatic abilities, are discussed.

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INTRODUCTION

Bilingualism research in the modern era has been dominated by a potential bilingual advantage in executive functioning. This advantage, which is supported by many studies (Bialystok, 1999; Bialystok et al., 2004; Costa et al., 2008), has been communicated to the general public through significant media coverage (Bhattacharjee, 2012; Reville, 2014). Yet, several recent studies have failed to replicate this finding (Morton and Harper, 2007; Paap and Greenberg, 2013; Antón et al., 2014), leading many researchers to doubt its validity (de Bruin et al., 2015; Paap et al., 2016), and creating a division in the bilingualism research community between believers and skeptics (Bak, 2016; Bialystok, 2016; Titone et al., 2017). This ambiguous state of the literature is not limited to executive functioning. It extends to other aspects of mental functioning, such as Theory of Mind, a socio-cognitive ability that is thought to be closely linked to executive functioning (Devine and Hughes, 2014).

In the research addressing whether bilingual children have an advantage over their monolingual peers in the development of Theory of Mind, the answer has been mixed (Goetz, 2003; Kovács, 2009; Kyuchukov and De Villiers, 2009; Fan et al., 2015; Gordon, 2016; Dahlgren et al., 2017), often even within a single study (Bialystok and Senman, 2004; Chan, 2004; Nguyen and Astington, 2014; Diaz and Farrar, 2018). To help disambiguate the ambiguous literature, the current study

statistically combined data from many previous studies through a meta-analysis. To provide the background for the meta-analysis, the rest of the Introduction describes the concept of a Theory of Mind and common tests of this ability, followed by reasons for why bilingual children might perform better than their monolingual peers on these tests.

Theory of Mind refers to the ability to attribute mental states to other people and to predict and explain other people's behavior on the basis of those attributed mental states. This ability is often assessed through a false belief test, such as the unexpected-transfer test (Wimmer and Perner, 1983; Baron-Cohen et al., 1985) and the unexpected-contents test (Hogrefe et al., 1986; Perner et al., 1987).

In a popular version of the unexpected-transfer test, known as the Sally-Anne test (Baron-Cohen et al., 1985), participants see a character, who is named Sally, put a marble into a basket. Sally then leaves the scene, and while away, a second character, who is named Anne, removes the marble from the basket and puts it into a box. Next, Sally returns to the scene to retrieve the marble. The key question for the participant is: "Where will Sally look for the marble?" The correct answer is that Sally will look for the marble in the basket, which is where she put it (and not in the box, where it currently is). Answering correctly requires assigning the correct mental state to Sally (namely, the false belief that the marble is in the basket) and predicting her behavior on the basis of that assigned mental state (namely, that she will look in the basket because she falsely believes that the marble is in the basket).

In another commonly-used assessment of Theory of Mind called an unexpected-contents test (Hogrefe et al., 1986; Perner et al., 1987), participants are shown, for example, a tube of Smarties candies and are asked what the tube contains. Participants invariably answer "Smarties" but when the tube is opened, pencils unexpectedly appear (rather than the anticipated Smarties candies). Participants are then asked what someone else, such as a classmate, would predict is contained in the Smarties tube. The correct answer, which is Smarties candies (rather than pencils), requires assigning the correct mental state to someone else (namely, the false belief that the tube contains Smarties candies) and predicting a person's behavior on the basis of that assigned mental state (namely, that the person will say that they think Smarties are contained in the tube).

These false belief tests and other Theory of Mind tests are failed by many children before they turn four years old (Wellman et al., 2001), but there is significant variability among children. For example, many children on the autism spectrum fail to pass these tests even when they are several years older than four (Happé, 1995). Even among typically developing children, there is detectable variability, such as differences across cultures. For example, meta-analyses have revealed faster Theory of Mind development for children from mainland China, Canada, and the United States relative to children from Hong Kong (Liu et al., 2008), and for children from Australia and Canada relative to children from Austria and Japan (Wellman et al., 2001), differences that are thought to be related to certain environmental factors, such as the child's linguistic environment. These cultural differences in the rate of Theory of Mind

development suggest that Theory of Mind is malleable and could potentially be facilitated by a dual-language (i.e., bilingual) environment.

Consistent with this line of thinking, previous studies have provided evidence that bilingualism accelerates Theory of Mind development (Goetz, 2003; Farhadian et al., 2010; Han and Lee, 2013; Diaz and Farrar, 2017). For example, Kovács (2009) found that more than twice as many 2 and 3 year-old Romanian-Hungarian bilingual children passed an unexpected-transfer test than intelligence-matched 2 and 3 year-old Romanian monolingual children.

There are three main accounts for why bilingual children might pass Theory of Mind tests earlier than monolinguals: the "executive functioning" account (Goetz, 2003; Bialystok and Senman, 2004; Kovács, 2009; Greenberg et al., 2013), the "metalinguistic awareness" account (Goetz, 2003; Diaz and Farrar, 2017), and the "socio-pragmatic" account (Goetz, 2003; Fan et al., 2015).

The first account, "executive functioning," is based on evidence that bilingualism improves executive functioning (Carlson and Meltzoff, 2008; Bialystok and Viswanathan, 2009) and that level of executive functioning is a significant predictor of Theory of Mind performance (Devine and Hughes, 2014). The supposed enhanced attentional control abilities of bilinguals could be used to down-regulate their own mental state (i.e., their own beliefs and knowledge) while up-regulating someone else's mental state. The second account, "metalinguistic awareness," is based on evidence that bilingualism enhances metalinguistic awareness (Ben-Zeev, 1977; Bialystok, 1988) and that metalinguistic awareness is linked to Theory of Mind development (Doherty and Perner, 1998; Doherty, 2000). Bilinguals' metalinguistic understanding that there are two labels for the same concept (i.e., one label in each language) might facilitate the understanding that two people can have a different mental state in relation to the same event (and thus that someone else's mental state can differ from their own). The third account, "socio-pragmatic," is that bilinguals come to understand that some people speak only one of their languages (either language A or language B) and some people speak both of their languages (languages A and B). This understanding that two people can have different (or similar) language knowledge may transfer to the more general understanding that two people can have a different (or similar) mental state.

All three of these accounts predicts a bilingual advantage in Theory of Mind development. This prediction has received support both from studies that have used traditional false belief tests, such as the unexpected-location and unexpected-contents tests (Goetz, 2003; Kovács, 2009; Farhadian et al., 2010), as well as studies that have used non-traditional Theory of Mind tests, such as tests that assess the ability to take someone else's visual-spatial perspective when it differs from one's own visual-spatial perspective (Greenberg et al., 2013; Fan et al., 2015). In contrast, several other studies have failed to find a bilingual advantage, both on traditional false belief tests (Kyuchukov and De Villiers, 2009; Pearson, 2013; Nguyen and Astington, 2014; Gordon, 2016; Dahlgren et al., 2017) and non-traditional Theory of Mind tests (Gordon, 2016; Dahlgren et al., 2017).

The inconsistent results across individual studies make it difficult to draw a conclusion about the effects of bilingualism on Theory of Mind development. To help draw a conclusion, the current study statistically combined data from many studies through a meta-analysis. Specifically, a main analysis was conducted, which involved aggregating raw Theory of Mind scores across studies that have compared bilingual and monolingual children on Theory of Mind tests. A secondary analysis was then conducted on the subset of these studies that reported Theory of Mind scores that were statistically adjusted to account for a bilingual disadvantage in language proficiency. It has been argued that bilinguals' lower receptive language proficiency hurts their performance on language-based Theory of Mind tests, thereby concealing a bilingual advantage that would have otherwise emerged (Chan, 2004; Nguyen and Astington, 2014; Diaz and Farrar, 2017, 2018). Thus, the current study presents a main meta-analysis on raw Theory of Mind scores and a secondary meta-analysis on language-adjusted Theory of Mind scores.

METHOD

Literature Search

To identify eligible studies, a three-step process was planned. First, a search through the databases PsycARTICLES, PsycINFO, and MEDLINE was to be conducted using the search terms "bilingual," "Theory of Mind," and "false belief." Second, after identifying eligible articles through the database search, the reference lists of these eligible studies were to be scanned for additional studies that might not have been detected in the database search (i.e., cited studies were to be searched). Third, after eligible articles were identified through both the database search and the reference list search, the studies that cited these eligible studies were to be checked for eligibility (i.e., cited-by studies were to be searched). (Then, in a re-iterative process, the reference lists of the studies identified in the second step and the reference lists and citations of the studies identified in the third step were to be checked.) After completing the search plan in March-May of 2018, a total of 2,032 studies had been considered (though a small subset were duplicates), of which 16 satisfied the inclusion criteria.

Inclusion Criteria

To be eligible for inclusion, a study had to satisfy the following requirements: the study (1) tested bilinguals and monolinguals, (2) tested children rather than adults, (3) tested spoken language users rather than sign language users, and (4) tested participants on a valid Theory of Mind test¹. Included studies also provided

¹Two studies (Berguno and Bowler, 2004; Yow and Markman, 2015) did not use a measure of Theory of Mind that was deemed valid for the current purpose and were thus not included in the meta-analysis. Berguno and Bowler (2004) did not use any Theory of Mind tests that assessed the attribution of mental states to others (only to oneself). Because this study did not assess the key component of Theory of Mind, it was not included in the meta-analysis. Yow and Markman (2015) used a word learning test that included a Theory of Mind component. Because there is evidence for a bilingual advantage in word learning (Kaushanskaya et al., 2014), better performance on the word learning test might *not* reflect a bilingual advantage in Theory of Mind *per se*. Due to this confound, this study was not

sufficient data to compute an effect size and were reported in a journal ($k = 13$) or a dissertation ($k = 3$).

The 16 studies that were included in the main analysis (i.e., the analysis of raw Theory of Mind scores) are shown in **Table 1**. (Note that the order of the studies in the table was arranged to duplicate the order in **Figure 1**.) Collectively, the 16 studies tested 1,283 participants (655 monolinguals, 628 bilinguals). A subset of these studies ($k = 8$) was included in a secondary analysis (i.e., the analysis of language proficiency adjusted Theory of Mind scores). This secondary analysis used studies that reported Theory of Mind data that were statistically adjusted to account for the confounding variable of bilinguals' reduced language proficiency. These 8 studies, which included 569 participants (311 monolinguals, 258 bilinguals), are marked with an asterisk in **Table 1**.

Most of the studies in the meta-analyses used a version of the unexpected-location or unexpected-transfer false belief test, but some studies used non-traditional Theory of Mind tests (see **Table 1**; Greenberg et al., 2013; Han and Lee, 2013; Fan et al., 2015). Additionally, most of the studies tested English-speaking monolinguals and bilinguals, but some tested non-English speakers (see **Table 1**; Kovács, 2008, 2009; Kyuchukov and De Villiers, 2009; Farhadian et al., 2010; Dahlgren et al., 2017). Furthermore, most of the studies tested children between the ages of 3 and 5, but there were some exceptions (Greenberg et al., 2013; Fan et al., 2015; Dahlgren et al., 2017).

Statistical Analyses

For both the main and secondary analyses, Cohen's d , also known as the Standardized Difference in Means, was used as the effect size measure (Cohen, 1992). The main analysis used raw means and variances to compute Cohen's d , whereas the secondary analysis used statistically adjusted means and variances (typically from an Analysis of Covariance) to compute Cohen's d . When a study used multiple Theory of Mind tests, the effect sizes were pooled together to create a single grand effect size for each study. The Cohen's d effect sizes were entered into a random-effects model. The computing of the effect sizes and the running of the random-effects model were performed in the software Comprehensive Meta-Analysis (Borenstein et al., 2005).

In addition to analyses of effect sizes, potential publication bias was also examined. To this end, a funnel plot with effect sizes and standard errors was visually inspected for symmetry. Following visual inspection, Egger's regression intercept test (Egger et al., 1997) was conducted. The software Comprehensive Meta-Analysis (Borenstein et al., 2005) was used to complete the tests of potential publication bias.

RESULTS

Main Analysis: Raw Scores

The meta-analysis of raw Theory of Mind scores from the 16 studies indicated a small bilingual advantage, Cohen's $d = 0.22$,

included in the meta-analysis. It is important to note, however, that the results of both of these studies were consistent with the results of the meta-analysis (i.e., a bilingual advantage).

TABLE 1 | Studies included in main analysis.

	Monolingual N	Bilingual N	Monolingual languages	Bilingual languages	Theory of Mind Tests
Diaz and Farrar, 2018*	33	32	English	English & Spanish	Unexpected-Transfer, Unexpected-Contents, Other
Kyuchukov and De Villiers, 2009 ^a	60	60	Bulgarian	Bulgarian & Romani	Unexpected-Transfer, Unexpected-Contents
Pearson, 2013	40	28	English	English & Spanish	Unexpected-Transfer
Bialystok and Senman, 2004 ^b	52	43	English	English & Other	Other
Gordon, 2016 ^c	26	26	English	English & Spanish	Unexpected-Transfer, Unexpected-Contents, Other
Dahlgren et al., 2017	14	14	Swedish or Slavic	Swedish & Slavic	Unexpected-Transfer, Other
Nguyen and Astington, 2014*	48	24	English or French	English & French	Unexpected-Transfer, Unexpected-Contents
Diaz and Farrar, 2017 ^d	35	38	English	English & Spanish	Unexpected-Transfer, Unexpected-Contents, Other
Kovács, 2009 ^e	28	28	Italian	Romanian & Slovenian	Unexpected-Transfer, Unexpected-Contents
Chan, 2004*	29	31	English	English & Chinese	Unexpected-Transfer, Unexpected-Contents, Other
Goetz, 2003*	64	40	English or Chinese	English & Chinese	Unexpected-Transfer, Unexpected-Contents, Other
Han and Lee, 2013	60	73	Korean	English & Korean	Other
Greenberg et al., 2013	45	37	English	English & Other	Other
Kovács, 2009	32	32	Romanian	Romanian & Hungarian	Unexpected-Transfer, Other
Farhadian et al., 2010	65	98	Persian	Persian & Kurdish	Unexpected-Transfer, Unexpected-Contents
Fan et al., 2015*	24	24	English	English & Other	Other

*The study was included in the secondary analysis

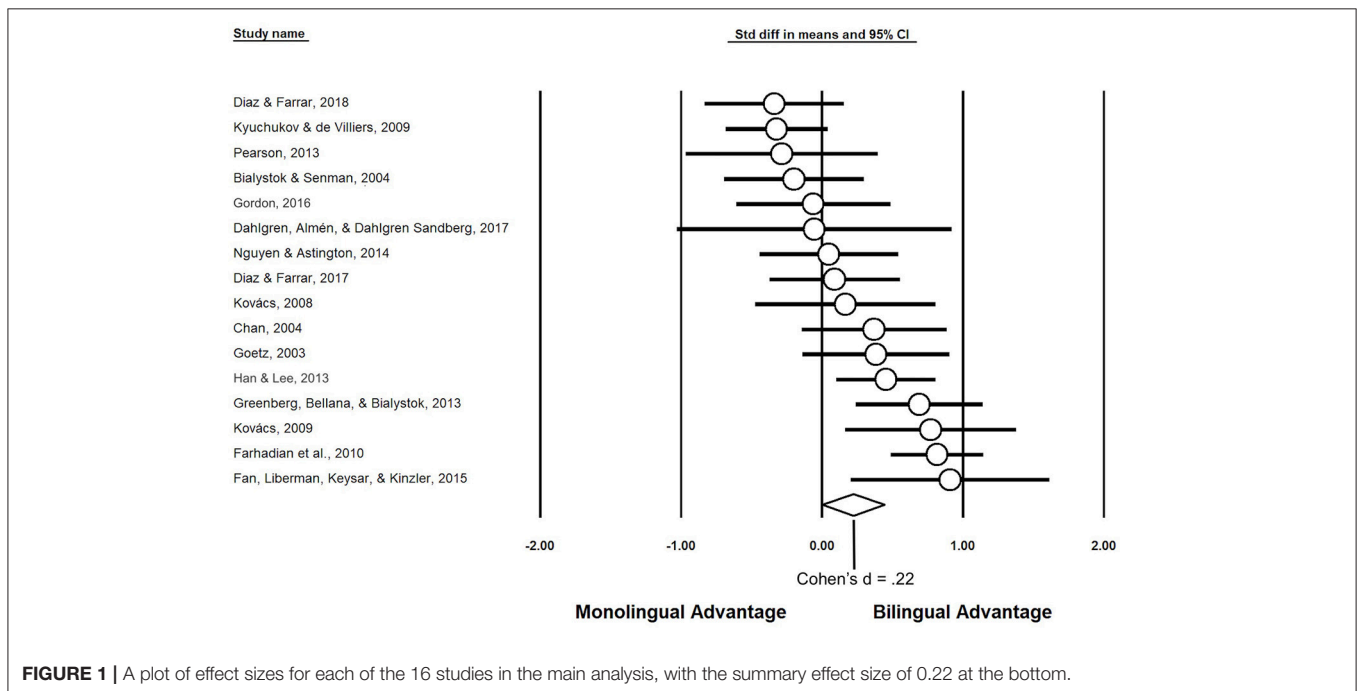
^aBilinguals were tested in both their L1 and L2. The L1 test scores were used to compute the effect size so that Theory of Mind scores for both monolinguals and bilinguals were based on their native language performance.

^bIn the secondary analysis, only the appearance results of the appearance-reality test were used to compute an effect size because the reality questions did not require a Theory of Mind.

^cGordon's dissertation Millett, 2010 was used to extract additional data that were not included in the journal version.

^dA subset of participants was tested a second time but for a more accurate statistical calculation only time 1 data were included in the effect size calculation.

^eThis dissertation contained an experiment that was published in Kovács (2009). So as to not give this experiment double weight, it was not included when computing the effect size for Kovács (2008).

**FIGURE 1** | A plot of effect sizes for each of the 16 studies in the main analysis, with the summary effect size of 0.22 at the bottom.

$p = 0.050$, $z = 1.96$, $SE = 0.11$, 95% Confidence Interval = 0.00-0.44. A plot of the effect sizes for each of the 16 studies and the summary effect size (Cohen's $d = 0.22$) is displayed in **Figure 1**.

To assess the possibility of publication bias, a funnel plot was generated. See **Figure 2** for the plot. There is no apparent asymmetry in the plot, suggestive of no publication bias.

Confirming the lack of publication bias, the Eggers regression intercept test was not significant, $t_{(14)} = 0.65, p = 0.53$.

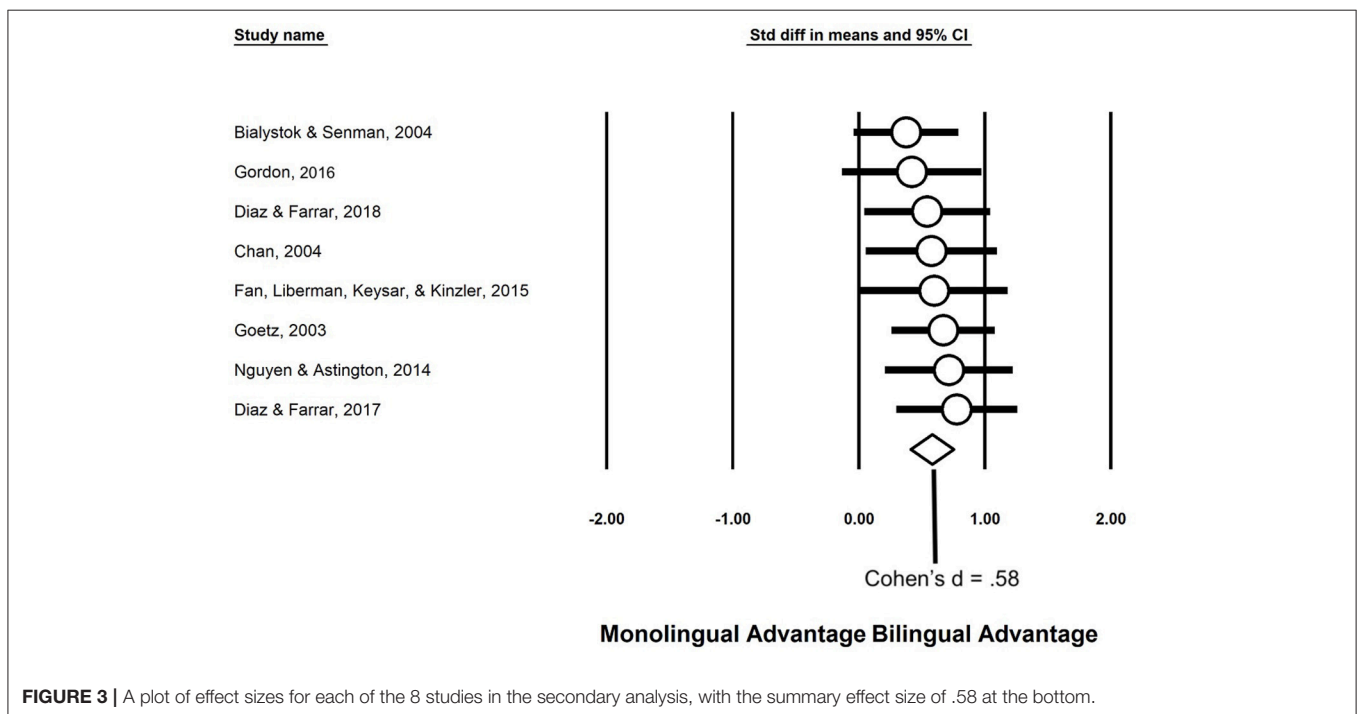
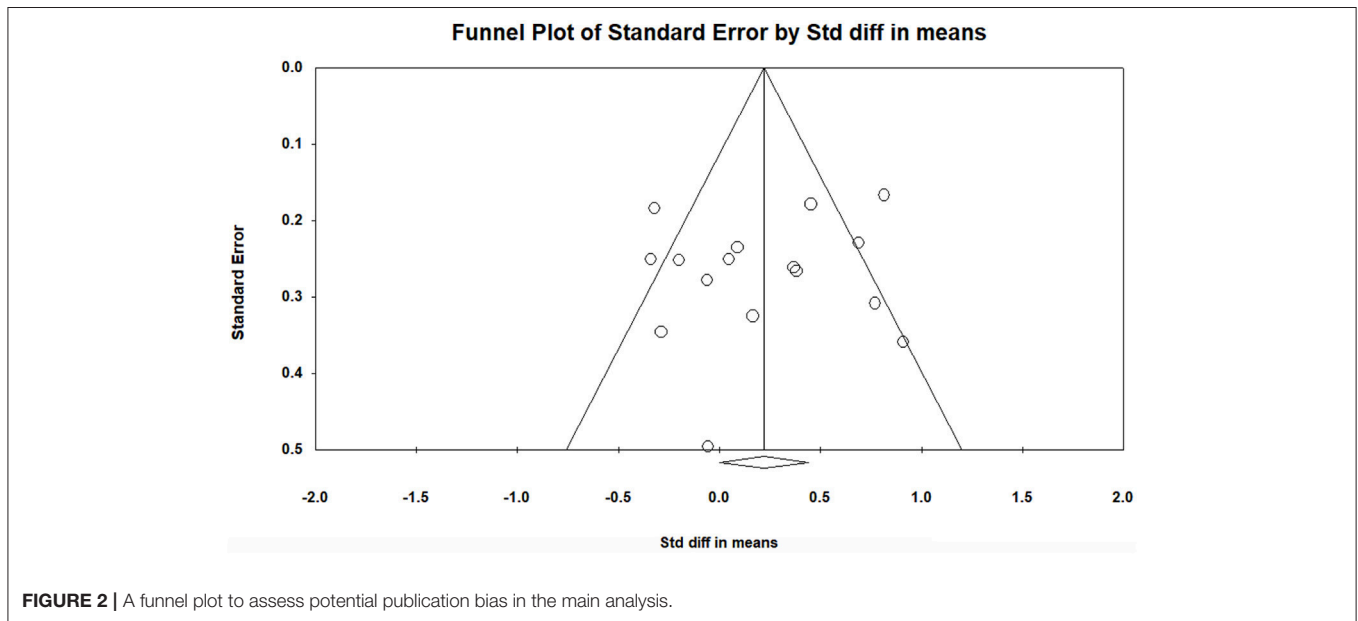
Secondary Analysis: Language Proficiency Adjusted Scores

The secondary meta-analysis was conducted on the 8 studies that reported Theory of Mind scores that were adjusted for bilingual-monolingual differences in language proficiency. This analysis indicated a medium-size bilingual advantage, Cohen's $d = 0.58, p < 0.001, z = 6.70, SE = 0.09, 95\%$ Confidence Interval = 0.41–0.75. See **Figure 3** for a plot of the effect sizes.

A funnel plot, which is displayed in **Figure 4**, was created to check for potential publication bias. There is no obvious asymmetry in the plot, implying no publication bias. Eggers regression intercept test also indicated no publication bias, as the test was not significant, $t_{(6)} = 0.17, p = 0.87$.

DISCUSSION

The main meta-analysis, which compared bilingual and monolingual children's raw Theory of Mind scores, revealed a small bilingual advantage. The size of this bilingual-monolingual



difference (i.e., a Cohen's d in the “small” range) is similar to the effect of early education interventions on cognitive, school, and social outcomes (Camilli et al., 2010). The secondary meta-analysis, which used transformed Theory of Mind scores that were adjusted for language proficiency, revealed a medium-size bilingual advantage. This secondary analysis, however, should be interpreted with caution, given that these studies may have violated assumptions of the Analysis of Covariance (Miller and Chapman, 2001; Paap et al., 2015). Even with skepticism for the secondary analysis, the main analysis provides evidence that acquiring two languages helps Theory of Mind development.

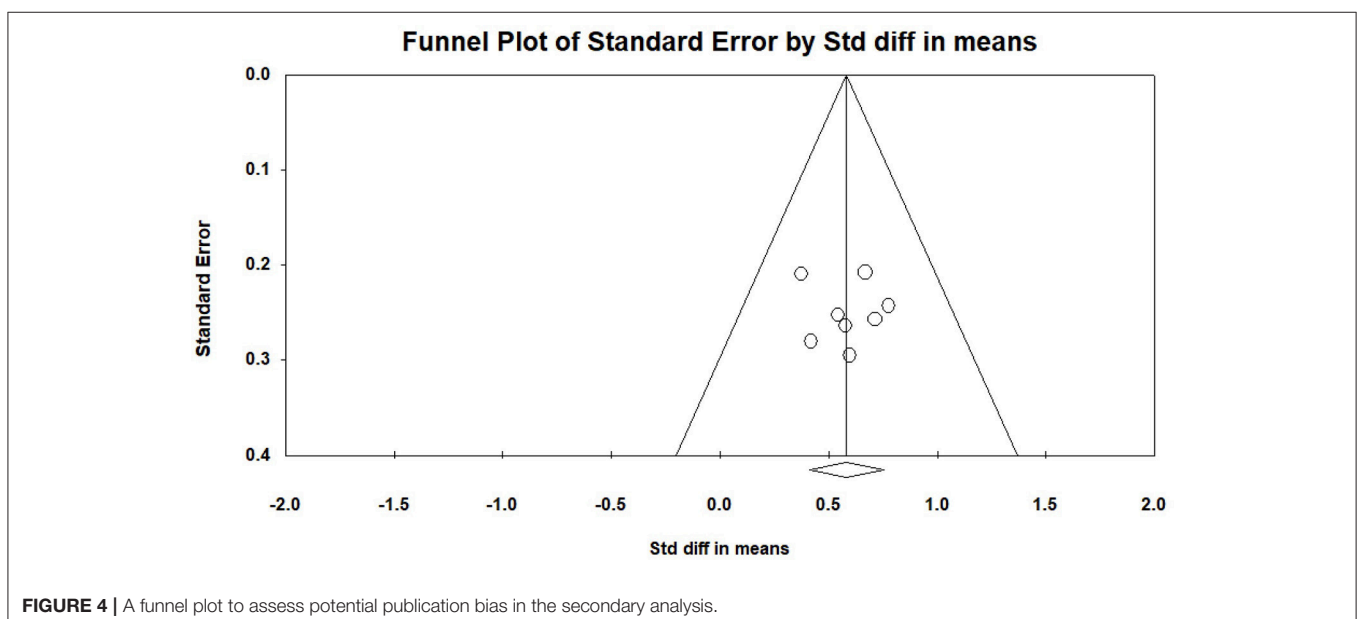
This meta-analytical finding of a bilingual advantage would have less validity if evidence for publication bias had been found. Indeed, in the high-profile meta-analysis by de Bruin et al. (2015), a bilingual advantage in executive functioning was revealed, but so was a publication bias. Using the same method as de Bruin et al. (i.e., the Eggers test), there was no evidence for publication bias in either the main analysis or the secondary analysis.

While the current study indicates a bilingual advantage in Theory of Mind, it does not address the reasons why. In the Introduction, three accounts for why bilinguals might have an advantage in mental state reasoning were laid out—i.e., the “executive functioning” account, the “metalinguistic awareness” account, and the “socio-pragmatic” account. Though future research is needed to determine the relative contributions of these accounts and others, some of the studies included in this meta-analysis provide germane preliminary evidence. Regarding the “executive functioning” account, evidence for this account comes from the Kovács (2008) finding that a bilingual advantage emerges when the Theory of Mind test has high inhibitory demands but not when it has low inhibitory demands. However, evidence against this account comes from several other studies that have found that measures of executive

functioning (such as the dimensional change card sorting test) do not statistically mediate the bilingual advantage in Theory of Mind (Nguyen and Astington, 2014; Fan et al., 2015; Diaz and Farrar, 2017, 2018). Regarding the “metalinguistic awareness” account, Diaz and Farrar (2017) and Chan (2004) found that measures of metalinguistic awareness (such as symbol substitution, synonym judgment, and homonym selection) statistically mediate the bilingual advantage. Regarding the “socio-pragmatic” account, while there is no statistical mediation evidence, Fan et al. (2015) found a Theory of Mind advantage in children who were not bilingual but were exposed to a second language. The performance by these children suggests that Theory of Mind may be augmented by learning that one's linguistic knowledge can be different from that of other people.

Regardless of the source, this bilingual advantage is likely to have meaningful real-world consequences. On the one hand, an enhanced Theory of Mind may help in the development of prosocial behavior. For example, a recent meta-analysis of 20 studies revealed that children who scored higher on Theory of Mind tests were more popular among their peers (Slaughter et al., 2015). On the other hand, negative effects of an enhanced Theory of Mind are possible. For instance, a recent study found that Theory of Mind training led honest children to begin lying (Ding et al., 2015).

In sum, the current study took a meta-analytical approach to the question of whether learning two languages has a positive impact on mental state reasoning. The results indicated a small- or medium-size positive effect (depending on the analysis), an effect that may carry real-world implications for bilingual children's social competence. Though plausible accounts of this bilingual advantage have been put forward, future research is needed to determine more precisely why a dual-language environment is helpful for Theory of Mind development.



AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and approved it for publication.

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