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The association of imperative and declarative intentional communication with language in young children with autism spectrum disorder: A meta-analysis

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ABSTRACT

Background: Theoretically, specific pragmatic functions of intentional communication are differentially associated with language use in children with autism spectrum disorder (ASD). The primary purpose of this meta-analysis was to compare the relation of declarative and imperative intentional communication acts (ICAs), respectively, with language skills. We also examined five possible moderators of the separate associations and the difference in associations: metric used to quantify ICAs, expressive versus receptive language, longitudinal or concurrent correlations, within-study interobserver reliability of rating pragmatic function of ICAs, and risk for correlated measurement error.
Method: Included studies provided at least 1 zero-order correlation (concurrent or longitudinal) of language measures with declarative or imperative ICAs. Participants were children with ASD ($n = 727$), aged 8 years and younger.
Results: Twenty-three studies were included. Declarative ICAs were significantly associated with language (weighted mean $r = 0.42$; 95% CI [0.34, 0.50]). Imperative ICAs were not significantly associated with language. Moderator effects were not detected.
Conclusions: The association of declarative ICAs and language has implications for early treatment of ASD-related language deficits. Failure to find a significant association of imperative ICAs and language could have been due to low statistical power and/or publication bias; more research on imperative ICAs is needed.

Contents

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1. Introduction

For children with autism spectrum disorder (ASD), the development of at least some communicative speech (i.e., expressive language) by the age of 5 or 6 years has been shown to be associated with better outcomes in adulthood, as have receptive language skills in early childhood (Howlin, Mawhood, & Rutter, 2000; Magiati, Tay, & Howlin, 2014; Mawhood, Howlin, & Rutter, 2000). Many children with ASD do not learn these language skills without intervention; finding early correlates of later receptive and expressive language could identify potential causes of, and treatments for, language deficits in these children. One such correlate is intentional communication (Charman et al., 2005; Yoder, Watson, & Lambert, 2015).

Intentional communication, which includes the use of spoken and nonverbal behavior, can be challenging for individuals with ASD. Intentional communication consists of gestures, vocalizations (including words), or symbol use that are directed toward another person, as signified by posture, gaze shift, touch, or other observable action (Brady et al., 2012). Intentional communication acts (ICAs) can serve different pragmatic functions. The present meta-analysis focuses on two pragmatic functions of ICAs – imperative and declarative – and their potential links with receptive and expressive language in children with ASD. Reported concurrent and longitudinal associations of imperative and declarative ICAs with language in children with ASD who have clinically significant language impairments vary widely in the literature.

1.1. Defining imperative and declarative ICAs

Imperative ICAs are those whose pragmatic function is to make requests. This function is often referred to as *initiation of behavior regulation* or *initiating behavior requests* (IBR; Mundy et al., 2007; Mundy, Sigman, Ungerer, & Sherman, 1987). Imperative ICAs span a continuum from ordering to suggesting (Tomasello, Carpenter, & Liszkowski, 2007). From an applied behavior analytic perspective, imperative ICAs are a subset of mands; the behavior specifies its reinforcer (Skinner, 1957). Their behavioral function can be escape (i.e., removal of aversive stimuli) or tangible reinforcement (i.e., access to a preferred item or activity). The reinforcement for imperative ICAs is socially mediated because the reinforcer is inaccessible without the intervention of another person. However, the social component is not the reinforcer for the imperative ICA.

Declarative ICAs, on the other hand, specify social attention as the reinforcer. They serve to direct another person's attention, comment, share information, or share interest (i.e., initiation of joint attention [IJA]; Mundy et al., 1987; Tomasello et al., 2007). For example, a child may point toward an interesting object while laughing and shifting his or her gaze back and forth between the object to a person to share interest. From an applied behavior analytic perspective, declarative ICAs are related primarily to tacts (Skinner, 1957).

1.2. Theoretical rationale for predicted associations between ICAs and language

Imperative and declarative ICAs create opportunities for caregivers to add linguistic information to the child's ICA (i.e., linguistic mapping). Multiple studies have found significant associations between caregiver linguistic mapping and later language skills in children with ASD (Dimitrova, Özçaliskan, & Adamson, 2016; Haebig, McDuffie, & Ellis Weismer, 2013; McDuffie and Yoder, 2010; Perryman et al., 2013; Siller, Hutman, & Sigman, 2013; Siller & Sigman, 2002, 2008). Linguistic mapping after a child's imperative or declarative ICA could facilitate word learning by pairing spoken words with the referents (i.e., objects or events) of the child's preceding communication act (Kasari, Paparella, Freeman, & Jahromi, 2008; McDuffie & Yoder, 2010).

In addition, imperative and declarative ICAs typically require the child performing the ICA to coordinate his or her attention between the object or action being requested and the person from whom the child is requesting (Yoder & Lieberman, 2008). Children who demonstrate coordinated attention during ICAs of either function are hypothetically more likely to attend to and learn from adult speech (e.g., Baron-Cohen, Baldwin, & Crowson, 1997), supporting receptive and expressive language growth.

Theoretically, frequent use of imperative ICAs promotes language skills because children who use nonverbal imperative ICAs frequently are motivated to learn to use spoken language to meet their wants and needs efficiently. The frequent use of declarative ICAs promotes language skills, in theory, because they indicate to caregivers that the child is generally interested in communicating with others about the surrounding environment beyond meeting wants and needs. Theoretically, showing this interest in activities and object spectacles elicits frequent communicative exchanges in which caregivers provide rich linguistic input about the child's current focus of attention over multiple turns. These exchanges give the child many opportunities to process linguistic input about the same referents while in an optimal engagement state for processing linguistic input, thus promoting language learning (Bottema-Beutel, Yoder, Hochman, & Watson, 2014; Mundy & Neal, 2001).

1.3. Rationale for Comparing the Strength of Association Between Imperative and Declarative ICAs with Language

Because both imperative and declarative ICAs should relate to later language in theory, the theoretical basis for predicting which function is more related to later language is far from clear. For example, considering the core deficits in ASD, language learning via declarative ICAs could occur infrequently for children with ASD because their very restricted interests limit the stimuli of interest on which to comment (American Psychiatric Association, 2013; Yoder & Lieberman, 2008). Empirically, research has suggested that children with ASD produce significantly fewer declarative ICAs than typically developing children (Dawson et al., 2004; Özçalışkan, Adamson, & Dimitrova, 2016) and children with non-ASD developmental delay or language impairment (Stone, Ousley, Yoder, Hogan, & Hepburn, 1997; Wong & Kasari, 2012). Additionally, evidence suggests that children with ASD have less motivation to communicate for purely social rewards (Mundy & Neal, 2001; Mundy, 1995). Therefore, it is possible that an association between declarative ICAs and language skills is difficult to detect in groups of children with ASD who do not speak frequently due to low variance in their use of declarative ICAs. However, many studies have shown a statistically significant association between declarative ICAs and language, indicating that there *is* sufficient variance in declarative ICAs for the association to be detected. Of course, the same limitation applies to detection of an association of imperative ICAs and language: sufficient variance in imperative ICAs must be present. Few question whether there is sufficient variance in imperative ICAs to detect an association with language.

Declarative ICAs could have a stronger association with language than imperative ICAs because a child's generalized tendency to use declarative ICAs (i.e., frequent sharing of interest across stimuli, settings, and people, as well as over time) signals to caregivers that the child is eager to interact socially in communication about diverse referents. As previously mentioned, this generalized behavioral tendency could prompt caregivers to provide frequent linguistic input about the child's foci of attention and referents of communication. A child's frequent use of imperative ICAs, on the other hand, does not indicate the child's interest in sharing of objects and events in the world, but rather the child's interest in accessing a reinforcer. Theoretically, the more instrumental nature of interactions with a child who uses many imperative ICAs does not motivate the same quality or quantity of interaction as does the more social nature of interactions with a child who uses many declarative ICAs.

Because no prior systematic reviews or meta-analyses are available on this topic, the strength of the association between imperative and declarative ICAs with language in the population of children with ASD is unknown. Single studies only provide point estimates for the effect size of the associations of interest. With this meta-analysis, we seek to improve population estimates for the effect sizes for the associations of both pragmatic functions of intentional communication with receptive and expressive language. Although the associations suggested here are primarily longitudinal, this meta-analysis includes concurrent and longitudinal correlational studies to maximize the number of relevant effect sizes included, thereby maximizing the precision of the estimates for the population effect sizes of the associations of interest. Improving the estimates of the magnitude of these associations will improve grounds for selecting the relative emphasis placed on the two pragmatic functions in early intervention for children with ASD.

1.4. Rationale for moderator analyses

We tested five study characteristics that hypothetically affect the effect sizes of interest. First, we hypothesized a priori that the metric used to quantify communication acts moderates correlations between language and ICAs. These metrics include frequency (e.g., number of ICAs with an imperative or declarative function), proportion (e.g., number of ICAs with an imperative or declarative function divided by number of opportunities for that type of ICA), and scale (e.g., expert rating scale of a participant's use of imperative or declarative ICAs). When the assumptions necessary for the use of proportion metrics (i.e., a positive linear relation between the numerator and denominator of the proportion) are not met, measurement error is higher than that for frequency metrics (Cohen, Cohen, West, & Aiken, 2003; Yoder & Symons, 2010). Rating scales do not provide precise estimates of the occurrence of a given behavior due to restricted range, leading to a lack of sensitivity to individual differences (Yoder & Symons, 2010). For example, on a rating scale of 0–2, a child who produced two declarative ICAs could receive the same rating as a child who produced 20 declarative ICAs. An inability to differentiate such widely varied skills obscures (a) correlations that would be detected with a more sensitive measure and (b) changes within participants over time. Thus, we predicted that the difference between the association of declarative ICAs with language and the association of imperative ICAs with language would be greater for correlations using frequency metrics compared with proportion or rating scale metrics were used due to the measurement error associated with proportions and rating scales.

Second, following our initial analyses, we hypothesized that the presence of risk for correlated measurement error differentially affected the associations of language with imperative and declarative ICAs. The risk of correlated measurement error, in this case, is associated with measuring declarative or imperative ICAs in the same procedure as the language measure or using parent report for both measures. Systematically more correlated measurement error in measuring the association between one pragmatic function and language than when measuring the association between the other pragmatic function and language would increase the likelihood of Type I error (Yoder & Symons, 2010). Thus, risk for correlated measurement error is one possible alternative explanation for differing weighted mean associations between imperative and declarative ICAs with language.

Third, we predicted that research design (i.e., longitudinal versus concurrent correlations) moderated the difference in the respective relations of imperative and declarative ICAs with language. Longitudinal research designs provide more information about potential causation than concurrent ones do because the former meets the assumption of temporal precedence of the putative cause relative to the putative effect, while the latter does not. On one hand, concurrent associations tend to be stronger than longitudinal correlations because the interval between ICA and language measures in the longitudinal correlational design allows more time for multiple influences on language measures than does the concurrent correlational design. On the other hand, long intervals between ICA and language measures might be necessary to detect the effect that the ICAs have on language.

Fourth, we hypothesized that different levels of interobserver reliability (an important quality indicator) across declarative and imperative ICAs could contribute to differences in associations of each with language. Low reliability tends to attenuate associations. Thus, we investigated the potential moderation effect of systematically lower interobserver reliability of one pragmatic function than the other on the difference between the associations of language with declarative versus imperative ICAs.

Finally, our initial analyses led us to hypothesize that declarative ICAs differentially predict receptive versus expressive language skills because the two language modalities require different skills. Theoretically, children who use many declarative ICAs acquire relatively large receptive vocabularies because of their interest in the world and its labels and by eliciting linguistic responses to their attentional and communicative leads. However, these children may not necessarily use these words expressively due to delays in consonant production (McCleery, Tully, Slevc, & Schreibman, 2006), limitations in oral motor skills (Gernsbacher, Sauer, Geye, Schweigert, & Hill Goldsmith, 2008), and other physical or neurological issues that inhibit spoken language production.

2. Methods

2.1. Eligibility criteria

To be included in the present meta-analysis, studies were required to meet each of the following criteria:

a) Study was written in English. Resources for translation were not available for this meta-analysis.
b) Study contained at least one report on a zero-order correlation of imperative or declarative ICAs with receptive and/or expressive language outcomes.
c) The correlation in (b) was reported for a group of five or more participants diagnosed with ASD. Studies with fewer than five participants would not have the power to detect even a very strong correlation.
d) Participants in (c) had a mean age less than or equal to 96 months (an age frequently used as the maximum for early childhood in education fields; e.g., National Association for the Education of Young Children, n.d.).

Additionally, studies were excluded if they met any of the following criteria:

a) Participants were described as having high-functioning autism or Asperger syndrome. In studies conducted using diagnostic criteria from the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev), the label of Asperger syndrome signified that overall language acquisition was typical (American Psychiatric Association, 2000). The term *high-functioning autism* is often used to refer to the same diagnosis as Asperger syndrome (Autism Speaks, n.d.). Participants with diagnoses of Asperger syndrome and/or high-functioning autism were excluded because they were unlikely to exhibit the same deficits in language skills as children with ASD who were not categorized in this way.
b) Correlations were only reported for post-treatment outcomes.
c) The study design was qualitative or single-case.
d) Participants were grouped such that participants with ASD were only described as part of a larger group, mixed with participants who do not have ASD. Studies of high-risk siblings of children with ASD, assuming those siblings who develop ASD themselves were not analyzed as a separate group, met this exclusion criterion.

e) Correlations were not reported for separate pragmatic functions of communication acts (e.g., imperative and declarative ICAs were only reported in combination, or declarative ICAs were only reported in combination with response to joint attention).

2.2. Search strategies and sources of information

An iterative process was implemented to develop a set of search terms to locate the relevant studies. Terms were related to study designs, participant populations, and study variables (i.e., measures of language and at least one of the two pragmatic functions of ICAs). In early iterations of database searches, several terms that identified studies as being irrelevant to the present research questions were added to the final search terms as exclusion terms. Specific search terms are listed in the Appendix. Searches were further restricted to return documents written in English. Dates were not restricted in the initial database searches, which were completed between October 6 and October 13, 2015. Updated search results on October 6, 2016 were restricted to publication dates after August 2015. The following databases were searched: PsycINFO, PsycARTICLES, PubMed, ProQuest Education, ProQuest Social Sciences, ProQuest Psychology, ProQuest Dissertations and Theses Global, Dissertations and Theses at Vanderbilt, Language and Linguistics Behavior Abstracts, and Communication and Mass Media.

Additional methods used to locate studies included review of the reference lists of included studies and related literature syntheses, forward searches of citations to included studies using Google Scholar, internet searches, and contact with experts. In addition, all articles from the past year that were available online for six journals (*Autism*, *Journal of Autism and Developmental Disorders*, *Exceptional Children*, *Developmental Psychology*, *Research in Autism Spectrum Disorders*, and *Journal of Speech, Language, and Hearing Research*) were hand searched to identify recent studies that had not yet reached databases. The initial hand search was completed on November 23, 2015; the same procedures were followed for the search update on

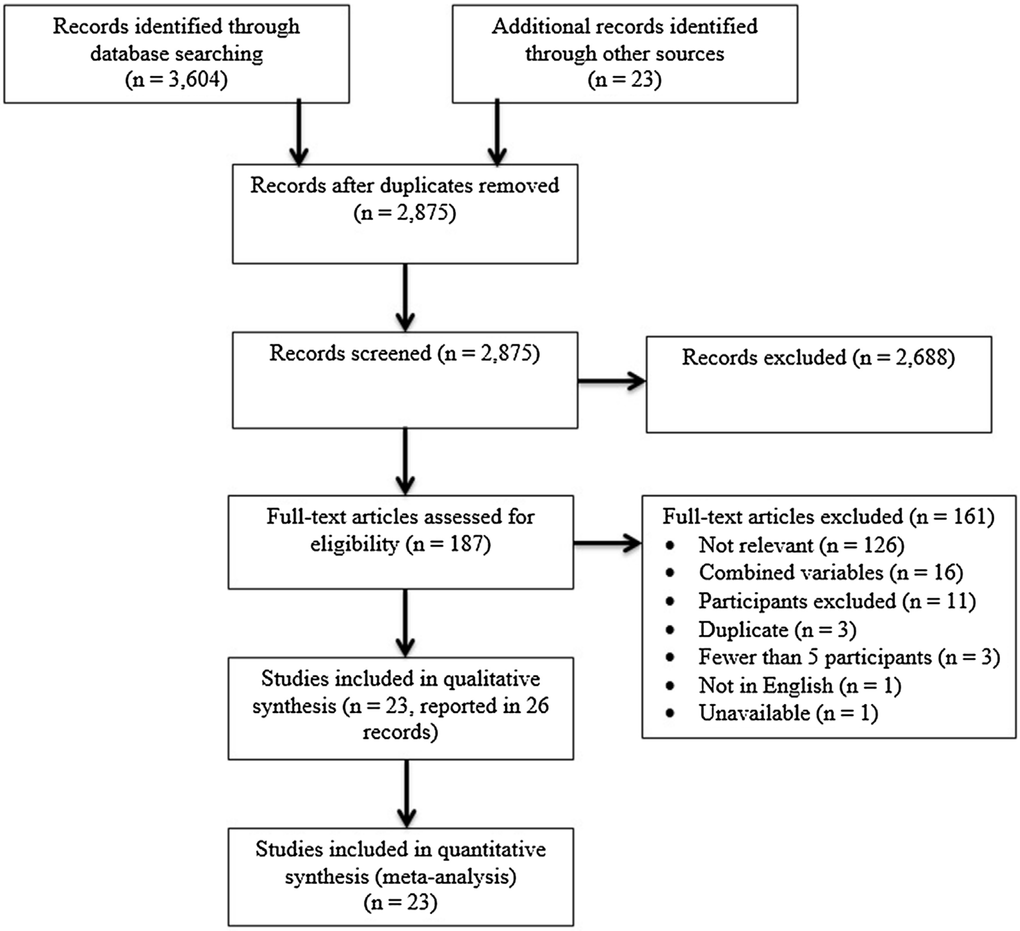

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart.

October 6, 2016. Dissertations, theses, books, book chapters, conference proceedings, and monographs were reviewed as possible sources of grey literature.

2.3. Study selection

The first author conducted abstract screening for all studies, and full-text eligibility screening for all studies that passed abstract screening. The second author independently screened 20% of documents at the abstract and full-text eligibility levels. Documents checked for reliability were selected using a random number generator. The first author coded the 23 included studies; the second author independently coded 22% of them ($n = 5$). Point-by-point agreement (i.e., agreements

Table 1
Characteristics of Studies Included in the Meta-Analysis.

Reference	Participants		Number of effect sizes		Average effect size		Metric(s)	Measures	
	Average age	N	Dec	Imp	Dec	Imp		Language	Dec and/or imp ICAs
Bono et al. (2004)	46.7	29	1	0	0.48	–	Frequency	Multiple across participants	ESCS
Carpenter et al. (2002)	48.8	12	1	1	−0.52*	−0.26*	Frequency	Other	Other
‡Charman (2003)	20.6	18	4	0	0.53	–	Proportion	Reynell	Other
Dawson et al. (2004)	43.5	72	8	0	0.46^	–	Frequency and scale	Vineland, MSEL	ESCS, ADOS-G
Delinicolas and Young (2007)	47.5	56	2	0	0.56	–	Frequency	PPVT-III, LDS	ESCS-Abridged
‡Drew et al. (2007)	20.7	23	4	4	0.59	0.02	Proportion	Reynell, MCDI	SCATA
‡Gillespie-Lynch et al. (2015)	12.2	10	4	0	0.19**	–	Frequency	CELF-4	ESCS
Hurwitz and Watson (2015)	44.8	20	1	0	0.46	–	Proportion	PLS-4	JAP
Maljaars et al. (2011)	85.2	26	2	2	0.71	−0.70	Proportion	Schlichting, Reynell (Dutch)	modified CSBS
‡McDuffie (2004); McDuffie et al. (2005)	32.4	29	4	4	0.55	0.36	Frequency	MCDI	STAT
Mundy et al. (1987)	54.5	16	2	2	0.56**	0.59**	Scale	Reynell	ESCS
‡Mundy et al. (1990)	44.9	15	2	0	0.58	–	Frequency	Reynell	ESCS
Murray (2001); Murray et al. (2008)	57.6	20	3	0	0.33*	–	Scale	MSEL, other	Other
‡Özçalışkan et al. (2016)	31	23	1	1	0.74	0.56	Frequency	CPP	EVT
‡Perryman et al. (2013)	21	37	2	0	0.18	–	Frequency	MSEL	ESCS-Abridged
Pickard and Ingersoll (2015)	44.8	53	9	0	0.25	–	Frequency	MCDI, multiple across participants	ESCS
Schietecatte et al. (2012)	36.8	23	6	0	0.06	–	Proportion	Reynell (Dutch)	adapted ESCS
Sigman and Ruskin (1999)	45	54	1	1	0.51	0.18	Frequency	Multiple across participants	ESCS
‡Siller (2006); Siller and Sigman (2008)	45.2	28	4	0	0.52	–	Frequency	Multiple across participants	ESCS
Smith (2011)	49.7	19	1	0	0.15	–	Frequency	MCDI	ESCS
‡Stone and Yoder (2001)	30.9	35	2	0	0.32	–	Frequency	Composite: MCDI, SICD-R, PLS-3	PIA
‡Toth et al. (2006)	43.6	60	3	3	0.52	0.23	Frequency	MSEL	ESCS
Van der Paelt et al. (2014)	39.2	51	4	4	0.32	0.23	Frequency	Reynell (Dutch)	ESCS

Note: Average age is reported in months. N = number of participants. Dec = declarative. Imp = imperative. ICAs = intentional communication acts. ESCS (-Abridged) = Early Social Communication Scales (Mundy et al., 2003). Other = measure described but not named. Reynell = Reynell Developmental Language Scales (Reynell, 1985). Vineland = Vineland Adaptive Behavior Scales (Sparrow, Cicchetti, & Balla, 2005). MSEL = Mullen Scales of Early Learning (Mullen, 1995). ADOS-G = Autism Diagnostic Observation Schedule—Generic (Lord, Rutter, Goode, & Heemsbergen, 1989). PPVT-III = Peabody Picture Vocabulary Test—Third Edition (Dunn & Dunn, 1997). LDS = Language Development Survey (Achenbach & Rescorla, 2000). MCDI = MacArthur Communicative Development Inventory (Fenson et al., 1993). SCATA = Social Communication Assessment for Toddlers with Autism (Drew et al., 2007). CELF–4 = Clinical Evaluation of Language Fundamentals-4 (Semel, Wiig, & Second, 2003). PLS-3 and -4 = Preschool Language Scale, 3rd or 4th Edition (Zimmerman, Steiner, & Pond, 1991; Zimmerman, Steiner, & Pond, 2002). JAP = Joint Attention Protocol (Watson, Baranek, & Poston, 2003). Schlichting = Schlichting Test for Language Production (Schlichting, Van Eldik, Spelberg, Van der Meulen, & Van der Meulen, 1995) CSBS = Communication and Symbolic Behavior Scales (Wetherby & Prizant, 2002). STAT = Screening Tool for Autism in Two-Year-Olds (Stone, Coonrod, & Ousley, 2000). CPP = Communication Play Protocol (Adamson, Bakeman, Deckner, & Romski, 2009). EVT = Expressive Vocabulary Test (Williams, 1997). SICD-R = Sequenced Inventory of Communication Development – Revised (Hedrick, Prather, & Tobin, 1984). PIA = Parent Interview for Autism (Stone & Hogan, 1993).
This table includes only effect sizes and, in the case of longitudinal studies, time periods included in the present meta-analysis. When studies included multiple participant groups, only the number of participants in the ASD group is reported here. For longitudinal studies, this table includes: (a) when attrition was reported, the highest number of participants, and (b) the youngest reported average age of participants. Studies with two citations are dissertations that were later published as journal articles.
Effect sizes are reported as Pearson's r unless otherwise noted. * denotes effect sizes reported as Spearman's rho. ** denotes effect sizes reported as tau in primary studies, converted here to Pearson's r. – denotes study did not report any effect sizes for imperative ICAs.
^ = When the Autism Diagnostic Observation Schedule was used as the measure of ICAs, the sign has been changed to reflect higher scores being associated with increased use of ICAs (rather than higher scores reflecting more impairment), in line with other assessments.
‡ = This study provided at least one longitudinal effect size.

divided by agreements plus disagreements, multiplied by 100) was calculated for all three screening types. Aside from passing inclusion and exclusion criteria, studies were not omitted based on quality.

2.4. Variables and summary measures

Data extracted from the primary studies included (a) the measures used to estimate language and intentional communication abilities of participants, (b) whether ICAs were imperative or declarative, (c) the number of participants, used to calculate the variance and standard error and in the equation to calculate Fisher's *z*, (d) the value of the correlation coefficient, which was converted to Fisher's *z* as described in the next paragraph, (e) the metric used to quantify ICAs, (f) the presence or absence of risk for correlated measurement error caused by using the same procedure to estimate language and pragmatic function of ICAs, (g) whether correlations were concurrent or longitudinal, and (h) reported reliability or agreement statistics and the metric in which those data were reported.

2.5. Correlation coefficients

We used Fisher's *z*-transformed correlations to compute effect sizes because it adjusts for the effect that number of participants can have on a Pearson product moment correlation (Borenstein, Hedges, Higgins, & Rothstein, 2009). Correlations reported in Kendall's tau ($n = 2$) were converted to Fisher's *z* using the equation detailed by Walker (2003). Correlations reported as either Pearson's *r* or Spearman's rho were converted to Fisher's *z* using an online tool from the Campbell Collaboration (Wilson, n.d.). Weighted mean correlation coefficients and their confidence intervals were converted from Fisher's *z* to Pearson's *r* using the formula provided by Borenstein et al. (2009).

2.6. Analytic strategies

All statistical processing was performed in Stata 14.1. Robust variance estimation using weights from a random-effects model was used to synthesize the quantitative data. We used robust variance estimation to address statistical dependence caused by correlated effect sizes because many studies provided multiple effect sizes on the same outcomes and participants (Hedges, Tipton, & Johnson, 2010; Tanner-Smith & Tipton, 2014).

Potential moderators were assessed using meta-regression with robust variance estimates. Heterogeneity was assessed using visual inspection of Galbraith plots and analysis of τ^2. Galbraith plots are scatterplots that provide a visualization of meta-analytic results, wherein precision of individual estimates increases as distance from the origin increases, and vertical scatter of data points indicates the degree of heterogeneity (Anzures-Cabrera & Higgins, 2010). τ^2 is an estimate of the amount of true variance (i.e., variance not attributable to error) between studies, which can sometimes be explained by moderators (Borenstein et al., 2009). We assessed the possibility of publication bias using three tests applied separately to imperative and declarative ICAs: a modified Egger meta-regression test and two types of funnel plots. We also conducted two sensitivity analyses to determine whether the final results of the meta-analysis changed due to (a) inclusion of correlations reported using tau and Spearman's rho or (b) varying values of assumed rho (the intraclass correlation coefficient that indicates the degree to which effect sizes are dependent) in the robust variance estimation (Borenstein et al., 2009).

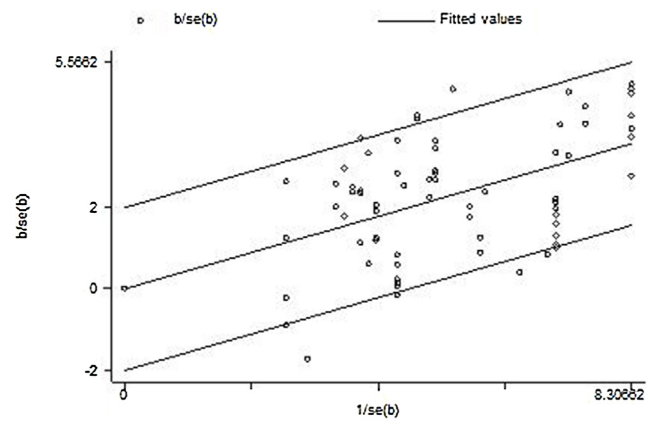

Fig. 2. Galbraith plot for correlations of declarative intentional communication acts and language outcomes.

3. Results

3.1. Study selection and characteristics

Database searches yielded 3604 documents, and 23 additional documents were identified through other sources. After elimination of duplicates and abstract screening, 188 documents remained; 187 were retrieved and screened for eligibility using the full text. The remaining document was not available online, in print, or via interlibrary loan services. See Fig. 1 for Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram, including reasons for exclusion at the full text screening level. Twenty-three studies were located that met inclusion criteria. Table 1 displays characteristics of included studies. These studies included 727 participants, ranging from 12 to 89 months old, and 93 relevant correlations (22 imperative, 71 declarative; 33 longitudinal, 60 concurrent). For longitudinal effect sizes, the time elapsed between measurements ranged from 4 to 77 months. The studies spanned the past 30 years (i.e., 1987 through 2016) and included one monograph, four dissertations (three of which were also published as journal articles), and 18 additional published articles. When a journal article was based on a dissertation, we analyzed both documents together as a single study, rather than discarding either document or duplicating effect sizes in analyses. Interobserver agreement of study selection was 88.2% for the title and abstract screening level and 100% for the full text screening level. Agreement at the study coding level was 95.4%. Where needed, the first and second authors discussed study coding decisions to reach consensus. Consensus decisions were used in analyses.

3.2. Synthesis of results

The weighted mean effect size for the correlation of declarative ICAs and language was moderate and significant ($r = 0.42$; 95% CI [0.34, 0.50]). Because the confidence interval did not include zero, we rejected the null hypothesis that declarative ICAs and language were unassociated in this population. In contrast, the weighted mean effect size for the relation between imperative ICAs and language was not significant ($r = 0.18$; 95% CI [−0.20, 0.58]). We failed to reject the null hypothesis that imperative ICAs were unassociated with language in young children with ASD. The low number of included studies (nine) influenced the large confidence interval for the weighted mean association of imperative ICAs and language; more studies would be needed to attain a narrower confidence interval (see Tanner-Smith & Tipton, 2014, for more information on confidence intervals and robust variance estimation). Because the confidence intervals overlap, it is unlikely the relative strength of the two weighted mean effect sizes significantly differ. Indeed, meta-regression did not indicate a statistically significant difference in the means ($p > 0.1$).

3.3. Heterogeneity

For declarative ICAs, the variance of true effects was trivial ($\tau^2 = 0.02$). The Galbraith plot for declarative ICAs (Fig. 2) showed little heterogeneity. Only eight of 71 effect sizes fell outside the confidence bounds. See Anzures-Cabrera and Higgins (2010) for details of interpreting Galbraith plots. For imperative ICAs, variance of true effects was larger ($\tau^2 = 0.14$) than that of declarative ICAs. The Galbraith plot for imperative ICAs (Fig. 3) showed some between-study variability. Six of 22 effect sizes fell outside the confidence bands.

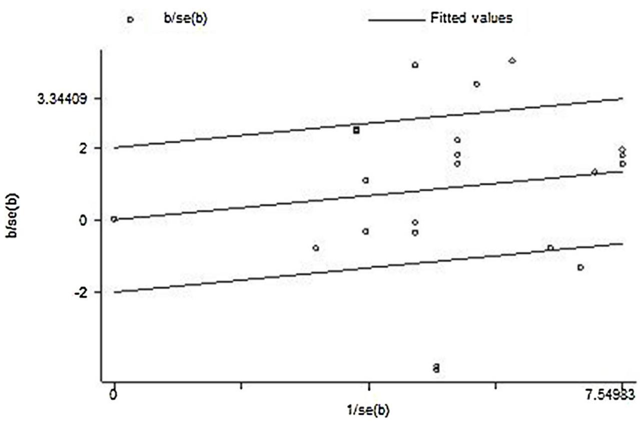

Fig. 3. Galbraith plot for correlations of imperative intentional communication acts and language outcomes.

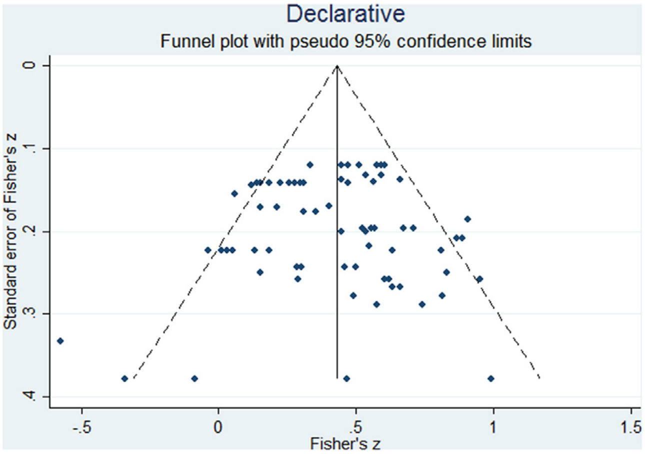

Fig. 4. Funnel plot for correlations of declarative intentional communication acts and language outcomes.

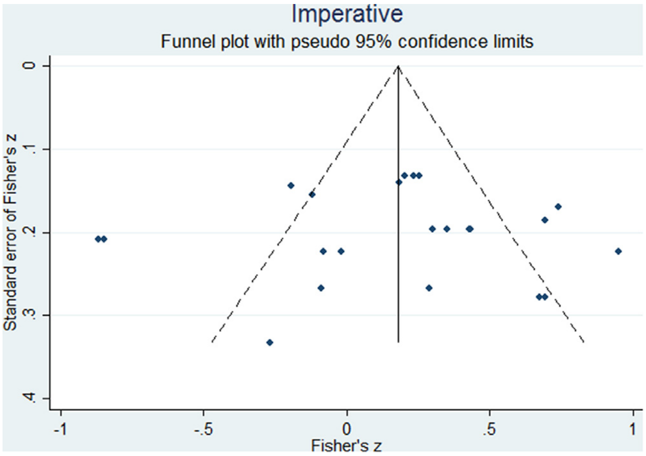

Fig. 5. Funnel plot for correlations of imperative intentional communication acts and language outcomes.

3.4. Additional analyses

3.4.1. Moderators

There was little true between-study variability (i.e., trivial τ^2) to be explained by moderator effects within declarative ICAs, and the number of studies examining imperative ICAs was not sufficient for reliable moderator analyses. Accordingly, we found no evidence that metric, interobserver reliability, risk of correlated measurement error, research design (i.e., longitudinal versus concurrent correlations), or language modality (i.e., expressive versus receptive language) moderated associations of language with imperative ICAs, associations of language with declarative ICAs, or the difference in associations (all $ps > 0.1$).

3.5. Publication bias

No evidence of publication bias was found for declarative ICAs; the funnel plot (Fig. 4) was highly symmetrical. The mildly asymmetric funnel plot for imperative ICAs (Fig. 5) could signal publication bias. Modified Egger tests, using meta-regression with robust variance estimation to predict effect sizes from their standard errors, did not provide evidence of small-study bias for either pragmatic function (both $ps > 0.3$).

We noted an item of interest that could have driven publication bias suggested for imperative ICAs. The included studies most commonly measured declarative ICAs with the Early Social Communication Scales (ESCS; Mundy et al., 2003). Typically, the ESCS quantifies communication acts for IBR and for IJA (i.e., imperative and declarative ICAs, respectively). For ten included studies, the authors used the ESCS and reported on the link between IJA and language, but not between IBR and language. We had three speculations as to why this could have occurred: (a) Researchers modified the ESCS protocol and purposefully did not collect data on IBR. One included report explicitly stated this decision (Delinicolas & Young, 2007). (b) Researchers collected IBR data but did not hypothesize a link between imperative ICAs and language and thus did not calculate the correlation between the two. (c) Researchers collected IBR data, found a nonsignificant correlation between imperative ICAs and language, and opted not to report it. This third possibility presents the risk of outcome reporting bias, which is in alignment with the asymmetric funnel plot suggesting possible publication bias for associations of imperative ICAs and language. This bias risk is especially problematic given the overall difficulty in finding a sufficient number of correlations between imperative ICAs and language.

3.6. Sensitivity analyses

Sensitivity analyses demonstrated that varying values of assumed rho for robust variance estimation did not have any substantial impact on results, nor did inclusion or exclusion of studies using tau or Spearman's rho to report the correlation coefficient.

4. Discussion

The findings of the current meta-analysis supported the association of declarative ICAs and language skills in young children with ASD. The findings did not support an association of imperative ICAs and language for children with ASD. This lack of a statistically significant association between imperative ICAs and language could have been caused by low statistical power of the meta-analysis; only nine studies reported data on this correlation. Additionally, the low number of reported correlations of language with imperative ICAs reduced the power for testing the relative strengths of the association between language and imperative ICAs versus declarative ICAs. Consequently, we cannot draw conclusions about this comparison with confidence.

The identified correlation between declarative ICAs and language in children with ASD across many studies lends support to the hypothesis that the two are causally linked, if only indirectly. Replicated findings indicate that children with ASD use declarative ICAs at a lower rate than children with non-ASD developmental delay, language impairment, or typical development (Özçalışkan et al., 2016; Dawson et al., 2004; Stone et al., 1997). The moderate, positive weighted mean correlation between declarative ICAs and language suggested that children with ASD who do use at least some declarative ICAs have, or will learn, better language skills than those who use fewer or no declarative ICAs. A possible mediator of this association is caregiver verbal responses to child leads (i.e., linguistic input), which children who demonstrate a generalized tendency to use declarative ICAs could elicit at high rates. Theoretically, verbal responses to child communicative and attentional leads facilitate receptive vocabulary because the caregivers' words match or are related to the child's communication or focus of attention. The receptive vocabulary then forms the semantic basis for expressive word use.

For all tested moderators, the low between-study variability of correlations between language and declarative ICAs, the low number of studies reporting on associations between imperative ICAs and language, and the lack of a statistically significant difference in their weighted means reduced the likelihood of detecting an effect. The most parsimonious explanation for the lack of positive findings on all five moderators was low statistical power. Thus, continued investigation is warranted. Next, we elaborate on the rationale for continued testing of each moderator effect.

We did not find evidence that the metric used to quantify imperative and declarative ICAs affected the magnitude of the associations of interest. Although it is possible that the metric used to quantify imperative and declarative ICAs did not affect their associations with language, this was unlikely due to the irrelevance of the potentially increased measurement error often associated with proportion and scale metrics. A more parsimonious explanation is that the low number of studies reporting on the association of imperative ICAs with language in general, and the low number of studies using the proportion metric or expert rating scales to measure either pragmatic function, resulted in insufficient power to detect effects that might be present in the population.

Similarly, only two studies showed risk for correlated measurement error, and overall, studies showed high interobserver reliability. Although these positive indicators of study quality increase confidence in the meta-analytic results, it remains unknown whether correlated measurement error affected findings of those studies. It appears unlikely that differential reliability of the ICA coding resulted in differences, albeit nonsignificant, in the strength of mean association between ICA function and language.

Moderation by research design (i.e., longitudinal vs. concurrent correlations) was not found. It is possible that differences in the strength of association between ICAs and language as a function of design would only be detected if longitudinal designs were for longer intervals between ICAs and language. That is, compared to the literature reviewed here, more studies with longer periods of time between measurement of declarative and imperative ICAs and language would be required to detect differential associations of language across concurrent and longitudinal effect sizes.

Moderation by language modality (i.e., receptive or expressive language) of the association of declarative ICAs and language was not detected. Low statistical power could account for this null finding. The theories suggesting that ICAs are related to language implicitly suggest that the link with receptive language is stronger than that with expressive language because expressive language requires the added demands of speech production.

4.1. Limitations

Three limitations of this meta-analysis should be acknowledged. First, the research design of the studies analyzed (i.e., correlational) did not permit causal inferences about the relation between language and pragmatic functions of ICAs. One or more unknown and uncontrolled variables could have affected both language skills and declarative or imperative ICAs. For example, mental age likely has a common association with declarative ICA use and language development.

Second, as in any systematic review or meta-analysis, there was a risk of failing to include all relevant studies. We minimized the potential for unfound studies due to inadequate search terms or incomplete indexing of articles by using multiple search strategies. Including only studies written in English presented a risk of language bias, which is a form of publication bias, and is problematic because studies with statistically significant results are oversampled (Borenstein et al., 2009; Egger et al., 1997). In addition, our search terms could have excluded relevant studies with mixed methods (e.g., a longitudinal correlational study with qualitative components where the word *qualitative* was in the title or abstract).

Third, we did not exclude studies based on quality. Instead, we included as many relevant studies as we could locate and examined associations between several aspects of study rigor and the strength of correlation between ICA type and language (e.g., within-study reliability, design, correlated measurement error). In no case did these aspects of study quality covary with the strength of key associations. As is usually the case in literature syntheses, it could be that other quality-related issues changed our estimates of the weighted mean correlations in some way. For example, poor psychometrics of language measures could have attenuated associations.

4.2. Treatment implications

Because results indicated that declarative ICAs were significantly associated with language and the mean association between imperative ICAs and language was low, it is tempting to conclude that treatment to promote language for young children with ASD should emphasize teaching the production of declarative ICAs. This approach contrasts with popular treatment approaches that primarily teach requesting skills. However, given the overlapping confidence intervals of the associations of language and imperative or declarative ICAs, and the lack of statistical significance of the difference in their mean associations, it would be premature to call for a greater focus on teaching declarative ICAs over imperative ICAs based on the meta-analytic findings alone. However, the findings do support including declarative ICAs as a treatment goal, echoing numerous studies on the topic (for a review, see White et al., 2011).

A strong case can be made that a generalized tendency to use declarative ICAs reflects a tendency toward using behavior that is reinforced by attention. This generalized tendency could support language learning (Yoder & Lieberman, 2008). However, teaching a child to perform behaviors that *appear* to be declarative ICAs (but do not necessarily reflect actual interest or positive affect) might not have the desired effect on language learning, because it does not necessarily lead to enhancing the degree to which social attention is reinforcing, nor the child's breadth of interest in the world. This lack of generalization can be seen in the lack of generalized frequent use of even the taught declarative behavior across multiple contexts, or the reversal of taught declarative behaviors when the treatment is withdrawn. For example, if a child is taught to point toward an object while smiling and gaze shifting, but this set of behaviors is reinforced with the object rather than social attention (Meindl & Cannella-Malone, 2011), then one would not expect the potentially special effect of declarative ICAs on future language learning. As pointed out by Yoder and Lieberman (2008), directly teaching the frequent use of true declarative ICAs (i.e., declarative ICAs that are child-initiated, not an immediate imitation, and motivated by attention rather than by tangible reinforcers) and promoting generalization of this skill over time and across settings, communication partners, and stimuli might prove to be a difficult task. Yet, we have very strong evidence that treatment can facilitate highly generalized use of declarative ICAs in children with ASD (Kasari, Freeman, & Paparella, 2006). Initial strategies for teaching declarative ICAs might include expanding the diversity of play and object interest, pairing tangible and social reinforcement, and adult modeling of declarative ICAs (Warren et al., 2006; Yoder & Lieberman, 2008).

Expanding diversity of play and object interest might promote use of declarative ICAs by giving the child a greater number of interesting items and events about which to comment (Yoder & Lieberman, 2008). Several approaches have been used successfully to promote diverse play skills in children with ASD. Briefly, these include video modeling (D'Ateno, Mangiapanello, & Taylor, 2003; Dauphin, Kinney, & Stromer, 2004; Lydon, Healy, & Leader, 2011), pivotal response training (Lydon et al., 2011; Stahmer, 1995; Vismara & Lyons, 2007), matrix training (Dauphin et al., 2004), integrated play groups (Wolfberg & Schuler, 1993), social stories (Barry & Burlew, 2004), and milieu-based interventions (Kasari et al., 2006, 2008).

Pairing tangible and social reinforcement might work to increase declarative ICAs by increasing the value of attention as a reinforcer. For example, when a child shares his or her excitement about an active wind-up toy and, consequently, an adult smiles, exclaims with a positive voice tone, and winds up the toy again, an association between the repeated toy activation and positive affect from adult might be established. That child might learn that the adult's positive voice tone and smiles are pleasant through their frequent pairing with items and events of interest over time (Yoder & Lieberman, 2008).

By modeling declarative ICAs, an adult provides examples for both the form (i.e., words and gestures that are effective in drawing another person's attention to an item or event of interest) and the function of sharing interest. Such demonstration is done in the context of turn-taking routines that involve an interesting effect (e.g., block tower falling over). Treatment packages that increased joint attention skills (e.g., Kasari et al., 2006) have included modeling of declarative ICAs (Kaale, Smith, & Sponheim, 2012).

4.3. Research implications

More research is needed to ascertain whether language and imperative ICAs might be related in this population, whether other participant characteristics moderate the putative link, and whether it is stronger or weaker than the association of declarative ICAs with language. Investigation of predictors of declarative ICAs and mechanisms that might be driving the sizable association of declarative ICAs and language, such as caregiver linguistic input, could provide additional insight into possible causes of communication deficits in ASD. Research on the contingency of caregiver linguistic input following child imperative and declarative ICAs could add information on the mechanism behind their relative potential contributions to language, as well. A meta-analysis of the effects of teaching declarative ICAs would be appropriate, given sufficient primary studies on the topic. Direct comparison of measurements of ICAs using frequency, proportion, and rating scale metrics using the same data might clarify the impact of metric choice.

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Appendix A.

Search Terms

In title or abstract: a disability term (autism, autistic, ASD, “pervasive developmental disorder,” or “PDD-NOS”).

AND in title or abstract: a variable term (language, languages, linguistic, speech, spoken, vocabulary, vocabularies, productive, production, expressive, expression, receptive, or reception).

AND in full text: a variable term (imperative, imperatives, demand, demands, demanding, demanded, request, requests, requesting, requested, “behavior regulation,” “behavioral regulation,” “regulate behavior,” “regulates behavior,” “regulated behavior,” “behavior regulating,” protoimperative, protoimperatives, protest, protesting, protests, IBR, IJA, “affect sharing,” “share affect,” “shared affect,” attention, protodeclarative, protodeclaratives, declare, declarative, declaratives, declares, comment, comments, commenting, commented, joint attention, tangible, tangibles, escape, escaping, mand, manding, manded).

NOT in title or abstract: excluded study design terms (“single subject,” “single case,” “multiple baseline,” “alternating treatments,” “multi-element,” “A-B-A-B,” or qualitative).

NOT in title: terms indicative of an irrelevant study (Alzheimer, atomoxetine, avian, bullying, calcium, cerebellar, cerebrum, coronary, cortex, “Dandy-Walker,” divalproex, epigenetic, fluoxetine, hydrogen, mammal, mammalian, mice, mouse, nonhuman, Parkinson, paroxetine, pharmacotherapy, pollutant, pollution, protein, rhesus monkey, rhesus monkeys, risperidone, Rorschach, sodium, suicidal, suicide, suicides, or zebra).

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