



Review article

A meta-analysis of the association between vocalizations and expressive language in children with autism spectrum disorder

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ABSTRACT

Background: Targeting the frequency or complexity of prelinguistic vocalizations might improve the language trajectory of children with autism spectrum disorder (ASD) who exhibit continued expressive language deficits.

Aims: This meta-analysis evaluates the strength of the association between various measures of vocalizations and expressive language in young children with ASD and five putative moderators of that association to inform prelinguistic intervention development: consonant-centricity, communicativeness, concurrent versus longitudinal research design, risk for correlated measurement error, and publication status.

Methods and procedures: We systematically searched databases and other sources for correlations between vocalizations and expressive language in children with ASD less than 9 years old. Using robust variance estimation, we calculated the weighted mean effect size and conducted moderator analyses.

Outcomes and results: Nine studies (19 reports), which included 362 participants and 109 unique effect sizes, met inclusion criteria. The weighted mean effect size between vocalizations and expressive language was significant ($r = 0.50$, 95% CI [0.23, 0.76]). As predicted, concurrent correlations were significantly stronger than longitudinal correlations. Other moderator effects were not detected.

Conclusions and implications: Young children with ASD demonstrate a strong association between vocalizations and expressive language skills. Future experimental studies should investigate causal relations to guide intervention development.

What this paper adds?

- This study is the first known meta-analysis on the association between vocalizations and expressive language in young children with autism spectrum disorder (ASD).
- Nine studies (19 reports), which included at least 362 participants and 109 unique effect sizes, met inclusion criteria.
- The results indicate a significant weighted mean effect size of $r = 0.50$, 95% CI [0.23, 0.76].
- The weighted mean effect size is particularly strong for concurrent correlations ($r = 0.77$, 95% CI [0.45, 1.0]).
- The findings provide support for investigating causal relations between prelinguistic vocalizations and expressive language in young children with ASD to inform language intervention, particularly at the early stages of language development.

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1. Introduction

Many children with autism spectrum disorder (ASD) continue to demonstrate language skills below those of their peers and a substantial portion do not obtain useful speech, which is defined as “expressive language that may be used frequently, communicatively, referentially, and in a semantically diverse manner” (Yoder, Watson, & Lambert, 2015, p. 1254). Addressing expressive language deficits is particularly important in light of the strong predictive relation between expressive language skills and social and adaptive outcomes for children with ASD (Billstedt, Gillberg, & Gillberg, 2005; Howlin, 2000). Researchers must continue to optimize expressive language interventions (e.g., Tager-Flusberg, Paul, & Lord, 2005). Early deficits in vocal development may dramatically influence spoken language development in children with ASD (e.g., Patten et al., 2014; Paul, Chawarska, Cicchetti, & Valkmar, 2008; Plumb & Wetherby, 2013). In this meta-analysis, we aim to synthesize the current literature on the association between vocalizations and expressive language in children with ASD to inform vocalization measurement and language interventions targeting prelinguistic vocalizations.

1.1. Continuity of babbling and spoken words in typical development

Infraphonological theory (Oller, 2000) offers a framework for vocal development, in which vocalizations become more speech-like across development. For example, early infant vocalizations exhibit limited speech-likeness but show capabilities necessary for speech (e.g., phonation). The speech-likeness of vocalizations becomes particularly prominent when canonical syllables emerge. The phonological similarities between infant vocalizations and early words, differentiated acoustic characteristics of babbling across languages, and correlations between early vocalizations and later language skills in children with typical development strongly suggest that early vocalizations are continuous with language development (McCune & Vihman, 2001; McGillion et al., 2017; Oller, 2000; Rvachew, Mattock, Polka, and Ménard, 2006; Vihman, 2017). These contemporary reports effectively counter prior theories positing discontinuity between babbling and spoken words (e.g., Jakobson, 1968). Vocalization frequency and consonant use in prelinguistic vocalizations predict later expressive language in children with typical development (Camp, Burgess, Morgan, & Zerbe, 1987; Stoel-Gammon, 1991; Watt, Wetherby, & Shumway, 2006). Intervening at the prelinguistic stage may alter a child’s trajectory for producing spoken words.

1.2. Areas of need in vocal development in children with ASD

Differences in the total frequency of vocalizations between children with and without ASD or those at high versus low risk for ASD have been mixed (Patten et al., 2014; Paul, Fuerst, Ramsay, Chawarska, & Klin, 2011; Sheinkopf, Mundy, Oller, & Steffens, 2000). Yet, replicated deficits in the use of canonical syllables and speech-like vocalizations have been shown (Patten et al., 2014; Paul et al., 2011; Plumb & Wetherby, 2013; Werner, Dawson, Munson, & Osterling, 2005). Children with or at high risk for ASD also present with less diverse vocalizations, including smaller consonant inventories, than children with typical development (Paul et al., 2008; Paul et al., 2011; Wetherby, Watt, Morgan, & Shumway, 2007). In addition, children with ASD are more likely to produce vocalizations without a communicative purpose compared with typically developing, same-age peers (Plumb & Wetherby, 2013; Shumway & Wetherby, 2009).

1.3. Defining and measuring vocalizations in children with ASD

Vocalization definitions vary across studies. Authors of studies may or may not distinguish between communicative versus noncommunicative vocalizations, non-word vocalizations versus spoken words, and distress signals (e.g., crying) versus non-distress signals. Various vocalization measures differ in emphasis on particular vocalization features (e.g., acoustic qualities, communicative function, and phonetic content) and collection methods (e.g., human coding or automated vocal analyses). The heterogeneity in vocalization definitions and measurement techniques may at least partially explain variations in associations between vocalizations and expressive language.

2. The current literature synthesis

Despite multiple reports of associations between vocalizations and expressive language in children with ASD, to our knowledge, no systematic reviews or meta-analyses have been completed on this association. The current meta-analysis was conducted to inform intervention by providing a more accurate population estimate of the association between vocalizations and expressive language for children with ASD than point estimates from single studies. Further, the meta-analytic approach permits consideration of factors that may explain differences in reported findings to inform (a) the measurement of vocalizations and (b) the development of language interventions targeting prelinguistic vocalizations.

2.1. Factors that may influence the association between vocalizations and expressive language

2.1.1. Consonant-centricity

Consonant-centric measures characterize vocalizations based on the presence of consonants (e.g., consonant inventory and proportion of vocalizations with a canonical syllable). Non-consonant-centric vocalization measures focus on vowels or do not

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