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A Systematic Review of Definitions of Nonverbal and Minimally Verbal in the
Autism Research Literature

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Running Head: DEFINITIONS OF NV AND MV IN ASD

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Research Literature**

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This review was completed in collaboration with Lynn Kern Koegel, PhD, Pumpki Lei Su, PhD, Mohini Vaidya, and Stephen Camarata, PhD. Thus, this thesis was based on and informed by the collaborative project, which also resulted in publications (Koegel et al., 2019, 2020a, 2020b).

Abstract

This systematic review evaluated definitions of “nonverbal” or “minimally verbal” in intervention studies that focused on improving expressive verbal communication in children with autism spectrum disorder (ASD). We reviewed sample size, number of participants, participant age, participant sex, and assessment measures used to determine communication ability. Our review yielded relatively few studies focusing on verbal expressive communication with nonverbal or minimally verbal children with ASD. Further, we found large inconsistencies in definitions of “nonverbal” and “minimally verbal” and measures used to assess verbal communication ability. Guidelines are suggested to in order to standardize terminology and allow for aggregation of research data that can inform best practice for interventions tailored to this population. Suggestions include creating a more uniform assessment protocol with systematic descriptions of early communication learners, as this is a foundational step for understanding the heterogeneity in nonverbal and minimally verbal children with ASD and replicating research findings for this subgroup.

Keywords: autism spectrum disorder, intervention, minimally verbal, nonverbal, review

Introduction

The past three decades have seen a remarkable boom in the research literature focusing on individuals with autism spectrum disorder (ASD). The number of papers published with the term “autism” has recently increased by approximately 24-fold (Pubmed index) (Chakrabarti, 2017); however, the bulk of these publications have focused on the autism phenotype with few support needs, variously described as “high functioning,” “HFA,” “Asperger’s Disorder,” or “mild autism.” Only about 11% of studies have targeted the most comprehensively impacted individuals with ASD, such as those who are nonverbal or minimally verbal (Jack & Pelfrey, 2017). This gap in knowledge regarding the communication, outcomes, development, and prognosis of nonverbal or minimally verbal children has been highlighted in the Interagency Autism Coordinating Committee (IACC) strategic plan, which called for additional research focusing on this underserved subgroup (IACC, 2017).

Current estimates suggest that up to one third of children with ASD are either minimally verbal or completely nonverbal, yet this population is studied less frequently. Nonverbal and minimally verbal phenotypes together make up approximately one quarter to one third of the total population of individuals diagnosed with ASD (National Research Council, 2001; Rose et al., 2016; Tager-Flusberg & Kasari, 2013). Despite the high prevalence of nonverbal and minimally verbal individuals with ASD, this subgroup remains largely understudied in the research literature. For example, when examining 367 studies published between 1991 and 2013, Stedman and colleagues (2019) found a 16.5% average annual decrease in the likelihood of including “severely affected” participants from 1990 to 2013. Further, only 29% of the studies reported any communication measure whatsoever. Additionally, providing reliable and valid

assessments of the developmental functioning of children with ASD proves extremely difficult, which limits these individuals' inclusion in research studies (Tager-Flusberg & Kasari, 2013).

The dearth of research evidence is especially problematic given that nonverbal and minimally verbal individuals with ASD arguably have the phenotypes with the greatest support needs. Language delay is the most common reason for initial diagnostic consultation by parents (De Giacomo & Fombonne, 1998), and the failure to develop expressive verbal communication is one of the most concerning symptoms of ASD, as it can interfere with development in many areas, including academic, behavior, socialization, and later employment (Franchini et al., 2018). Language skills are important factors for childhood development; Szatmari and colleagues determined language to be the single best predictor for behavioral, communicative, and socialization outcomes in children with ASD (2003). Additionally, measures of verbal expression in toddlers with ASD are strongly correlated with subsequent outcomes, as assessed by developmental and ASD symptom measures (Franchini et al., 2018). In other words, individuals with lower verbal skills will likely demonstrate more pronounced deficits across other skill domains. Research suggests that verbal functioning in children is more malleable than other skill sets, such as those comprising social or nonverbal interaction, so communication-based intervention strategies may be the most effective in improving long-term outcomes for individuals with ASD (Kim et al., 2016).

However, inconsistency in definitions of “nonverbal” and “minimally verbal” in the research literature poses challenges when analyzing even the limited research base on interventions for nonverbal or minimally verbal children with ASD. Intervention outcomes may vary depending on how “nonverbal” and “minimally verbal” are defined in these studies (e.g., numerical criteria, sounds vs. words), making these definitions important constructs to measure

accurately and precisely. For instance, young children with even a single consistent, verbal word experience better outcomes than those with none (Tager-Flusberg & Kasari, 2013). Similarly, children who are able to imitate and exhibit other appropriate attentional behaviors are likely to have better communicative outcomes (Koegel et al., 2009).

All of these issues translate into challenges in providing clinical services, counseling families, understanding long-term outcomes, and other issues regarding evidence-based assessment and implementation. Because ASD encompasses broad symptomology, as well as severity of symptoms, there is crucial to better understand how researchers have addressed assessment of individuals with ASD who have the most significant deficits in communication.

Therefore, the purpose of this study is to identify how intervention studies over the past nearly 60 years have defined, described, and measured “nonverbal” and “minimally verbal” in regard to individuals with ASD through a systematic review of the research literature. We aim to aggregate this information in the hopes of identifying and organizing key parameters that will increase systematicity in approaches to identifying language abilities in studies focused on this population of individuals with ASD.

Method

This study was part of a collaboration with Lynn Koegel, PhD (LK), Stephen Camarata, PhD (SC), Pumpki Su, PhD (PS), and Mohini Vaidya (MV). The following methods were used to classify and review the studies of NV and MV children with ASD, as shown in Figure 1.

Design

This review involved a systematic analysis of studies that focused on intervention applied with participants with ASD who were identified as nonverbal or minimally verbal. A systematic search of articles was performed first. These articles were screened by title and abstract prior to

full articles review. Independent reliability was gathered for title, abstract, and article level screening and for data gleaned from the articles that appear in the summary table (Table 1).

Search Procedures

A systematic search procedure was used to identify studies for inclusion in this review. First, a literature search was performed with Vanderbilt University's ProQuest through Mendeley reference manager and citation generator (<https://www.mendeley.com/reference-management/reference-manager>) using the key words "autism," "autistic," "Asperger," "autisms," or "ASD" AND "minimally verbal," "minimally fluent," "preverbal," "pre-verbal," "nonverbal," or "non-verbal" "mute" AND "vocabulary," "words," "communication," "language," or "lexical." The publication span entered was 1960 to 2018. Articles were extrapolated from 83 data bases, including ProQuest Central, PsychInfo, and PsychArticles, and imported into Mendeley reference manager. This search yielded a total of 2,007 results, which were then alphabetized by article title. Duplicates were removed, yielding a total of 1,231 articles.

Screening Measures

Title Screening. First, the titles were independently read and screened by LK and SC, who were most senior and most familiar with the research, in order to capture studies that targeted minimally or nonverbal children or described their participants as minimally or nonverbal in the title. LK served as the primary coder and SC served as the reliability coder. The following inclusion criteria were used:

1. Titles that included "minimally verbal" children with ASD
2. Titles that included "nonverbal" children with ASD
3. Treatment/intervention articles targeting initial verbal communication skills

Reliability for the title screening of the 1,231 articles was 90%. Articles from the title screening that were included by only one or by both coders were included for the abstract review. The title search of the 1,231 studies yielded 237 articles meeting the inclusion/exclusion criteria.

Abstract Screening. Following the title search, abstracts from the 237 articles were screened using the additional following specific inclusion and exclusion criteria:

(a) Intervention. Articles that did not provide an intervention that targeted verbal expressive communication (e.g., receptive communication exclusively, reading, vision, pointing) or used AAC or sign language that was not a component of an intervention designed to target verbal expressive communication skills were excluded;

(b) Diagnosis. To be included, participants were required to have been diagnosed with ASD and identified by the authors as minimally verbal, nonverbal, or another description indicating early word production (e.g., “first words”) as their verbal developmental level. While we did review studies with “Asperger” and the general ASD literature, we excluded studies whose participants were more advanced than early or first words, such as highly verbal participants (e.g., “High Functioning Autism”, PDD-NOS wherein verbal skills were advanced or relatively unimpaired, or Asperger Disorder), or those with advanced verbal communication goals (e.g., verbal conversation skills or complex language structures);

(c) Measurement. Included studies involved verbal behavior (e.g., words, word attempts, or sounds) as a dependent variable. Studies that involved nonverbal modes of communication (e.g., augmentative or sign language) wherein verbal words were not measured were excluded;

(d) Design. Commentaries, book reviews, reviews of the literature, errata, or uncontrolled case studies (e.g., $n = 1$) were excluded. Studies that involved systematic, experimentally controlled

intervention were included. Randomized controlled trials, quasi-experimental designs, and single-case designs with at least two participants were examples of included study designs; (e) Language. Studies conducted in a spoken language other than English were excluded due to the authors' inexperience with the other languages appearing in the topic search.

LK and SC screened the first 50 abstracts with 96% reliability. To assess reliability, KB and PS also screened the first 50 abstracts. Their reliability with the primary coder (LK) was 87%. This served as a training, as the 13% of articles that were not reliable with the primary coder were discussed as to the reasons they should be included or excluded in regard to the stated guidelines. Next, half of the remaining 187 abstracts (237-50) were screened by LK and MV and the remainder were screened by KB (primary coder) and PS (reliability coder). Thus, reliability was completed for all 237 articles. The overall reliability from the abstract screening was 89%. Abstracts that were identified by only one author were included, as not to miss any articles. The abstract search yielded 67 articles meeting the inclusion/exclusion criteria to be reviewed.

Article Review and Data Evaluation

Articles were then divided equally among LK, KB, PS, and SC, who served as the primary coders.

Inclusion Criteria: The 67 intervention articles were read in full and 31 were determined to meet the inclusion criteria used in the abstract screenings, and were therefore included in this review. These articles were examined in detail.

MV, who was blinded to the coding from the other authors, assessed for reliability. Of the 67 articles, 19 articles (28%) were reviewed for reliability purposes relating to inclusion/exclusion along with the information extracted from each article. Two articles were excluded after discussion by LK and SC during the analysis (one was conducted in a language

other than English, and the other targeted advanced nonverbal social behaviors in individuals with Asperger Disorder). During our reading of the articles, two additional articles were located and included in the analysis. Thus, reliability on inclusion/exclusion was 89%.

Data Evaluation: The 31 included studies were summarized in regard to (a) participant age; (b) sample size; (c) participant sex; (d) nonverbal or minimally verbal; and (e) measure used to assess verbal ability.

Reliability regarding sample size differed on one article (the study cited a different number of participants in the abstract and text). Thus, reliability on the number of participants was 95%. One inconsistency was found in the age of participants, thus reliability on that measure was 95%. Additionally, one inconsistency was found on the number of male vs female participants, also resulting in 95% reliability. Reliability as to whether participants were described as nonverbal or minimally verbal was 84%, primarily due to differences in the descriptions of the participants. Reliability on the assessment measures used was 100%, although amount of detail included by coders varied. If any discrepancies in reliability occurred, SC and LK read and discussed the articles to decide on the information that would be included in Table 1. Following the creation of the summary table of the articles, each coder re-checked the articles that they coded for accuracy.

Results

Across the 31 studies included in this systematic review, there were 647 unique participants. Four studies encompassed the same participants (Almirall et al. 2016; DiStefano et al., 2016; Kasari et al., 2014; Shire et al., 2018), so only participants from the largest study were included in subsequent analysis to prevent overrepresenting those participants.

Participant Characteristics

Among the 27 studies that explicitly reported sex of participants or from which sex could be deduced from participant descriptions, 78% of participants were male and 22% were female. This ratio is consistent with the reported four times as many boys as girls diagnosed with ASD (Loomes, 2017).

Participants in the studies ranged in age from 1;4 to 23;0. The majority (54%) of participants were preschool-aged (under 5;0), while 46% were elementary school-aged (5;0-12;11). Only 0.8% of participants were in the secondary school age group (13;0 or older). Eight studies were comprised exclusively of preschool-aged children. Of these, two studies included only nonverbal participants, two studies included both nonverbal and minimally verbal participants, and four studies did not clearly specify whether the children were minimally verbal or nonverbal. Thus, only two studies in the literature with a total of six participants focused exclusively on nonverbal children under five years of age (Drash et al., 1999; Koegel et al., 2009). Eleven studies exclusively included elementary school-aged participants, which included a total of 48 participants identified as nonverbal. Ten studies included a combination of preschool and elementary school-aged children for a total of 224 participants, in which 59 participants across six studies were nonverbal. Two additional studies (Miller & Miller, 1973; Tardif et al., 2017) encompassed a heterogeneous group of 21 total participants with a wide age range (5-23 years old) and included 19 nonverbal participants.

Assessment Measures

Assessment measures used to determine whether the children were verbal or nonverbal differed across studies (Fig. 2). Five of the 31 studies (16%) assessed participants during natural language interactions, either as the sole measure or in conjunction with other measures. Three studies (10%) included behavioral observations, four studies (13%) included informal parent

reports, eight studies (26%) included standardized parent measures (e.g., Vineland Adaptive Behavior Scales [VABS] or MacArthur-Bates Communicative Development Inventories [CDI]), two studies included teacher reports, and one study included an unspecified parent questionnaire. Fifteen studies (48%) did not clearly indicate how verbal or nonverbal characterization was determined. Of those, four studies (13%) reported whether participants were nonverbal using the Autism Diagnostic Observation Scale (ADOS); however, it was unclear how the ADOS was utilized to determine whether a participant was nonverbal or minimally verbal since this is not its intended use. Table 2 lists the various assessment measures in the reviewed literature.

Studies also included the following assessment measures, though not to characterize participants as nonverbal or minimally verbal. One study that included minimally verbal participants and another that included nonverbal participants used the Kaufman Speech Praxis Test. Two studies included expressive vocabulary tests and three studies included receptive vocabulary tests. The remainder of the studies reported measures that were not used by other studies reviewed, including the Autism Diagnostic Interview (ADI-R), picture-based assessments, phoneme repetition tests, language tests (Receptive Emergent Language Test-3 [REEL-3], Preschool Language Scale [PLS], Test of Language Development, and Sequenced Inventory of Communication Development), or the Communication and Symbolic Behavior Scales (CSBS-DP). Five of the 31 studies included a verbal or nonverbal IQ test or a more general test of functioning that were not language specific. In regard to cognitive functioning, three studies gave the Mullen Scales of Early Learning (MSEL), one study gave the Psychoeducational Profile-Revised (PEP-R), and one the Leiter Test of Nonverbal Intelligence (Leiter-R).

Descriptions of Participant Communication Skills

The authors' descriptions of nonverbal and minimally verbal varied considerably among the studies included in this review. Of the 31 studies, 15 (48%) reportedly included exclusively nonverbal participants only, seven (23%) included exclusively minimally verbal participants, two (6%) included a combination of nonverbal and minimally verbal participants, and seven (23%) did not characterize participants with these terms. Many articles contained ambiguous, imprecise, or otherwise unclear with regard to the participants' communication levels. Only 19 studies (61%) stated criteria for classifying participants as nonverbal or minimally verbal, and these criteria were inconsistent. For instance, some criteria were quantitative (e.g., "1-10 words"; Schreibman & Stahmer, 2014) while others had qualitative criteria (e.g., "functional", "intelligible") either exclusively or in combination with quantitative criteria (Chenausky et al., 2016; Koegel, Vernon, & Koegel, 2009).

Criterion specificity also varied. Multiple studies defined the criterion for "nonverbal" as fewer than 20 spontaneous novel words in a 20-minute language sample (e.g., Almirall et al., 2016), and other studies identified participants as nonverbal, but did not indicate how this characterization was determined (e.g., Sandiford et al., 2013).

Discussion

In this study, we aimed to elucidate current definitions of "nonverbal" and "minimally verbal" in interventional research studies for children with ASD in order to assess the degree of consensus on these essential terms within the research literature. Despite the high priority for developing effective treatments for this population (e.g., Interagency Council on Autism, 2017), this systematic review resulted in only 31 intervention studies that focused on teaching expressive verbal communication to minimally verbal or nonverbal individuals with ASD. In particular, very few studies have focused on nonverbal individuals with ASD. For instance, only

two identified studies focused exclusively on teaching verbal communication to nonverbal preschool children—with an aggregate of only six children participating—over more than five decades.

Additionally, among the 19 studies (61%) that stated criteria for classifying participants as nonverbal or minimally verbal, the authors' definitions varied greatly. With regards to “nonverbal,” Harris and colleagues (1983) defined criterion as no words, Rogers and colleagues (2006) cited that “inclusion criteria were...spontaneous use of less than five functional words per day according to parent report as well as clinician observation,” and Gordon and colleagues (2011) stated that nonverbal participants “use[d] little or no functional language (i.e. no more than single words)”. From these definitions, we can see how qualitative cutoffs, elicitation procedures, interpretations of “functional”, and participants' abilities to combine words all affect whether or not a child with ASD is considered nonverbal. Another complication was that definitions occasionally contradicted each other within a single study. For instance, one study reported that parents had heard words, but the children had no functional language (Drash et al., 1999); thus, it was difficult to determine the actual verbal level of the participants.

Definitions of “minimally verbal” were equally, if not more, variable. Almirall and colleagues (2016) used the detailed criterion “fewer than 20 spontaneous novel words in a 20-min natural language sample” while Harris and colleagues (1983) defined minimally verbal as “speech was limited to a few words” and Schreibman and Stahmer (2014) used the criterion of “any words [used] communicatively.” Based on these definitions, children who (a) used no words, (b) imitated words, (c) used 50 novel, single words, or (d) used two-word combinations with communicative intent would all be classified differently. Also of note, the ambiguous word “few” could refer to either the number of unique, individual words or the length of utterance

(Harris et al., 1983). In addition to the previously stated inconsistencies, “minimally verbal” was sometimes used as a blanket term that also included nonverbal participants.

Further, inconsistency in assessment measures meant that the participants had different opportunities to demonstrate their verbal ability. A 20-minute language sample from a child could result in a different record of verbal productions than a parent report (based on months or years of informal data collection) of that same child’s verbal productions. The vast majority of the studies in this review did not collect communication samples or behavioral assessments in the participants’ natural settings, despite this being common practice for assessing nonverbal children in the field of speech-language pathology (Campbell et al., 2003). Tager-Flusberg and Kasari (2013) discussed important areas of assessment for this population that would strengthen understandings of children’s progress in communication abilities; these areas included speech sound development, the relationship between expressive language and intelligence quotient scores, oral-motor skills, imitation, and social withdrawal. Inclusion of systematic measures of these domains, in addition to verbal skills, would benefit studies of this population by increasing comprehensiveness.

The broad range of definitions and assessment measures utilized in the literature may have a profound impact on key aspects of intervention and outcomes. For example, aggregating outcomes for children with one verbal word at the onset of intervention with those beginning with 50 or more verbal words under the phenotype “minimally verbal” may lead to inaccurate interpretations of intervention efficacy. Inconsistencies may also limit Level I evidence for interventions with this population by preventing aggregation. In fact, the diversity of participants in this study prevented us from conducting a meta-analysis on intervention outcomes. While studies of interventions for nonverbal and minimally verbal individuals are underrepresented in

the ASD literature, the existing studies show the potential of effective interventions at improving outcomes of verbal communication (Koegel et al., 2019). However, additional studies that use more specific and consistent participant descriptions are necessary to inform clinical decisions. Without specific guidelines and strategies in place, nonverbal and minimally verbal children with ASD may receive subpar interventions.

Based on our systematic review, we suggest including the following information in studies of communication for nonverbal and minimally verbal individuals with ASD:

- (a) Participant Descriptions. Participants should be clearly identified as nonverbal or minimally verbal using systematic assessment appropriate for this purpose. Credible estimates of word counts should be included for minimally verbal individuals and credible procedures identifying individuals as nonverbal should also be included in future studies.
- (b) Language Samples. Assessment should include a natural communication interaction (i.e., language sample; e.g., Almirall et al., 2016), optimally with both a familiar communication partner (e.g., caregiver) and a trained interactor (e.g., clinician). This may help capture greater quantity of verbal production with a caregiver as well as stimulated sound and word production with a clinician. Assessment should also include standard observational measures of verbal abilities, as standardized testing results can be difficult to obtain and may underestimate the abilities of children with ASD (Koegel et al., 1997).
- (c) Speech Assessments. Speech can include elicited production of phonemes, syllables, and word approximations, which may indicate a prognosis of greater word acquisition (e.g., Laski et al., 1988). Assessing sound imitation may be especially helpful for individuals with no expressive words, as children who can verbally imitate sounds may have better treatment outcomes (Gevarter & Horan, 2018). Speech assessments can also take the form of observational

checklists that denote speech sound ability (e.g., Chenausky et al., 2016). Research suggests that a thorough evaluation of children's phonetic repertoires may be helpful for prognosis and use in intervention (Tager-Flusberg et al., 2017). Therefore, a phoneme inventory is recommended.

(d) Standardized Vocabulary and Language Tests. Receptive and expressive vocabulary tests should be used if the child is minimally verbal. Standardized parent and teacher report instruments (e.g., CDI) should have strong validity and reliability because tests may pose challenges for children with ASD and suffer from decreased validity.

(e) Echolalia. Many participants who were reported to use no functional words were also reported to produce echolalic utterances (Lovaas et al., 1973; Tardif et al., 2017). Many of the studies we reviewed did not distinguish between echolalic and typical utterances, or they excluded echolalia (e.g., "functional" communication or words; Gordon et al., 2011; Koegel, Shirotova, & Koegel, 2009), thus making it difficult to capture the extent of the children's verbal communication. Therefore, the nature and extent of echolalia should be reported.

(f) Nonverbal Social Behavior. Nonverbal skills including joint attention, play, attentiveness, socially responsive behavior, and motor imitation have all been discussed as correlates of or precursors to the onset of first words. These skills are associated with favorable verbal communication outcomes (Jones, 2009), so clearer understanding of nonverbal social behaviors may help explain acquisition of communicative skills such as verbalizing.

(g) Age. Age is a critical when considering nonverbal and minimally verbal phenotypes. "Nonverbal" status is typical of infants, but is a clinical marker by two years of age, and is evidence of a severe disability by three years of age. Therefore, intervention studies should include age designations—such as "infants" up to 12 months, "toddlers" aged 1-3 years, "preschoolers" aged 3-5 years, "school-age" from 5-12 years, and "adolescent/adult" over 12

years of age— in the title and abstract. Some of the studies reviewed used such broad age ranges that limited our ability to assess which interventions were appropriate for various age groups.

Specific age designations should lessen this problem.

(h) Estimates of Cognitive Ability. Cognitive tests are beneficial in that they give an indication of a child’s general functioning level (e.g., Ozonoff & Cathcart, 1998), which can be helpful for post hoc analyses of intervention effects in nonverbal and minimally verbal individuals with ASD and for aggregating subgroups (Lancaster & Camarata, 2019).

(i) Caregiver and/or Teacher report. Caregiver and teacher report can greatly supplement other assessments, especially considering standardized testing’s underestimation of abilities in individuals with ASD (Koegel et al., 1997). Many formal parent report measures (e.g., ADI, Behavioral Intervention Rating Scale [BIRS]) are valid and reliable. Reports by individuals not trained in language development should ideally be combined with other standardized and observational measures.

Including as many of the above components, which are summarized in Table 3, as possible will increase systematicity in future studies of intervention for nonverbal and minimally children with ASD. Greater systematicity will enable aggregation of data across studies and more accurate interpretation of intervention effects, which will help advance the evidence base.

Limitations and Future Research

It is possible that some studies were missed in this analysis due to the key words used. For instance, the term “complex communication needs” was not included in the key word search. The breadth of the article catchment was intended to reduce the number of studies missed. Additionally, studies with controlled (e.g., ABAB) single-case designs were missed as we only reviewed studies with replications across at least two participants. Another limitation is that we

did not review studies in which AAC was exclusively used as an intervention for nonverbal and minimally verbal individuals, as the goal of this study was to examine exclusively verbal interventions in ASD.

In conclusion, a standardized and more comprehensive set of participant descriptions and assessment measures is important for addressing the communication abilities and needs of the nonverbal and minimally verbal individuals with ASD going forward. Future research is warranted to determine best practices for supporting individuals with ASD in acquiring words.

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*Indicates studies that were included in the systematic analysis

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Figure 1

PRISMA flow diagram of the systematic review process (Moher et al., 2009)

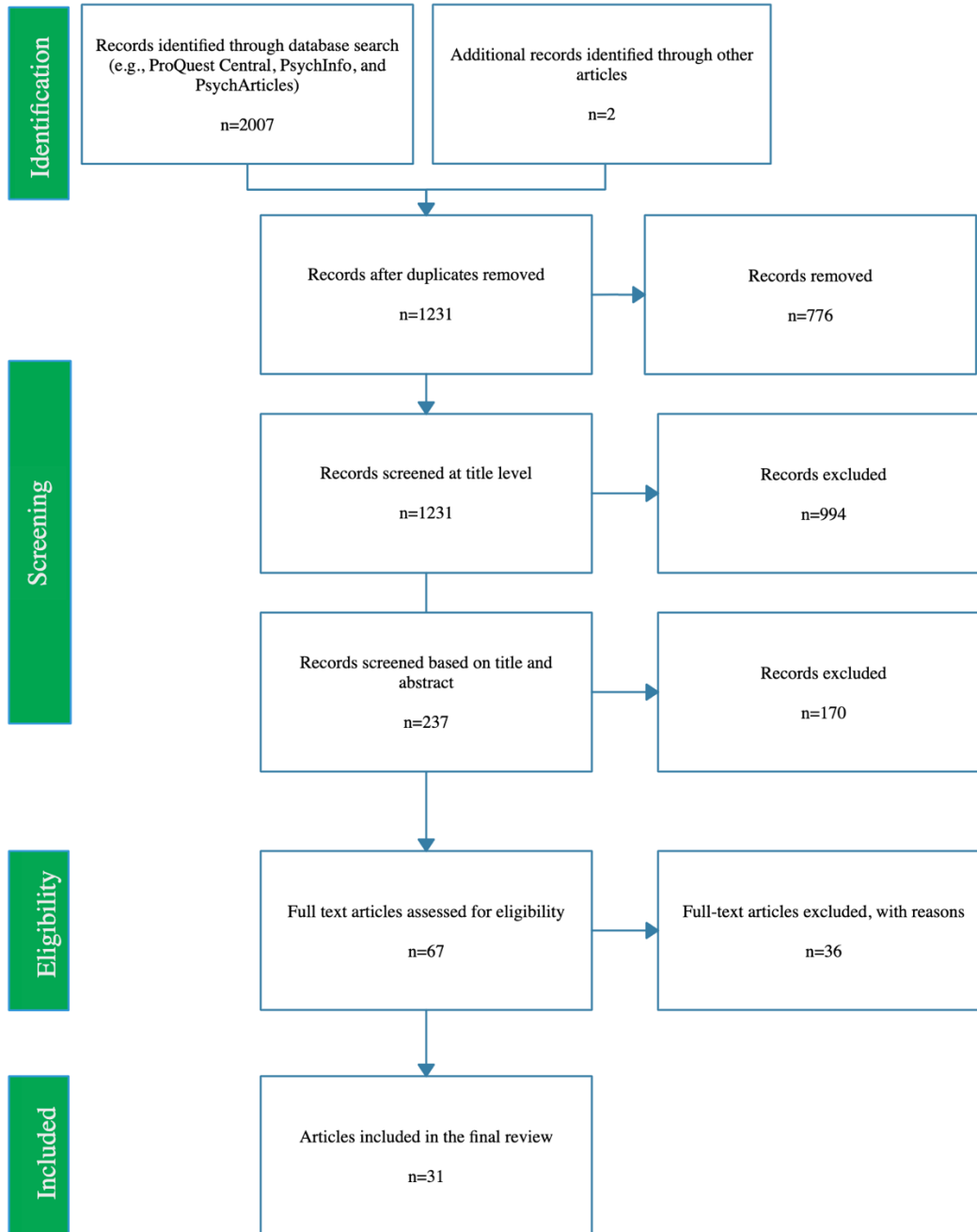
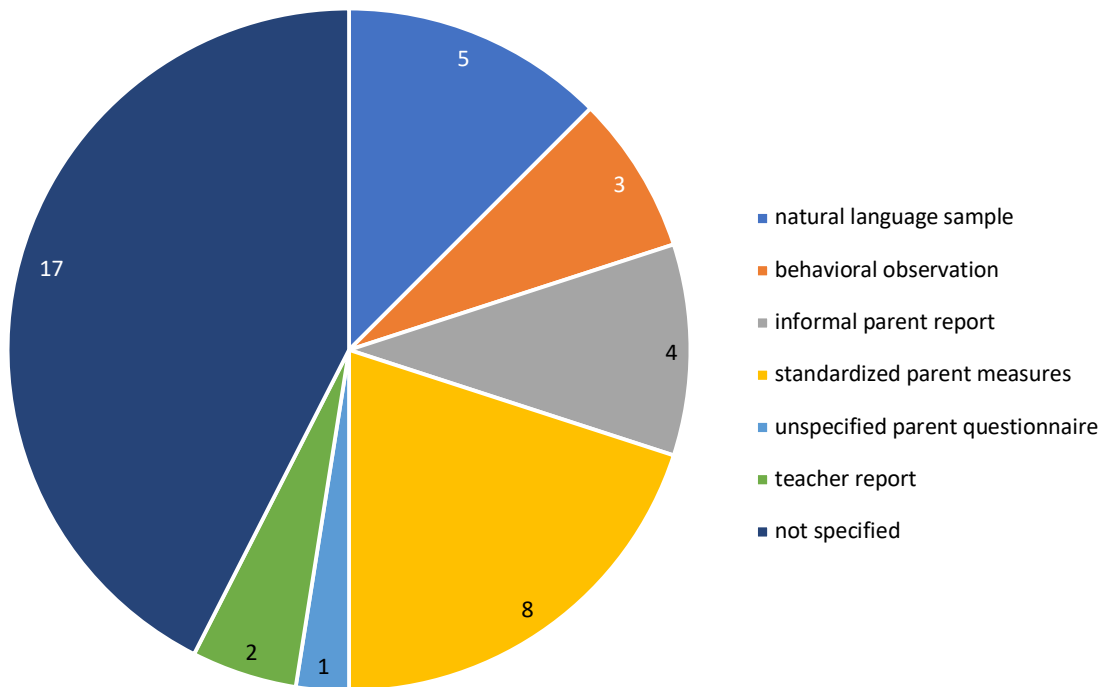


Figure 2

Types of assessment measure(s) used to determine whether participants were verbal or nonverbal.



Note. Numbers represent the number of studies that utilized each assessment measure. The total exceeds the number of studies included in the review, as some studies cited multiple measures.

Figure 2

Percentage of studies that included nonverbal and/or minimally verbal participants

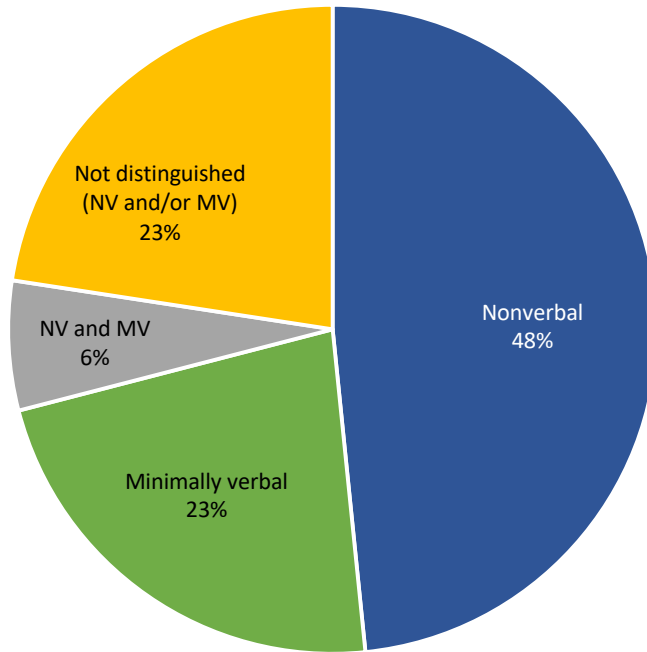


Table 1

Summary table of the 31 studies included in this systematic review

Authors, Year	Age of Participants in Years	Sample Size (n)	Participant (n_{Male}, n_{Female})	Nonverbal (NV) or Minimally Verbal (MV)	Assessment Measure (used to assess NV/MV)
Almirall, DiStefano, Chang et al., 2016	4;5-9;0	61	51,10	MV	Defined as fewer than 20 spontaneous novel words in a 20-min natural language sample
Charlop-Christy, Carpenter, Li, et al., 2002	3;8-12	3	3,0	NV & MV “did not speak or rarely spoke”; imitated sounds, phrases, or requested food items (one child used spontaneous word combinations and one said a single word)	Minnesota Child Developmental Inventory, PPVT, VABS (tests differed across participants), behavioral observations and probes
Chenausky, Norton, Tager-Flusberg, et al., 2016	3;5 – 9;8	30	20, 3	MV < 20 intelligible words; no productive syntax	Parent report and baseline assessments Kaufman Speech Praxis Test (KSPT) phoneme repetition test repeat ≥ 2 speech sounds
DiStefano, Shih, Kaiser, et al., 2016	5-8	55	Not reported	MV. Mean # of diff words 17.3 MLU 1.3	ADOS Leiter, PPVT, Natural language sample (20 mins)
Drash, High, Tudor, et al., 1999	2;6-3;6	3	3, 0	NV (no functional language)	Researchers evaluated participants’ initial levels of mands, echoics, and tacts

Esch, Esch, & Love, 2009	2;6 & 7;1	2	2, 0	NV	NV defined as “no functional speech” Kaufman Speech Praxis Test for Children (both failed)
Franco, Davis, & Davis, 2013	5;1-8;3	6	5, 0	NV	NV defined as “lack of functional communication (i.e., no consistent use of vocalizations, eye gaze, or gestures to communicate)”, verified via parent interview and REEL-3
Green, Charman, McConachie, et al., 2010	2;0-4;11	152	124, 28	Not specified	Not specified: - Participants had to be diagnosed with core autism - Children with a nonverbal age equivalent to 12 months or younger on the MELS were excluded
Gevarter & Horan, 2018	3;6-5;3	6	5, 1	MV	Could imitate 25 syllables and reduplicated syllables, Vineland Communication
Gordon, Pasco, McElduff, et al., 2011	4-10	84	73, 11	38 no words, 31 single words, 15 at least 1 phrase	ADOS. Expressive One Word Vocabulary Test; Mullen Verbal Level Nonverbal or Minimally Verbal
Harris, Wolchik, & Milch, 1982	2;3-4;6	9	10, 1	NV or MV (5 no words/4 some words)	Two half-hour videos
Hingtgen & Churchill, 1969	4;0-5;11	4	4, 0	NV “mute”	Mute and showed little or no language comprehension, but uttered noncommunicative sounds with varying frequency, no measures were provided
Jones, 2009	3;2 & 4;11	2	2, 0	Likely MV (not specified in the article)	Child 1: Preschool Language Scale 4 th edition (Expressive Language SS = 58, receptive =57); VABS (communication SS = 64) Child 2: Preschool Evaluation Scale: low average range (3 rd percentile) with his expressive language and social emotional subscale scores falling in the below average range (standard scores of 1 and 2, respectively).
Kasari, Kaiser, Goods, et al., 2014	5-8	61(30/31 in each group)	Not reported	MV < 20 spontaneous words during language sample with trained clinicians	20 min natural language sample, receptive language of 24 mos, proficient use of an SGD, average of 17 different words at baseline (5 children had 26-51 words)

					Adult was responsive to child but did not prompt the child to talk
Koegel, O'Dell, & Koegel, 1987	4;5-5;8	2	Not reported	NV	Intake description, VABS Verbal Level: No words. VABS Social: 1;6 and 2;8
Koegel, Shiratova, & Koegel, 2009	3;0-4;8	3	3, 0	NV	CDI no functional words and no object-label correspondence
Koegel, Vernon, & Koegel, 2009	3;2-3;5	3	3, 0	MV	2 children had < 10 functional words, 1 had ~ 75 words Vineland age equivalency scores were used to describe participants but not used to determine eligibility
Laski, Charlop, Schreibman, et al., 1988	5-9;7	8 (4 nonverbal, 4 echolalic)	7, 1	NV and MV	3 of 4 NV children could imitate sounds and a few words but no spontaneous words. 1 child was NV with no receptive vocab. 4 echolalic children could use phrases
Miller & Miller, 1973	5-23	19	12, 7	NV "most severely disturbed and unresponsive"	"Creak" score assigned to each child after observation and consultation with appropriate teachers, Little to no ability to understand spoken words
Ozonoff & Cathcart, 1998	2;7-5;9	22	18, 4	MV (Did not specify in article, pretest Mean Verbal age was 14.9 months in the treatment group and 19.1 in the control group)	Cognitive verbal age level on the Psychoeducational Profile-Revised
Oxman, Konstantareas, & Liebovitz-Bojm, 1979	9;1-9;5	10	5, 5	NV	Not specified: "minimal or no speech skills"
Rogers, Hayden, Hepburn, et al., 2006	1;8-5;5	10	10, 0	NV (<5 functional words/day)	Parent report and clinician observation of <5 spontaneous functional words/day

Sandiford, 2013	5;0-7;6	12	5, 7	NV	Defined as “having an expressive vocabulary of no more than 10 words which were not used on a daily basis and having no functional speech.” Assessment not specified
Scanlan, Leberfeld, & Freibrin, 1963	5;2-9;6	8	7, 1	NV and MV	Defined as “completely nonverbal or if they did not use words for purposes of communication”. Assessed by an initial language/communication examination including naming of objects or pictures, pantomiming the use of an object or picture, answering questions, etc.
Schriebman & Stahmer, 2014	1;8-3.9	39 (34/5)	20, 45	NV and MV	20 had no words; 18 had 1-10 words. CDI; VABS; Mullen Scales of Early Learning; ADOS, EOWPVT; and a 25-min parent-child interaction
Shire, Shih, & Kasari, 2018 *Partial data from 1 site of a multi-site study	5-8 Mean=6.74	22	22, 0	MV<20 words	10 min family Naturalistic Language Sample Receptive language of 2.38 and expressive of 1.83 on TELD Developmental age of at least 24 months
Strasberger & Ferreri, 2014	5;10-12;1	4	4, 0	NV (no functional speech)	Parent and teacher report, observation
Tardif, Latzko, Arciszewski, et al., 2017	5;6 & 16	2	2, 0	Not specified: Ss had verbal delay	Participant 1 presented a moderately delayed verbal development with verbal stereotypes Participant 2: extremely poor level of verbal expression (he could pronounce some syllables and repeat some words approximately but never spontaneously)
Wan, Bazen, Baars, et al., 2011	5;9-8;9	6	5, 1	NV	EVT and Mullen
Wetherby, Guthrie, Woods et al., 2014	1;4-1;8	82	71, 11	NV and MV inferred but not specified	VABS; participants were matched on pre-treatment NV developmental level - from the 2 recruitment sites: FSU recruited children from primary care screening by using the Communication and Symbolic Behavior Scales

					(CSBS) while UM children were referred because of parental or professional concern
Yoder & Layton, 1988	mean 5;0-5;6	60	Not specified	MV	Expressive and receptive ages of less than 28 months on the Sequenced Inventory of Communication Development (SICD); -demonstrate pre-treatment expressive vocabulary of 25 words or less as assessed by a parent questionnaire

Table 2*Measures used in the studies reviewed and what each assesses*

Assessment Tool	Measures
<i>Standardized</i>	
Autism Diagnostic Interview (ADI)	parent interview that provides results in the categories of Language/Communication, Reciprocal Social Interactions, and Repetitive Behaviors/Interests (Green et al., 2010)
Autism Diagnostic Observation Schedule (ADOS)	communication, social interaction, and play for individuals suspected of having ASD who are at least 12 months old (Almirall et al., 2016; Green et al., 2010; Rogers et al., 2006; Wetherby et al., 2014)
Behavioral Intervention Rating Scale (BIRS)	teachers' perceptions of classroom intervention treatment effectiveness (Strasberger et al., 2014)
Communication and Symbolic Behavior Scales Developmental Profile (CSBS-DP)	communicative competence (use of eye gaze, gestures, sounds, words, understanding, and play) of children with a functional communication age between 6 and 24 months; included Caregiver Questionnaire and Behavior Sample (Green et al., 2010)
Early Social-Communication Scales (ESCS)	individual differences in nonverbal communication skills in children with mental ages between 8 and 30 months of age (Almirall et al., 2016)
Expressive One-Word Picture Vocabulary Test (EOWPVT)	verbal expression of individuals aged 2 years to 80+ (Schriebman & Stahmer, 2014)
Fisher-Logemann Test of Articulation Competence	analysis and categorization of articulation errors (Oxman et al., 1979)
Kaufman Speech Praxis Test for Children (KSPT)	child's imitative responses to the clinician, motor-speech proficiency (Esch et al., 2009)
Leiter international performance scale-revised (Leiter-R)	cognitive functions in children and adolescents ages 2-20 (Almirall et al., 2016)
MacArthur-Bates Communicative Development Inventories (MB-CDIs or CDI)	early language, including vocabulary comprehension, production, gestures, and grammar; parent report (Green et al., 2010; Koegel et al., 2009; Rogers et al., 2006; Schriebman & Stahmer, 2014)
Mullen Scales of Early Learning (MSEL)	gross motor, fine motor, visual reception (or non-verbal problem solving), receptive language, and expressive language in children from birth to 68 months (Rogers et al., 2006; Schriebman & Stahmer 2014; Wetherby et al., 2014)
Psychoeducational Profile-Revised (PEP-R)	skills and behaviors (learning strengths, uneven development, emerging abilities) of children with autism and communication disabilities who are between developmental ages of 6 months and 7 years (Ozonoff & Cathcart, 1998)

Social Communication Questionnaire (SCQ)	Screener for ASD for children over 4 years old with a mental age over 2 years (Rogers et al., 2006)
Vineland Adaptive Behavior Scales (VABS)	personal and social skills, receptive and expressive communication, and motor skills of individuals from birth through adulthood (Green et al., 2010; Rogers et al., 2006; Schriebman & Stahmer, 2014; Wetherby et al., 2014)
<i>Non-Standardized</i>	
Naturalistic language sample	Naturalistic communication, including spontaneous communicative utterances, spontaneous requests, imitation, behaviors, receptive & expressive communication, peer-to-peer interactions, articulation
Structured play assessment	Number of unique play actions (Almirall et al., 2016)
Phoneme imitation task	Ability to repeat phonemes (Esch et al., 2009)
Rating forms/surveys	Teachers' impressions of children's language abilities (Green et al., 2010), parent satisfaction (Schriebman & Stahmer, 2014)
Interview	Teachers' and caregivers' perceptions of children's language abilities (Green et al., 2010)

Table 3*Review of the most salient components of the definition guideline*

Area		Guideline
Identification		Participants should be identified as nonverbal or minimally verbal. For nonverbal children with ASD, credible procedures need to be reported. For minimally verbal children, a credible estimates of word counts should be reported.
Language Assessment	Sampling Context	Language assessment should include a natural interactive communication sample, optimally with a familiar communication partner.
	Measure	Measures could include elicited production of phonemes, syllables, words, and short phrases. For minimally verbal children with ASD, standardized receptive and expressive vocabulary tests could be included.
	Reporter	Reporting early word use by parents and professionals not trained in word and language development may not provide an indication of consistent word use. These measures should be combined with other standardized and observational measures.
Cognitive Assessment		A cognitive measure of verbal and/or nonverbal reasoning should be included because this information is crucial for understanding intervention effects in nonverbal and minimally verbal children with ASD.

Note: This table is from Koegel and colleagues (2020a).